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BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Order Instituting Investigation Into the November 2016 Submission of San Diego Gas & Electric Company's Risk Assessment and Mitigation Phase.	Investigation 16-10-015 (Filed October 27, 2016)
Order Instituting Investigation Into the November 2016 Submission of Southern California Gas Company's Risk Assessment and Mitigation Phase.	Investigation 16-10-016 (Filed October 27, 2016)

RISK ASSESSMENT AND MITIGATION PHASE REPORT OF SAN DIEGO GAS & ELECTRIC COMPANY AND SOUTHERN CALIFORNIA GAS COMPANY

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November 30, 2016

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I. INTRODUCTION

In compliance with California Public Utilities Commission (Commission or CPUC) Decisions (D.) 14-12-025 and D.16-08-018 and the Commission's Rules of Practice and Procedure, San Diego Gas & Electric Company (SDG&E) and Southern California Gas Company (SoCalGas) submit their Risk Assessment Mitigation Phase (RAMP) Report (Report). The purpose of this Report is to present an assessment of the key safety risks of SDG&E and SoCalGas and the proposed activities for mitigating those risks. This Report will also show how the risk assessment approach presented in the Safety Model Assessment Proceeding (S-MAP), Application (A.) 15-05-002, is integrated in the RAMP and General Rate Case (GRC) processes. The basis for this Report and its content is described in detail below.

II. BACKGROUND AND PROCEDURAL HISTORY

In D.14-12-025, the Commission adopted a risk-based decision-making framework into the Rate Case Plan (RCP) for the energy utilities' GRCs. This risk-based decision-making framework was developed as a result of Senate Bill (SB) 705 (Statutes of 2011, Chapter 522), which declared in Public Utilities Code Section 963(b)(3):

> It is the policy of the state that the commission and each gas corporation place safety of the public and gas corporation employees as the top priority. The commission shall take all reasonable and appropriate actions necessary to

> carry out the safety priority policy of this paragraph consistent with the principle of just and reasonable cost-based rates.

In 2014, the California Legislature amended the Public Utilities Code by adding Section 750 which directed the Commission to "develop formal procedures to consider safety in a rate case application by an electrical corporation or gas corporation." [1] As a result of these directives, D.14-12-025 adopted a risk-based decision-making framework for the large energy utilities, including SDG&E and SoCalGas. This framework consists of the following:

> For the large energy utilities, this will take place through two new procedures, which feed into the GRC applications in which the utilities request funding for such safety-related activities. These two procedures are:
>
> > (1) filing of a Safety Model Assessment Proceeding (S-MAP) by each of the large energy utilities, which are to be consolidated; and
> >
> > (2) a subsequent Risk Assessment Mitigation Phase (RAMP) filing in an Order Instituting Investigation for the upcoming GRC wherein the large energy utility files its RAMP in the S-MAP reporting format describing how it plans to assess its risks, and to mitigate and minimize such risks. The RAMP submission, as clarified or modified in the RAMP proceeding, will then be incorporated into the large energy utility's GRC filing.[2]

D.16-08-018 adjudicated the consolidated S-MAP applications and the format of the RAMP submissions, specifically directing SDG&E and SoCalGas (the first in line for RAMP filings) to submit "based on …current risk evaluation and risk based decision making methodologies, and additional requirements as listed in the ten major components that shall be included in the RAMP filings."[3] In addition, D.16-08-018 adopted guidelines for what the RAMP submissions should include, as well as an evaluation method to evaluate the RAMP submissions.

D.14-12-025 requires "each of the four large energy utilities to send a letter to the Commission's Executive Director … requesting that an Order Instituting Investigation (OII) be

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[1] SB 900 (Statutes of 2014, Chapter 552).
[2] D.14-12-025 at 2-3.
[3] D.16-08-018, at 196, Ordering Paragraph 9 ("Because the Sempra utilities (San Diego Gas & Electric Company (SDG&E) and Southern California Gas Company (SoCalGas)) have limited time to file a Risk Assessment Mitigation Phase (RAMP), SDG&E and SoCalGas shall file a RAMP based on its current risk evaluation and risk-based decision making methodologies, and additional requirements as listed in the ten major components that shall be included in the RAMP filings.").

opened," by September 1 of the year preceding the utility's scheduled GRC application filing.[4] Pursuant to these instructions, SDG&E and SoCalGas sent such letters on September 1, 2016, and the Commission accordingly opened I.16-10-015 and I.16-10-016 on October 27, 2016, in order to initiate OIIs in connection with SDG&E's and SoCalGas' upcoming Test Year 2019 GRC applications. D.14-12-025 instructs that these OIIs "will provide a proceeding in which the RAMP submission can be made."[5] On November 17, 2016, Administrative Law Judge (ALJ) Lirag issued a ruling consolidating I.16-10-015 and I.16-10-016. SDG&E and SoCalGas have accordingly consolidated both utilities' RAMP submissions into this one Report, and have filed their submissions in their consolidated OII proceedings in accordance with D.14-12-025 and I.16-10-015/-016 (cons.). This Report uses the risk assessment methods and RAMP guidelines as directed in D.16-08-018. As described in D.14-12-025 and D.16-08-018, the utilities are filing their Report in this consolidated OII on November 30, 2016.

The content of this Report is also governed by the requirements of D.14-12-025 and D.16-08-018. D.14-12-025 describes the purpose of the RAMP filing as follows:

> The purpose of the RAMP filing will be to review the utility's RAMP submission for consistency and compliance with its prior S-MAP, and to determine whether the elements contained in the RAMP submission can be used in the utility's GRC filing to support its position on the assessment of its safety risks, and how it plans to manage, mitigate, and minimize those risks in the context of the utility's upcoming GRC application filing. The utility's RAMP submission shall contain the information that the Refined Straw Proposal has described, as summarized above.[6]

D.16-08-018 summarizes the required information described in D.14-12-025 as follows:

- The utility's prioritization of the risks it believes it is facing and a description of the methodology used to determine these risks.
- A description of the controls currently in place as well as the "baseline" costs associated with the current controls.
- The utility's prioritization of risk mitigation alternatives, in light of estimated mitigation costs in relation to risk mitigation benefits (Risk Mitigated to Cost Ratio).

[4] D.14-12-025 at 37-38.
[5] D.14-12-025 at 38.
[6] *Id*.

- The utility's risk mitigation plan, including an explanation of how the plan takes into account: utility financial constraints; execution feasibility; affordability impacts; and any other constraints identified by the utility.
- For comparison purposes, at least two other alternative mitigation plans the utility considered and an explanation of why the utility views these plans as inferior to the proposed plan.[7]

D.16-08-018 adopted additional detail and further requirements for the RAMP, including:

- Identify lessons learned in the current round to apply in future rounds.
- Move toward probabilistic modeling as much as possible.
- For those business areas with less data, improve the collection of data and provide a timeframe for improvement.
- Describe the company's safety culture, executive engagement, and compensation policies.
- Respond to immediate or short-term crises outside of the RAMP and GRC process.[8]

In accordance with D.14-12-025 and D.16-08-018, the utilities will host a public workshop after filing this Report. The Commission's Safety and Enforcement Division (SED) will then evaluate the Report in this consolidated OII for consistency and compliance with the utilities' S-MAP and prepare a report. D.16-08-018 notes that "[t]he objective of this staff report is to evaluate the utility's risk assessment procedures, and to assess the technical merits of the utility's proposal."[9] The parties to this proceeding will then have an opportunity to comment on the utilities' RAMP submission and on SED's report. The RAMP filing and comment process will then form the basis of the utilities' assessment of safety risks in their GRC filing.

III. PROPOSED SCHEDULE

A prehearing conference is scheduled for December 15, 2016.[10] On or before December 15, 2016, SDG&E, SoCalGas and SED will hold a public workshop on SDG&E's and

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[7] D.16-08-018 at 135-36.
[8] *Id*. at 151-152.
[9] *Id*. at 136-37, quoting D.14-12-025 at 38.
[10] *Administrative Law Judge's Ruling Consolidating Proceedings and Setting Prehearing Conference Schedule*, filed November 17, 2016.

SoCalGas' RAMP submission. By February 28, 2017, SED will file and serve a staff report on SDG&E's and SoCalGas' RAMP submission. Later events are identified in the OII as follows:

- By March 15, 2017, SED will hold a public workshop on SED's staff report;
- By April 10, 2017, other parties may file and serve comments on SDG&E and SoCalGas' RAMP submission, and on SED's staff report;
- Between April and May of 2017, additional workshops may be held on RAMP-related items if needed;
- Between May and August 2017, SDG&E and SoCalGas incorporate RAMP results into its Test Year 2019 GRC filing;
- By September 1, 2017, SDG&E and SoCalGas file Test Year 2019 GRC applications[11] and serve prepared testimony including changes resulting from the RAMP process.

Preparations for SDG&E's and SoCalGas' Test Year 2019 GRC application began in January 2016 and are well underway as of the time of this filing. A great deal of coordinated effort is necessary to prepare the utilities' GRC applications, which typically require over a year and a half to complete. As can readily be seen by the anticipated schedule, there is very little room for slippage of the output of the RAMP phase, which could endanger the utilities' ability to incorporate the RAMP results into their GRC application. SDG&E and SoCalGas urge the Commission to expedite the RAMP process as much as possible and to strive to avoid any delay in the anticipated schedule.

IV. SUMMARY OF RISKS AND ROADMAP

In accordance with the requirements of D.14-12-025 and D.16-08-018, as discussed above, the utilities' risks are summarized in the charts below, according to categories of risk. Each risk constitutes a separate chapter in the Report.

[11] In addition, by October 31, 2017, a PHC is to be held in SDG&E and SoCalGas' Test Year 2019 GRC application, and a discussion or comments on whether this OII should be consolidated with the GRC proceeding will take place at that time or shortly thereafter. As described in D.14-12-025, no decision will be issued in the OII, although the Commission indicated that a decision closing out the OII will be issued as part of a decision issued in the consolidated proceedings of this OII and the utilities' Test Year 2019 GRC proceeding.

Summary of Risks Addressed in SoCalGas and SDG&E's RAMP Report

	Gas	Electric	Cross-Cutting
SDG&E	Catastrophic Damage Involving Third Party Dig-Ins	Wildfires Caused by SDG&E Equipment (Including 3rd Party Pole Attachments)	Employee, Contractor & Public Safety
		Distributed Energy Resources (DERs) Safety and Operational Concerns	
		Major Disturbance to Electrical Service (e.g. Blackout)	Cyber Security
	Catastrophic Damage Involving High-Pressure Pipeline Failure	Fail to Black Start	Workplace Violence
		Aviation Incident	Records Management
		Unmanned Aircraft System (UAS) Incident	Workforce Planning
	Catastrophic Damage Involving Medium-Pressure Pipeline Failure	Electric Infrastructure Integrity	Climate Change Adaptation
		Public Safety Events – Electric	
SoCalGas	Catastrophic Damage involving Third Party Dig-Ins		Employee, Contractor & Public Safety
	Catastrophic Damage Involving High-Pressure Pipeline Failure		Cyber Security
	Catastrophic Damage Involving Medium-Pressure Pipeline Failure		Workplace Violence
	Catastrophic Event Related to Storage Well Integrity		Records Management
	Physical Security of Critical Infrastructure		Workforce Planning
			Climate Change Adaptation

An overview of the RAMP report and discussion of additional RAMP requirements noted in D.14-12-025 and D.16-08-018 can be found in the chapters below:

Chapter	**Subject**
RAMP-A	Overview and Approach
RAMP-B	Risk Management Framework
RAMP-C	Safety Culture
RAMP-D	Quantitative Risk Analysis/Probabilistic Modeling
RAMP-E	Data Collection
RAMP-F	Lessons Learned

Each risk chapter is then found in the Report in the following order:

Chapter	**Risk**
SCG-1	Catastrophic Damage involving Third Party Dig-Ins
SCG-2	Employee, Contractor, Customer and Public Safety
SCG-3	Cyber Security
SCG-4	Catastrophic Damage involving High-Pressure Pipeline Failure
SCG-5	Workplace Violence
SCG-6	Physical Security of Critical Gas Infrastructure
SCG-7	Workforce Planning
SCG-8	Records Management
SCG-9	Climate Change Adaptation
SCG-10	Catastrophic Damage involving Medium-Pressure Pipeline Failure
SCG-11	Catastrophic Event related to Storage Well Integrity

Chapter	**Risk**
SDG&E-1	Wildfires Caused by SDG&E Equipment
SDG&E-2	Catastrophic Damage involving Third Party Dig-Ins
SDG&E-3	Employee, Contractor and Public Safety
SDG&E-4	Distributed Energy Resources (DERs)
SDG&E-5	Major Disturbance to Electrical Service (Blackout)
SDG&E-6	Fail to Black Start
SDG&E-7	Cyber Security
SDG&E-8	Aviation Incident

SDG&E-9	Workplace Violence
SDG&E-10	Catastrophic Damage involving High-Pressure Gas Pipeline Failure
SDG&E-11	Unmanned Aircraft System (UAS) Incident
SDG&E-12	Electric Infrastructure Integrity
SDG&E-13	Records Management
SDG&E-14	Climate Change Adaptation
SDG&E-15	Public Safety Event - Electric
SDG&E-16	Catastrophic Damage Involving Medium Pressure Pipeline Failure
SDG&E-17	Workforce Planning

V. CONCLUSION

SDG&E and SoCalGas hereby submit their RAMP report and request an expedited schedule for its consideration in this proceeding, as set forth above, so that the utilities' Test Year 2019 GRC proceedings may be filed in September 2017 without delay.

Dated in San Diego, California, this 30th day of November, 2016.

Respectfully submitted,

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Risk Assessment Mitigation Phase
Risk Mitigation Plan
Overview and Approach
(RAMP – A)

November 30, 2016

#310404

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Overview and Approach

1 Overview

The California Public Utilities Commission's (Commission) new Risk Assessment Mitigation Phase (RAMP) requires SoCalGas and SDG&E to identify and quantify risks and risk mitigation in a different manner from the past. SoCalGas and SDG&E have always routinely assessed and mitigated risk to the public, employees and their infrastructure as part of their everyday business and take seriously their obligation to provide safe and reliable service. The utilities will continue to do so within the new RAMP framework, which will keep the Commission and the public informed as to how risk assessment and mitigation activities are indeed occurring within the utilities. This first formal RAMP filing identifies SoCalGas and SDG&E's baseline assessment of safety risks to the public, their employees and their systems, and what potential mitigation measures have been considered. Based on those potential mitigation measures, the utilities then propose certain mitigation measures to further reduce identified risks. The costs of reducing identified risks are then quantified in the "Risk Spend Efficiency" or the "RSE."

The Commission has ordered that RAMP be focused on safety-related risks and mitigating those risks. As a starting point, SoCalGas and SDG&E used the risk assessment that was conducted in 2015. That risk assessment across both utilities became the individual risk registry for each company. This RAMP filing is a product of SoCalGas and SDG&E's September 2015 annual risk registry assessment. As such, any events that occurred after September 2015 do not impact the risk registry or the 2015 risk assessment that was completed in September 2015. As with any useful risk assessment, the subsequent risk registry is not static and changes annually. Risks that were separate may be combined, new risks may appear and the level of the risk may change over time.

In each risk chapter contained in the RAMP filing, SoCalGas and SDG&E have quantified and/or identified several baseline mitigation activities that have already been taken by the utilities. The baseline mitigation activities, sometimes referred to as controls, reduce the risk to the level identified in the filing, which is why each risk in the RAMP filing is a residual risk after taking into account the 2015 baseline mitigation activities. The RAMP filing includes a reasonable worst case scenario for each risk to provide context for the risk score and the proposed mitigation measures to address that risk. The reasonable worst case scenario is not intended to include all potential scenarios. The 2015 baseline mitigation activities have been cumulative over time and continue to change as new risks appear to the safety of the system, such as cybersecurity risks. As new technology is available to mitigate risks, SoCalGas and SDG&E have proposed to use technology such as enterprise asset management to enhance communication between different systems that contain records. In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety, and the utilities take compliance activities very seriously.

This first-ever RAMP filing presents cost data in the best manner currently available, which is expected to evolve and mature over time. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of the utility to benchmark both capital and operations and maintenance (O&M) costs during that year. For all risks, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time, but do not take into account activities and costs to comply with new laws passed since September 2015. Some proposed mitigations, however, do take into account those new laws. The utilities' level of cost-tracking precision continues to develop and is expected to mature through experience over the next several General Rate Case (GRC) cycles.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. RAMP mitigation forecasts are provided only to estimate a range that will be refined with supporting testimony in the GRC. SoCalGas and SDG&E have made efforts to identify where overlapping costs for mitigation measures could mitigate more than one risk. This RAMP filing identifies costs associated with SoCalGas' and SDG&E's largest risks as of September 2015 but will not define the utilities' GRC requests, where the utilities will seek to mitigate other risks in addition to those identified in the RAMP filing.

SoCalGas and SDG&E look forward to working with the Commission on this RAMP filing.

2 Approach

As the first two utilities to file a RAMP in accordance with Decision 14-12-025 (Decision), SoCalGas and SDG&E developed an approach to meet the Commission's requirements as set out in the Decision. Representatives from SoCalGas and SDG&E have met with Commission staff and other California utilities to share the approach.

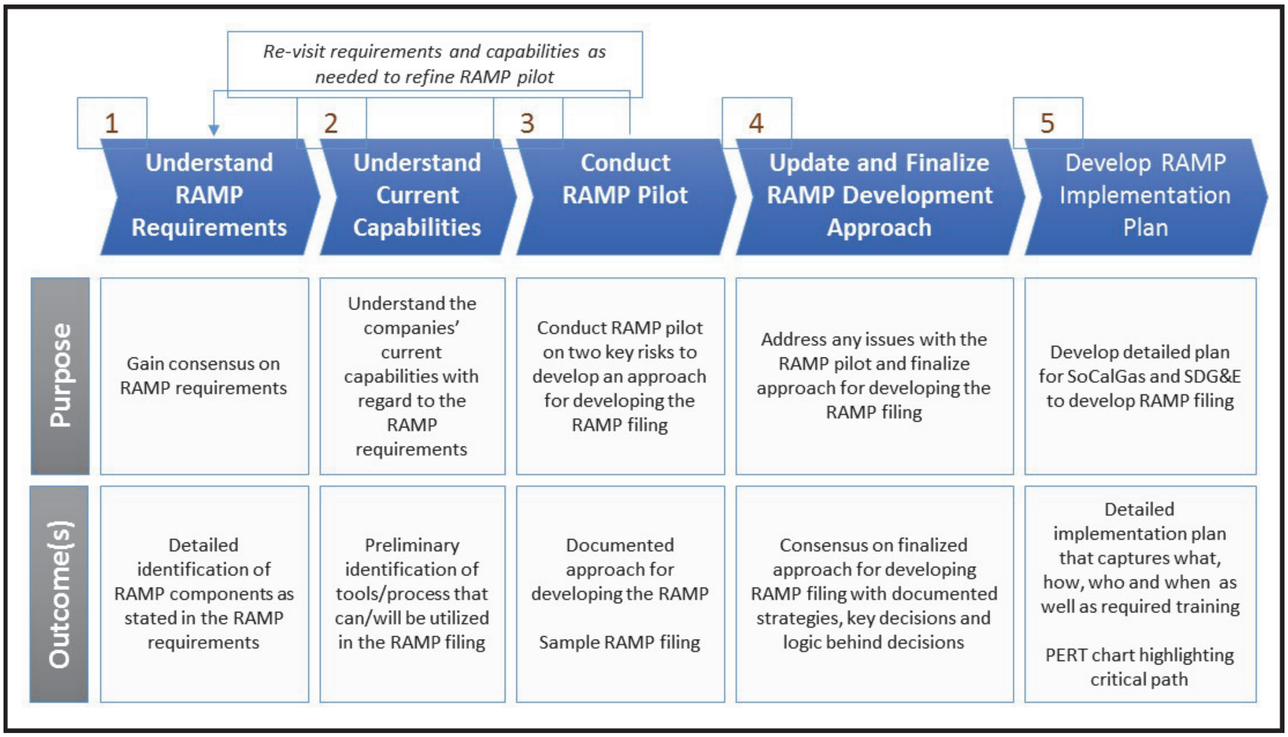
The approach adopted by SoCalGas and SDG&E and reviewed with Commission staff integrates the following:

- SoCalGas and SDG&E are not requesting dollar approval as part of the RAMP filing.
- In order to provide a comprehensive view of the risks addressed within the RAMP filing certain non-CPUC jurisdictional risks and associated costs (e.g. Federal Energy Regulatory Commission or FERC) have been included in the filing, but these will not carry over to the GRC filing.
- The analysis and the resulting order of priority of mitigations were performed at the individual risk level, not across all risks.
- The RAMP filing includes mandated compliance controls and mitigations, as well as ones identified by the Utilities.
- Ongoing spending on controls is needed to maintain the current levels of residual risks.

The Decision recognizes that there may be changes in RAMP filings as the process matures.[1] SoCalGas and SDG&E began the development of their approach in July 2015. Initially, SoCalGas and SDG&E pilot-tested how to meet the Commission's RAMP filing requirements. From the pilots, SoCalGas and SDG&E developed a process to complete the RAMP filing for 28 risks.

The diagram below summarizes the pilots:

Diagram 1, Summary of Pilot Process



Through the pilots, SoCalGas and SDG&E identified a six-step process for completing the RAMP filing. The six steps are summarized below:

1. Agree on the risks to be included in the RAMP filing.
2. Identify the controls and mitigations for each risk.
3. Develop, using SoCalGas and SDG&E data, third-party data and/or subject matter expertise, the estimated range of risk reduction derived from implementing each control and mitigation.
4. Review spending in historical years with a base year of 2015 (baseline) capital expenditures and O&M expenses and then estimating, using ranges, the anticipated capital forecasts (2017-2019) and estimated operations and

[1] Decision 16-08-018 pg. 132

maintenance forecasts for 2019 (forecast) for each control and mitigation. 2019 is the next Test Year for SoCalGas and SDG&E's next GRC.

5. Calculate the risk spend efficiency.
6. Create the risk mitigation plan describing the risk, associated controls and mitigations, baseline and forecast costs, risk reduction anticipated from proposed controls and mitigations, and risk spend efficiency.

In order to internally introduce the RAMP process within SDG&E and SoCalGas, training sessions were held with all of the participants (e.g., financial planners, risk managers subject matter experts, directors and leadership.) SoCalGas and SDG&E Enterprise Risk Management (ERM) and Regulatory Departments established a multi-level project organization structure that included an Executive Officer Committee, a senior team oversight committee made up of ERM, Regulatory and Legal Leaders, Project Management, Risk Managers, and Project team members to address the specific risks. Project dashboards were implemented to identify challenges and to monitor the status of each element of the RAMP approach.

Each of these steps required multiple planning sessions at the director and officer level, where opportunities were provided to discuss the assumptions, the costs and risk reduction benefits, and the material used to support the risk spend efficiency calculations. The steps are described in greater detail below.

Throughout the process, SoCalGas and SDG&E have used ranges to estimate costs, risk reduction and risk spend efficiency. Given the newness of RAMP and its associated requirements, exact precision in the numbers and figures cannot and should not be assumed.

3 Risks to Be Incorporated into the RAMP Filing

SoCalGas and SDG&E's risk framework uses a 7X7 matrix where the Safety, Health and Environment category is weighted at 40% as compared to 20% for each of the other three risk categories. For each of the categories, the utilities assigned a score ranging from one (1) ("Insignificant") to a seven (7)[2] ("Catastrophic"). Since, in general, the primary focus of the Commission and, in particular, the RAMP is understanding and mitigating safety risks, SoCalGas and SDG&E selected for inclusion in the RAMP all risks that received a score of four (4) or more in the Safety, Health and Environment category. The risks that qualified for inclusion in the RAMP are referred to as "RAMP Risks." SoCalGas and SDG&E have a total of 28 RAMP Risks; eight for gas, eight for electric and 12 cross-cutting risks.

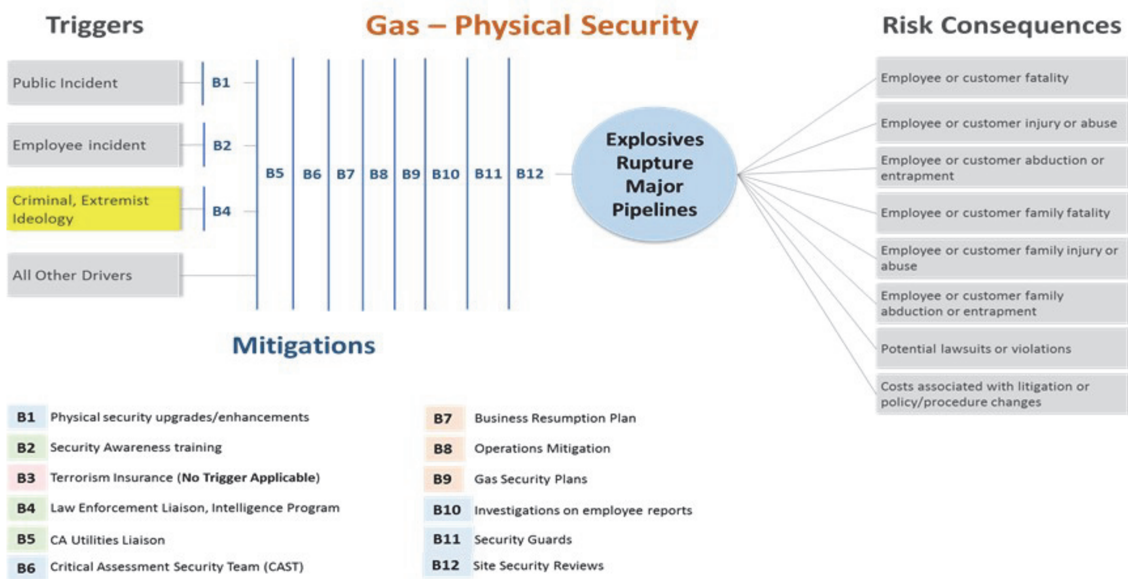
4 Controls and Mitigations for Each Risk

For each risk, the ERM team met with Risk Managers and leadership from each functional area (referred to as "subject matter experts" or "SMEs") to identify the existing controls and proposed mitigations for each of the 28 risks. In some cases, a risk may have a large number of controls or

[2] These are nonparametric labels and not intended to imply a ratio relationship.

mitigations (e.g., Physical Security of Critical Gas Infrastructure). As illustrated in Figure 1 these subject matter experts identified 12 existing controls (Baseline – B 1-12) for the triggers.

Figure 1: Example of Risk Triggers, Controls and Mitigations

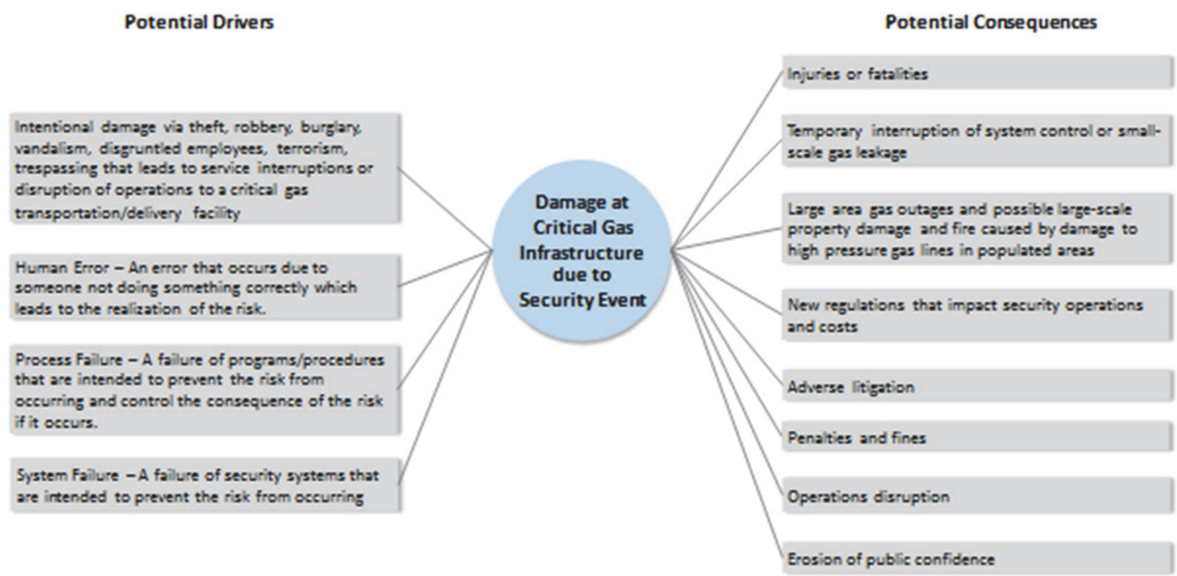


For each RAMP Risk, the proposed controls and mitigations were often further organized into logical mitigation groupings to support further analysis. The Company "grouped" the proposed mitigations: (1) By proposed mitigations in the Proposed Risk Mitigation Plan; (2) By similarities in potential triggers (or drivers), consequences, assets, or dependencies (e.g., software and training on software); or (3) As one portfolio (i.e., to cover a range of activities associated with the risk). This grouping created approximately 80 controls and mitigations across all 28 risks.

The ERM team used a Risk Bow-tie, shown in Figure 2 to group the controls and mitigations.[3] The utilities apply this approach to the Physical Security of Critical Gas Infrastructure (Physical Security) Risk as an example. The Physical Security Risk has four controls (Bs) and two mitigations (Proposed or Ps). The Physical Security Risk Bow-tie appears is provided below.

[3] As explained in the RAMP Risk chapters, the Risk Bow Tie is a commonly-used tool for risk analysis. Typically, the right side will illustrate the drivers that lead to a risk event for a particular risk and the right side will show the potential consequences of a risk event. The utilities applied this framework for the RAMP analysis.

Figure 2: Example of Risk Bow Tie Analysis



5 Baseline 2015 and Forecast 2017-2019 Capital and 2019 O&M Ranges

SoCalGas and SDG&E's accounting systems are not configured to capture costs by the types of risk-management activities as anticipated by the RAMP process. Therefore, in order to determine expenditures, whether capital or O&M, SoCalGas' and SDG&E's financial planners and ERM team applied a variety of approaches to identify costs. Generally, the planners and ERM team used the following process:

1. Considered each control or mitigation effort in light of current or planned operations.
2. Selected a methodology to estimate the cost impact of adopting the mitigation strategy (expressed in terms of 2015 dollars), whether O&M expense programs or capital projects. That methodology would generally fall into three types:
   a. Selected a like-kind current activity, and then applied historical costs/expenses;
   b. Selected a similar proxy activity, and then applied historical costs and adjusted as required; or
   c. Developed a zero-based cost estimate for the mitigation activity.
3. Developed a range estimate considering the likelihood of variations in scope, schedule and resource availability.

4. Developed the costs in such a way to identify, where possible, the jurisdiction of those expenses whether CPUC, FERC (such as for electric transmission and grid control) or other.

In some cases, controls and mitigations may address more than one risk included in the RAMP. For these controls and mitigations, *all* costs and reduction benefits associated with a control or mitigation were presented in each applicable risk chapters (i.e., the costs and associated risk reductions were not allocated – e.g., pro rata or by percentage, etc. – among risks).

6 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in the RAMP submission to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[4] SDG&E and SoCalGas define Risk Spend Efficiency (RSE) as a ratio developed to quantify and compare the estimated effectiveness of a mitigation at reducing risk to other mitigations for the same risk, or "risk reduction per dollar spent," as D.16-08-018 requires.[5]

The calculation of the RSE includes the quantification of the amount of Risk Reduction attributable to a mitigation, and the identification of the anticipated costs to achieve the reduction. SoCalGas and SDG&E determined the RSE for each RAMP Risk, using the mitigation groupings and ranges of costs identified, as referenced above. The utilities then ranked the proposed mitigations for each RAMP Risk in accordance with the RSE results, as shown in the last chapter of each Risk Mitigation Plan.

6.1 Calculating Risk Reduction

The SoCalGas and SDG&E used the following approach to calculate the Risk Reduction for each mitigation for each RAMP risk. The quantification process was designed to accommodate the variety of mitigations and variation in accessibility to data pertinent to calculating risk reductions.

1. **Group mitigations for analysis.** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations.** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.

[4] D.16-08-018 Ordering Paragraph 8.

[5] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

3. **Identify a methodology to quantify the impact of each mitigation grouping.** The Company identified the most pertinent methodology to determine the potential risk reduction from a mitigation grouping by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (or change in the risk score).** Using a pertinent methodology, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[6] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the annual risk reduction attributable to each mitigation.

Following is an example of how the ERM and Risk Manager applied this approach to calculating the risk reduction for the SoCalGas Dig-Ins Risk.

1. The ERM and Risk Manager used the risk bow tie, to form mitigation groupings. Mitigations were grouped based on similarity of risk drivers, or inter-dependency. For example, Public Awareness and Dig-In Prevention activities, were grouped together because if public awareness activities were discontinued, there would be far fewer, if any, calls for locate and mark; conversely, if locate and mark activities were discontinued, public awareness alone would not be effective in reducing dig-ins.
2. Next, the team identified which of these mitigations were current controls or incremental mitigations. The four mitigation groupings that emerged were:
   - In-Field Activities and Public Awareness (current activities)
   - In-Field Activities and Improvements (incremental activities)
   - Incremental Public Awareness (incremental activities)
3. Analysis (incremental activities) Using Incremental In-Field Activities and Improvements to represent the risk reduction analysis conducted for each mitigation grouping: ERM and the risk manager determined that a combination of

[6] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

SoCalGas dig-in data and subject matter expertise was the most applicable method of determining the level of risk after implementing this mitigation. The Company data identified the number of dig-in damages, by cause category. The subject matter experts used this data to calculate the proportion of each cause category potentially impacted by this incremental mitigation and thus the number of potentially preventable dig-ins. Next they estimated the effectiveness of each component of this incremental mitigation at reducing dig-ins. Multiplying the effectiveness by the number of potentially preventable dig-ins resulted in a percentage of the total number of dig-ins that this mitigation could reduce. In this case, this mitigation was estimated to reduce dig-ins by 12%.

4. Finally, the subject matter experts calculated a risk score based on this 12% reduction. The residual risk score for the SoCalGas dig-in risk was 233,365 points. Reducing this score by 12% yielded a calculated score of 205,361 points. The difference between these two scores, 28,004 points, is the annual risk reduction attributable to this mitigation.

6.2 Calculating Risk Spend Efficiency

The ERM team developed estimates and ranges for the risk spend efficiency using the risk reduction amounts and the costs referenced above. Figure shows the formula used to calculate the RSE. The *Annual Risk Reduction* is the number developed through the process described above. It is multiplied by the number of years for which the benefits from the risk reduction are expected.

The *Total Mitigation Cost* is the forecasted 3-year capital expenditure plus the annual O&M expenses multiplied by the number of years for which benefits from the risk reduction are expected. There is both a low estimate and high estimate of forecast capital and O&M costs for each mitigation.

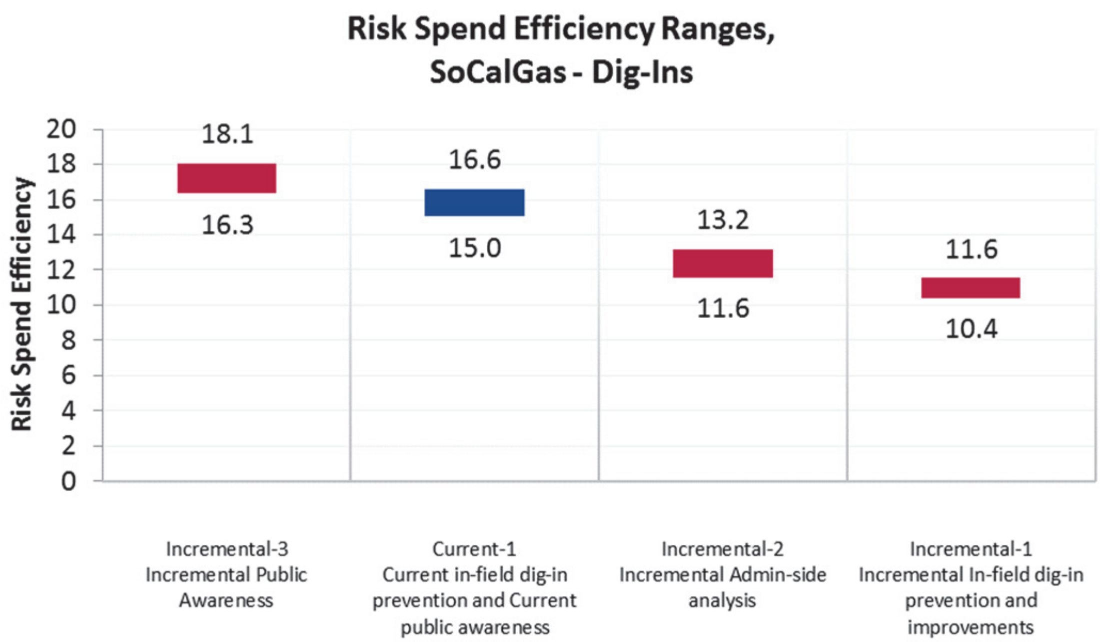
The result of this calculation is units of risk reduction per dollar. It is shown as a range, reflecting the low and high mitigation cost estimates. This number can be used to measure the relative efficiency of each mitigation to another.

Figure 3: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Annual\ Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

Again, using the SoCalGas Dig-Ins risk as an example, the ERM and Risk Managers used the risk reduction score for Incremental In-Field Activities and Improvements to calculate the risk reduction per dollar, or risk spend efficiency (RSE). For this mitigation, the expenditure is expected to yield 7 years of risk reduction, or a total of 196,028 points. These points were divided by the range of costs, in thousands, provided by SoCalGas, resulting in a RSE range of 10.4 – 11.6. This process was repeated to calculate the RSE for each of the SoCalGas Dig-Ins risk mitigations. Figure 4 below presents the results for each of the mitigations for the SoCalGas Dig-Ins risk.

Figure 4: RSEs for SoCalGas Dig-Ins Risk



7 Risk Mitigation Plan

There is a risk mitigation plan for each of the 28 risks in this Report. The plan incorporates all of the information and analysis described above, organized into the following sections:

1. Purpose – The definition of the risk
2. Background –Additional information to provide factual and where appropriate, legal context for the RAMP Risk
3. Risk Information – Description of the risk classification, potential risk drivers, and potential consequences, and how these components work into each respective Risk Bow Tie
4. Risk Score – Description of the reasonable worst case scenario (event) chosen to develop the risk score, an explanation of the assigned risk scores by impact area and frequency
5. Baseline Risk Pan – The controls and mitigations established as of 2015 to address the risk
6. Proposed Risk Plan – The controls and mitigations proposed to enhance or expand risk management activities

7. Summary of Mitigations – The baseline (2015) and forecast (in 2015 dollars) range of costs to implement the controls and mitigations
8. Risk Spend Efficiency – An explanation of the Annual Risk Reduction as applied to the specific risk, the calculation of the RSE, and the RSE results
9. Alternatives – The two alternatives considered as part of the risk evaluation

When reviewing each risk mitigation plan, the reader should take into consideration the following:

- This is the very first RAMP filing by any utility.
- The risk narratives are not meant to be comprehensive, but have been determined based on the risk as defined, available data, and other factors as discussed in the narrative.
- The RAMP is based on controls and mitigations in place in 2015, but safety activities cannot be fully captured by viewing one moment in time. As a practical matter, SoCalGas and SDG&E have always striven to improve safety protocols and processes and will continue to do so.
- The expenditure forecasts are provided in ranges, in 2015 dollars.
- The filing includes estimated ranges for costs, risk reduction benefit and risk spend efficiency, which may overlap with estimated cost ranges for other risks. The reader should not assume the same level of precision in the RAMP filing as there is with a GRC request.
- Each risk also had its own assumptions (e.g., what change would occur if baseline mitigation wasn't done), sources of data (industry benchmarks, subject matter expert estimates or some combination of both), and methodology of estimation, so cross-risk comparisons would be uncalibrated.

Risk Assessment Mitigation Phase

Risk Mitigation Plan

Lessons Learned
(RAMP – B)

November 30, 2016

#310403

SDGE — A Sempra Energy utility® | SoCalGas — A Sempra Energy utility®

Risk Management Framework

Consistent with the historic commitment of Southern California Gas Company (SoCalGas) and San Diego Gas & Electric Company (SDG&E) (collectively referred to as the utilities) of evaluating and mitigating risks to the public, employees, and infrastructure, the utilities implemented new risk management practices as described in the Safety Model Assessment Proceeding (S-MAP) proceeding, Application (A.) 15-05-002 and A.15-05-004. The utilities' risk management framework is consistent with the Cycla Corporation 10-step Evaluation Method adopted in Decision (D.) 16-08-018.[1] The utilities' consolidated Cycla's 10-steps into six distinct steps, each of which are described below:

1. Risk identification;
2. Risk analysis;
3. Risk evaluation and prioritization using a 7X7 matrix;
4. Mitigation plan development;
5. Risk-informed investment decisions and risk mitigation implementation; and
6. Monitoring and review.

Figure 1 Risk Management Process

[1] D.16-08-018 Ordering Paragraph 4.

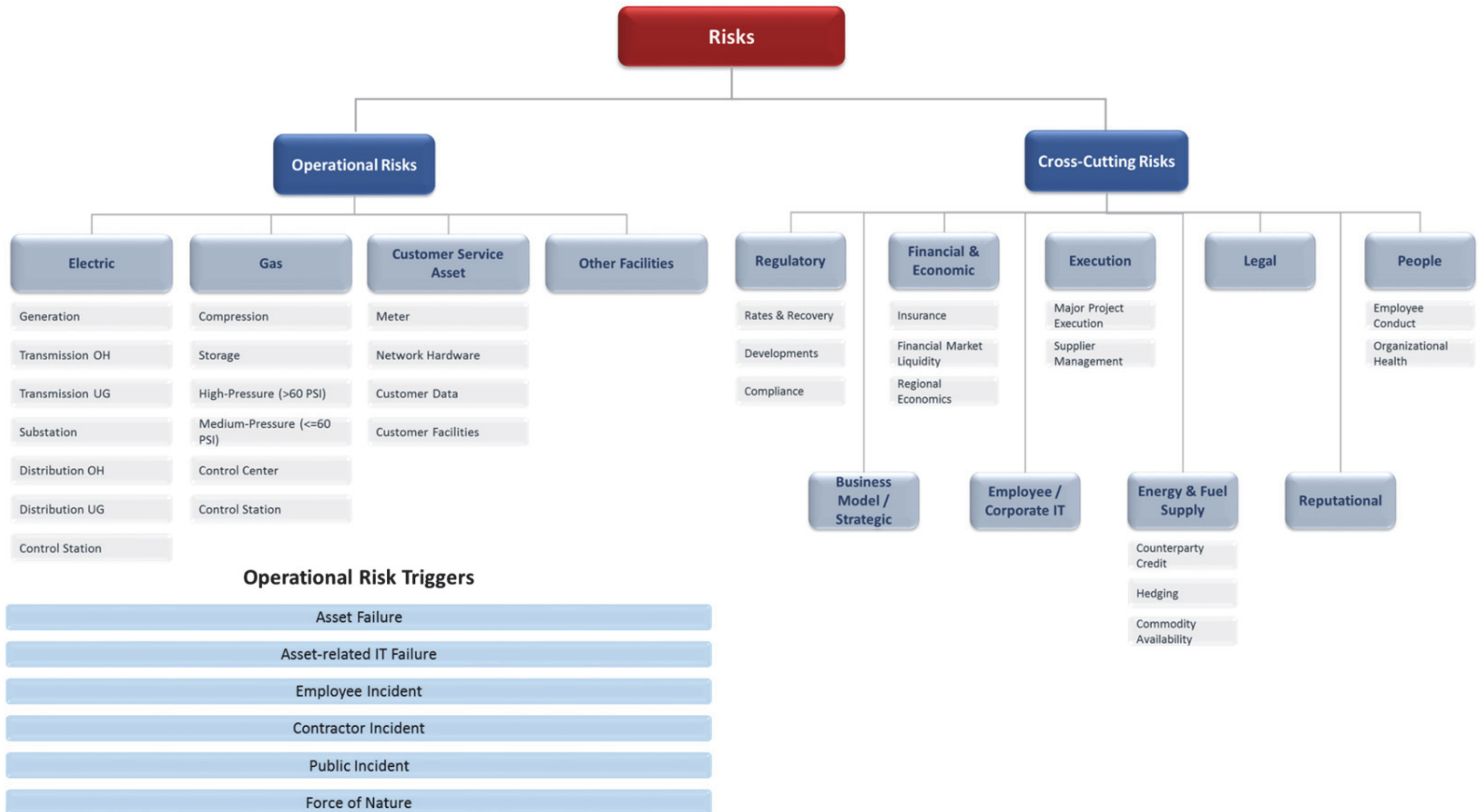
Risk Identification

Risk identification, as defined by ISO 31000, is the process of finding, recognizing and describing risks. It includes the identification of risk sources, events, their causes and potential consequences. On an annual basis, the Enterprise Risk Management (ERM) organization facilitates the enterprise risk identification process through interviews and meetings with risk owners and managers to review and discuss potential changes to the utilities' respective enterprise risk registry. The utilities are moving toward a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to help categorize and understand the spectrum of risks to which the companies are exposed using a common framework. The taxonomy helps ensure that the risk identification process covers the full range of risks to which the utilities are exposed, in a structured manner. As the companies' ERM function continues to evolve, the taxonomy will provide a shared language around risk and support a broader range of ERM activities, which include: risk ownership, mitigation planning, and risk measurement and monitoring (e.g., key risk indicators).

The taxonomy breaks into two main branches at the highest level: operational risks and cross-cutting risks. Operational risks are those events that can result in damage to or loss of company or public asset, environmental impact, personnel injury, and/or interruption of service to customers. These are defined as operational implications. The taxonomy further categorizes operational risks by commodity, asset-type and classifies risk triggers that tie to operational risks. Cross-cutting risks are called such because they cut across a range of assets, and are not linked to specific triggers associated with those assets.

The companies' early implementation of the taxonomy is laid out in this report and can be seen in each risk chapter where each risk was mapped to the appropriate categories of risk, assets and drivers in accordance with the taxonomy. Figure 1 below is a visual depiction of the taxonomy.

Figure 1 Risk Taxonomy



Risk Analysis

Risk analysis as defined by ISO 31000 is the process to comprehend the nature of risk and to determine the level of risk. It provides a basis for risk evaluation and decisions about risk mitigation. As stated in ISO 31000, risk analysis is undertaken with varying degrees of details depending on the risk and the availability of data and resources. The utilities utilize a combination of qualitative and quantitative analyses to analyze their risks. On an annual basis, the ERM organization facilitates a risk assessment session where risk owners discuss their risk analysis based on the information they have and the risk mitigations in place.

Risk Evaluation & Prioritization

Risk evaluation is the process of comparing the results of risk analysis against impact and likelihood dimensions. The utilities use the 7x7 Risk Evaluation Framework (REF) to evaluate the level of risks and differentiate risks from one another by gauging their frequency of occurrence against their potential impact. On an annual basis, the ERM organization facilitates the risk prioritization session where risk owners discuss the relative ranking of the utilities' enterprise risks with senior management and achieve consensus around risk priorities. In the REF, risk scores are calculated from two primary inputs: impact and frequency. The impact is the effect or outcome of an event. The frequency reflects the likelihood of the risk event occurring within a certain time. Both the impact and the frequency are evaluated on a scale of 1 – 7 as depicted in Figure 3 below.

	Impact						
	7	6	5	4	3	2	1
	Catastrophic	Severe	Extensive	Major	Moderate	Minor	Negligible
Health, Safety, & Environmental: Endanger workplace or public safety; impact to surrounding environment; Long-term: 10+ years Medium-term: 3-10 years Short-term: 1-3 years	Fatalities: Many fatalities and life threatening injuries to the public or employees. Immediate, severe, and irreversible impacts to environment	Fatalities: Few fatalities and life threatening injuries to the public or employees. Severe and long-term impacts to environment	Permanent/Serious Injuries or Illnesses: Many serious injuries or illnesses to the public or employees. Significant and medium-term impacts to environment	Permanent/Serious Injuries or Illnesses: Few serious injuries or illnesses to the public or employees. Significant and short-term impacts to environment	Minor Injuries or Illnesses: Minor injuries or illnesses to many public members or employees. Moderate and short-term impacts to environment	Minor Injuries or Illnesses: Minor injuries or illnesses to few public members or employees. Environmental impact is immediately correctable or contained within small area	No injury or illness or up to an un-reported negligible injury. No environmental impact
Operational and Reliability: Disruption to company operations that could impact customers; may be measured in quantity of impacted customers, critical locations, loss of energy flows, and/or duration	> 1 MM customers affected; or impacts an entire metropolitan area, including critical customers; or disruption of service of more than a year due to permanent loss to a facility	>100 K customers affected; or impacts multiple critical locations and customers; substantial disruption of service greater than 1 months	> 50 K customers affected; or impacts multiple critical locations or customers; substantial disruption of service greater than 10 days	> 10 K customers affected; impacts single critical location or customer; disruption of service greater than 1 day	> 1 K customers affected; impacts single critical location or customer; disruption of service for 1 day	> 100 customers affected; impacts small area with no disruption to critical location or customer; disruption of service less than 1 day	< 100 customers affected; impacts small localized area with no disruption to critical location/customer; disruption of service less than 3 hours
Regulatory, Legal, & Compliance: Diminishing relationship and increased scrutiny by regulators or government agencies; ongoing media coverage forces outreach to policy makers/regulators; increasing stakeholder revolt or objections leading to increased oversight; loss of license, exclusivity, or monopoly	Actions resulting in closure, split, sale of the company, or criminal conviction	Cease and desist orders are delivered by regulators; Critical assets and facilities are forced by regulators to be shut down; revoking license, market-based rate authority, or monopoly	Governmental, regulatory investigation (including criminal), and enforcement actions lasting longer than one year; violations that result in fines/penalties and large non-financial sanctions	Violations that result in fines or penalties, or a regulator enforces non-financial sanctions, or significant new and updated regulations are enacted as a result of an event	Violations that result in fines or penalties	Self-reported or regulator identified violations with no fines or penalties	No impact to administrative impact only
Financial : Potential financial loss, including disallowance, legal actions or fines, replacement energy, remediation, damage to 3rd party properties, etc.	Loss > $3 billion Ability to raise capital significantly impacted; or decrease in stock price greater than 25%; or potential insolvency	$1 B - $3 B Ability to raise capital is challenged; or decrease in stock price greater than 15%	$100 MM - $1 B Ability to raise capital becoming more difficult; or decrease in stock price greater than 5%	$10 MM - $100 MM	$1 MM - $10 MM	$50 K - $1 MM	< $50 K

	Frequency/Likelihood						
	7	6	5	4	3	2	1
	Common	Regular	Frequent	Occasional	Infrequent	Rare	Remote
Frequency of an occurrence: How often does the risk event occur	> 10 times per year	1-10 times per year	Once every 1-3 years	Once every 3-10 years	Once every 10-30 years	Once every 30-100 years	Once every 100+ years

The risk score for each risk is then calculated using the following algorithm:

Risk score = $\sum_{i=1}^{n} weight_i * frequency_i * 10^{impact_i}$

Each impact category is assigned a weight as follows:

- 40% for Health, Safety & Environmental,
- 20% for Operational and Reliability,
- 20% for Regulatory, Legal & Compliance, and
- 20% for Financial.

Frequency ratings translate to certain values as shown in the table below:

Frequency Rating	Value
1	0.005
2	0.018
3	0.058
4	0.183
5	0.577
6	3.162
7	31.623

Thus, if a risk received a score of 6 for Health, Safety & Environmental Impact, 5 for Operational and Reliability Impact, 5 for Regulatory, Legal & Compliance Impact, and 6 for Financial, it would receive a score of 369,280 based on the following calculation:

(Using frequency table, frequency 5 has value of 0.577)

= 0.4*0.577*106 [safety] + 0.2*0.577*105 [reliability] + 0.2*0.577*105 [compliance]

+ 0.2*0.577*106 [financial]

= 230,800 [safety] + 11,540 [reliability] + 11,540 [compliance] + 115,400 [financial]

= 369,280

Risk Mitigation Plan Development & Documentation

Based on the analysis and evaluation of risks, risk owners and managers develop and document risk mitigation plans to capture the state of the risk given current mitigations and any proposed additional mitigations. On an annual basis, the ERM organization facilitates the risk mitigation planning session where risk owners present their key risk mitigation plans and alternatives considered to the senior management team and discuss the feasibility and prudency of those proposed plans. This risk mitigation planning session helps shape the utilities' priorities going into the annual investment planning process and helps identify gaps and/or areas of overlap in risk mitigation plans.

Risk Informed Investment Decisions and Risk Mitigation Implementation

The capital planning process is the utilities' current process for prioritizing funding based on risk informed priorities and input from operations. On an annual basis, initial capital allocations begin with inputs from Functional Capital Committees that comprise subject matter experts who perform high level assessments of the capital requirements based on achieving the highest risk mitigation at the lowest attainable costs. These requirements are presented to the Capital Planning Committee which is a cross-functional team representing each functional area with capital requests. This committee reviews the spending requirement submissions from all functional areas, and projects are evaluated against priority metrics including safety, cost effectiveness, reliability, security, environmental and customer experience. The Capital Planning Committee then presents its recommendations for capital spending to the Executive Finance Committee which reviews the recommendations and either approves the proposed capital funding allocations or requests changes. Once the capital allocations are approved, each individual operating organization is chartered to manage their respective capital needs within the capital allotted by the plan. Similar to the utilities' risk evaluation processes, the capital planning process is continuing to evolve as the utilities endeavor to achieve the shared goal of determining the risk reduction per dollar invested. In this report, the utilities demonstrate the first steps towards this evolution by showcasing a pilot the utilities are currently conducting to calculate a risk spend efficiency for the proposed mitigations. This approach is further described in the Overview & Approach section of this report.

Monitoring and Review

Monitoring and review of all aspects of risk management supports the utilities' efforts at continuously improving its risk management framework. Periodic reviews of the utilities' risk registry are performed to keep the registry current and facilitate discussions on any emerging or new risks that the utilities could face. Existing Key Risk Indicators (KRIs) support the monitoring of the utilities' key risks and as mentioned above, the process of identifying and implementing KRIs will continue to improve this step of the process.

Risk Assessment Mitigation Phase

Risk Mitigation Plan

Supplemental Information Regarding Safety Culture, Organization and Compensation (RAMP – C)

November 30, 2016

#310402

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Supplemental Information Regarding Safety Culture, Organization and Compensation

1 Background

This chapter provides supplemental information regarding SDG&E's and SoCalGas' organizational structures and culture as they relate to safety, as required by D.16-08-018.[1] In addition to describing top risks and proposed mitigations in each of the individual risk assessment mitigation plan (RAMP) chapters of this filing, the Commission has instructed the utilities to include specific discussion in this filing regarding the following:

- Safety culture and organizational structure;
- Compensation policies related to safety.
- Executive and senior management engagement in the risk assessment, prioritization, mitigation, and budgeting process; and
- Utility board engagement and oversight over safety performance and expenditures.

This chapter addresses each of the above topics in turn below.

2 Safety Organizational Structure and Culture

Safety, reliability and security risk mitigation is incorporated into SDG&E's and SoCalGas' organizational structures, strategic governance and policies, day-to-day operations and resource allocation processes. SoCalGas' and SDG&E's safety organizational structures are described in detail within each utility's Employee, Contractor and Public Safety Events chapters included in this RAMP filing.

SoCalGas and SDG&E's test year (TY) 2016 GRC witness testimony also demonstrated the utilities' strong organizational structure as it relates to safety, as well as their strong commitment to improvement and development through ERM integration.[2] Bret Lane (now-Chief Operations Officer and President, SoCalGas), Scott Drury (now-President, SDG&E), and Caroline Winn (now-Chief Operations Officer, SDG&E) described how the utilities view safety as a three-pronged effort that requires vigilant attention to (1) employee safety, (2) customer/public safety, and (3) the safety of the utilities' gas and electric delivery systems. This focus is driven by the utilities' strong safety culture and is summarized in their Commitment to Safety statements, which is endorsed by the entire SoCalGas and SDG&E senior management team:

> [SoCalGas and SDG&E's] longstanding commitment to safety focuses on three primary areas--employee safety, customer safety and public safety. This safety

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[1] *See* D.16-08-018 at 140-42.
[2] Ex. 02 (SDG&E/Drury/Winn) at 8-9; Ex. 1 (SoCalGas/Lane) at 8-9.

> focus is embedded in what we do and is the foundation for who we are--from initial employee training, to the installation, operation and maintenance of our utility infrastructure, and to our commitment to provide safe and reliable service to our customers.

As Ms. Winn and Messrs. Lane, Drury, Schneider and Geier testified, SoCalGas and SDG&E's investments to manage safety and security risk of our infrastructure and services have had a direct impact on our safety and reliability performance. Evaluations and measures by independent third parties show that SoCalGas' and SDG&E's safety results compare favorably to those of peer utilities and companies. The results of recent safety surveys conducted by the National Safety Council indicate SoCalGas is in the 94th percentile and SDG&E is in the 85th percentile for safety culture.[3] The safety culture has led to improved Occupational Safety and Health Administration (OSHA) results. Over the past sixteen years the OSHA recordable incident rate[4] at SoCalGas has improved from 8.0 in the mid-1990s to 3.8 in 2015. At SDG&E, there has been a similar improvement trend, with the rate declining from 8.6 to 1.91 in 2015.

Diana Day, Vice President, Enterprise Risk Management at SoCalGas and SDG&E, also provided TY 2016 GRC testimony describing how the utilities have developed their safety culture via structures, roles and processes at all levels to address risks associated with our operations and facilities, as well as the companies' trajectories for developing and improving an ERM organization for both utilities. Ms. Day described the commitments SDG&E and SoCalGas made to reiterate their evolving risk management vision through their TY 2016 GRC request, including the request for funding to build and refine an ERM program that integrates risk with asset and investment management through governance structures, competencies and tools. The utilities' planned program included Ms. Day's newly created shared executive role, as well as two additional director positions and nine full-time equivalents. At this time, the utilities have developed an ERM organization with all of the positions forecasted in the last GRC, as well as taken steps to instill risk-informed decision making throughout the utilities. Regarding the utilities' safety culture, Ms. Day testified:

> Risk management at SoCalGas and SDG&E occurs at multiple levels. As mentioned previously, our utilities exhibit consistent attention to safety and security in everyday operations. One of our stated core values is, "Treat safety as way of life."[5] At all levels within SoCalGas and SDG&E, we pay significant attention to the development of structures, roles and processes to address the risks associated with our operations and facilities.
>
> Both SoCalGas and SDG&E have undertaken a thoughtful and measured approach to the adoption of structures and processes to further the development of a risk-aware culture. Both SDG&E and SoCalGas have developed risk registries, which identify

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[3] National Safety Council Safety Barometer Results Report 2016, SoCalGas and SDG&E.
[4] Of non-fatal work-related injuries and illnesses.
[5] Sempra Energy Governance Statement of Corporate Values, *available at* www.sempra com.

> and prioritize top risks within each organization. Each utility has implemented an investment management process that is used to prioritize investments that address risk mitigation actions. SDG&E formalized its approach to ERM by establishing a comprehensive risk management policy and guidelines, with defined, substantive roles and responsibilities established throughout the organization and transparent repeatable processes to support assessment of risk-reduction impact of projects.[6]

Ms. Day's GRC testimony identified other SDG&E and SoCalGas executives supporting safety-related policy testimony in the utilities' TY 2016 GRC request, including David Geier, Vice President of Electric Transmission and System Engineering for SDG&E and Douglas Schneider, now-Vice President of System Integrity and Asset Management for SDG&E and SoCalGas. Mr. Geier and Mr. Schneider presented risk policy testimony describing SoCalGas and SDG&E's long-established strong operational safety culture, as well as the utilities' continued commitment to developing ERM through targeted programs and initiatives. Together with Ms. Day, Mr. Geier and Mr. Schneider provided an overview of SDG&E's strong safety culture and commitment to further developing processes and programs designed to manage safety risks and to promote system reliability, and described the utilities' well-developed safety culture, founded on proven employee-based programs, safety training programs and education of workforce. These programs are detailed in each utility's Employee, Contractor and Public Safety Events chapters included in this RAMP filing, as noted above, and include initiatives such as:

- Environmental & Safety Compliance Management Program (ESCMP), an environmental, health and safety management system to plan, set priorities, inspect, educate, train, and monitor the effectiveness of environmental, health and safety activities in accordance with the internationally accepted standard, ISO 14001.
- Behavior Based Safety (BBS) Programs use a proactive approach to safety and health management, focusing on principles that recognize at-risk behaviors as a frequent cause of both minor and serious injuries. BBS is intended to reduce the occurrence of at-risk behaviors by modifying an individual's actions and/or behaviors through observation, feedback and positive interventions aimed at developing safe work habits.
- In addition, each utility holds regular safety meetings at many levels, including Executive Safety Council meetings, which have been in place for well over a decade, and annual Contractor Safety Summits, which have included hundreds of participants, representatives from other California utilities and the Safety Enforcement Division of the CPUC.

3 Executive and Senior Management Engagement

SoCalGas and SDG&E's TY 2016 GRC witness testimony also demonstrated executive and senior management's engagement in the risk assessment, prioritization, mitigation and budgeting processes.

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[6] Ex. 13 (SDG&E/Day) at 4.

Ms. Day described the commitments SDG&E and SoCalGas made to their evolving risk management vision through their TY 2016 GRC request, including the creation of Ms. Day's new executive role at both utilities and the utilities' plans to develop the shared ERM organization. Mr. Geier and Mr. Schneider also testified to SoCalGas and SDG&E's continued commitment to the growth and development of existing risk management processes into a more fully integrated ERM governance structure.

SDG&E described its process for incorporating safety and security risk into its electric operations investment portfolio in the TY 2016 risk policy testimony of David Geier, as follows:

> The approach SDG&E uses to address risk is a combination of bottom-up and top-down identification and management of risks, involving both capital projects and operations and maintenance (O&M) programs.…
>
> The capital decision methodology is a bottom-up process that begins with engineers and project managers using their experience and, in some cases, historic asset life and failure data, to identify which projects should be considered for capital funding. In the early stages of planning, alternative risk mitigation solutions will be considered. As the subject matter experts converge on a preferred approach ... to mitigate a particular risk, alternatives will progressively be set aside and further study expenses will not be made on them…. The project managers then review their proposals with their functional director.
>
> The portfolio of electric distribution capital projects is categorized as follows: Mandated, Safety & Risk Management, Reliability/Improvements, New Business, Capacity/Expansion, Franchise, Materials, Equipment/Tools/Miscellaneous, Overhead Pools, and Transmission/FERC Driven Project. The projects within these categories are prioritized, and the list of prioritized projects is then reviewed by our internal Capital Budget Committee, where individual projects are challenged to ensure they meet a reasonableness review for risk mitigation and compliance. Changes can and are made in the Capital Committee before the proposed budget is presented to the Executive Finance Committee (EFC).…
>
> The O&M decision methodology is closely linked to the capital decision methodology, because the O&M component of any given capital project follows as a necessity to completing the project…. The large majority of O&M activities are driven by compliance activities; and … are enhanced by SDG&E's strong commitment to public and employee safety and maintaining a safety culture.… Funding for these activities also undergoes a rigorous challenge and review at the Operating Budget Committee and EFC sessions.…
>
> From time to time risks and requirements may emerge during the fiscal year.… In situations where risks and requirements emerge outside of SDG&E's

traditional investment planning cycle, SDG&E management will re-prioritize work to ensure risk mitigation and compliance.[7]

SoCalGas described its capital planning process for incorporating its gas operations investment portfolio in the TY 2016 GRC testimony of Garry G. Yee, as follows:

> Generally, early during the third quarter of the year, SCG begins the capital planning process leading to organizational budgets. For non-balanced base capital, SCG Executive Finance Committee ("EFC") establishes a total annual capital expenditure target consistent with our authorized GRC funding for that period. From this total allocation, funding is prioritized based on continuous input from operations.
>
> - Step 1 - Initial capital allocations begin with inputs from Functional Capital Committees ("FCCs") that are organized by the nature and type of capital investment or function: Gas Operations, Customer Services, Information Technology, and Facilities/Environmental/Other. These teams of managers and subject matter experts perform a high level assessment of the capital requirements for serving customers to ensure that infrastructure is maintained and developed to provide safe, reliable service with the highest risk mitigation at the lowest attainable cost. Each FCC elicits broad input for developing each function's capital plan, and formulates a prioritized grouping of annual spending requirements.
>
> - Step 2 - The capital requirements as identified by the FCCs are provided to the Capital Planning Committee ("CPC"), a cross-functional team of Directors representing each operational area with capital requests. The CPC reviews the FCC submissions, cross-prioritizes projects among the FCCs and establishes a final ranking for proposed capital work. Projects determined to address safety, compliance or reliability issues receive the highest priority for funding.
>
> - Step 3 - The CPC presents its recommendations for capital spending consistent within each functional area and consistent with the overall funding target to the EFC, which reviews the recommendations and either approves the proposed capital funding allocations or requests changes.
>
> Once the capital allocations are approved, the individual operating organization is chartered to manage its respective capital needs within the allotted capital. The real-time prioritization of work within the context of the budget allocations is completed by the front-line and project managers on an ongoing and continuous basis. Regulatory compliance deadlines, customer scheduling requirements, and overall infrastructure condition are all factors taken into consideration as work elements are prioritized. Before starting a project or making any commitments, the project manager must secure specific project approval signatures in accordance with SCG's

[7] Ex. 21 SDG&E (Geier/Schneider) at 7-9 (internal footnotes omitted).

Internal Order process and the Sempra Energy Utilities' approval and commitment policy.[8]

Senior executives are now involved in at least three executive risk sessions each year to review top risks identified for the utilities, ranking and prioritization of the risks, and funding for the mitigations.

4 Compensation

SDG&E and SoCalGas' variable pay plans, commonly referred to as the Incentive Compensation Plans ("ICP"), motivates employees to meet or exceed important goals, including safety goals, by placing a portion of employee compensation at risk and subject to achievement of the plan's performance measures. As described in Debbie Robinson's TY 2016 GRC testimony, variable pay plans have been a part of SoCalGas' total compensation strategy since 1997, and SDG&E's since 1988.[9] Safety goals in the SoCalGas and SDG&E ICP plans promote employee and contractor safety through performance measures tied to a safe working environment. They also promote public safety through operational goals designed to support safe operations. Both the executive and non-executive ICP plans include safety-related performance measures.

Regarding executive compensation, thirty-five percent of the total 2016 ICP for SoCalGas and SDG&E executives is tied to safety-related performance measures. These measures include:

SDG&E:

- Employee and contractor safety measures focusing on a safe work environment
- Public-safety related operational measures focused on providing a safe and reliable system, such as:
  - Pipeline Safety Enhancement Program (PSEP)
  - Distribution system integrity
  - Reliability and major electric safety projects

SoCalGas:

- Employee and contractor safety measures focusing on a safe work environment
- Public-safety related operational measures focused on providing a safe and reliable system, such as:
  - Pipeline Safety Enhancement Program (PSEP)
  - Distribution system integrity
  - Storage Integrity Management program (SIMP)
    - Advance meter installation (AMI)

[8] Ex. 298 (SoCalGas/Yee) at 2-3.
[9] Exs. 191 (SoCalGas/Robinson) and 193 (SDG&E/Robinson) at 6-7.

For both utilities, the employee and contractor safety measures are based on safety performance throughout the year. However, the SDG&E and SoCalGas boards of directors may reduce or eliminate any payout for these safety measures in the event to a work-related fatality or serious injury. For example, in 2015, SDG&E achieved a record-low number of recordable injuries and performance exceeded the level required for a maximum payout. However, the SDG&E board of directors reduced the payout for SDG&E's employee safety measure to zero due to a work-related fatality.

Ms. Robinson also described SoCalGas' and SDG&E's employee wellness programs, designed to improve employee health and productivity.[10] Wellness programs promote healthy lifestyle changes and illness prevention, facilitate early detection and management of illness and disease, and help ensure that employees diagnosed with health conditions receive optimal and effective treatment. SDG&E and SoCalGas partner with health care providers and non-profit agencies to offer classes and educational materials to promote healthy behaviors to prevent illness. Current programs include safety stand down events and health fairs, gym membership fitness subsidy, worksite fitness programs, weight management, stress management, and smoking cessation. Linking wellness programs to employee safety programs through participation in safety stand down events is designed to further reinforce a focus on healthy behaviors and prevention of illnesses and injuries. These programs are also described in the Employee, Contractor and Public Safety Events chapters included in this RAMP filing.

5 Governance

The SoCalGas and SDG&E boards of directors determine the safety-related performance measures to be included in each year's ICP and review and approve the actual performance results. Each SoCalGas and SDG&E board meeting begins with a safety briefing. The briefings include a review of year-to-date safety performance as well as discussion of current safety topics. As noted above, the boards may exercise negative discretion to reduce or eliminate any payout for employee and/or contractor safety measures in the event of a work-related fatality or serious injury.

The Sempra Energy board of directors has developed an integrated risk management framework to assess, prioritize, manage and monitor risks across the company's operations. Sempra's full board has ultimate responsibility for risk oversight under this framework. Consistent with this approach, our corporate governance guidelines provide that the specific functions of the Board of Directors include assessing and monitoring risks and risk management strategies.

The Sempra Energy board believes that risk stretches far beyond any one committee. As a result, the board has diversified its risk oversight responsibilities across its membership, housing categories of risk oversight within board committees by topic. Any risk oversight that does not fall within a particular committee remains with the full board.

The Environmental, Health, Safety and Technology Committee of the Sempra Energy board of directors is responsible for:

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[10] Exs. 191 (SoCalGas/Robinson) and 193 (SDG&E/Robinson) at 24-25.

- Assisting the company's Board of Directors in overseeing the company's programs and performance related to environmental, health, safety and technology matters.
- Reviewing environmental, health and safety laws, regulations and developments at the global, national, regional and local level and evaluating ways to address these matters as part of the company's business strategy and operations.
- Reviewing cybersecurity programs and issues.
- Reviewing and evaluating technology developments that advance the company's overall business strategy.

The Compensation Committee of the Sempra Energy board of directors determines the safety measures that are included in the ICP for senior Sempra Energy corporate officers.

Quantitative Risk Assessment Probabilistic Modeling (RAMP – D)

November 30, 2016

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1. Introduction

Southern California Gas Company (SoCalGas) and San Diego Gas & Electric Company (SDG&E) ("the utilities") are expanding their usage of quantitative approaches for risk modeling. Several efforts are currently in place, and modeling of more risks will soon be undertaken. This chapter contains an overview of quantitative risk modeling as well as some examples of how the utilities are implementing those models. Also included is a table of the status of how quantitative risk modeling is being used for the top risks at both companies.

In short, quantitative risk modeling attempts to use numerical data, including calibrated subject matter expert opinion, as inputs to determine the likelihood of outcomes. There are different levels of sophistication and complexity for each model, and those levels should be correlated to the risk themselves; that is, smaller risks do not require as much sophistication. Quantitative modeling relies on logic that describes how events occur and what their consequences might be, while attributing likelihoods to each of the steps. For less complicated risks, a likelihood can be a simple mathematical term like "1 in 10 years", but in other situations with uncertainties, the likelihoods may be taken from an appropriate probability distribution. The sophisticated models might utilize a Monte Carlo approach that samples randomly chosen data from probability distributions, and does so many times until the types and likelihoods of outcomes is well understood. In the end, the quantitative approach is a flexible method that uses numerical data and logic to find the most realistic model of real-world risks.

2. Definitions

Quantitative

Typically used as a contrast to "qualitative." Involves using numerical values and attributes rather than descriptive attributes. Quantitative information can be obtained from empirical measureable data; as opposed to qualitative information that are subjective and difficult to measure. The distinction between quantitative and qualitative is important because the quantitative nature of the analysis uses numbers that can have arithmetic performed. A model can have varying degrees of quantitative characteristics; some models being completely quantitative and other models have quantitative elements.

Probabilistic

A method is considered probabilistic if it incorporates information that uses probabilities or likelihoods in a quantitative sense. These methods can range from simple uses of likelihoods or failure rates to sophisticated Monte Carlo modeling.

Probability Distribution

A probability distribution is a mathematical function that describes the likelihood of different outcomes occurring. Below is a simple example using standard dice. There is a 1 in 6 chance of any specific value being rolled, so the probability distribution would simply be 1/6 for each value of 1, 2, 3, 4, 5 and 6 (shown in Figure 1 below).

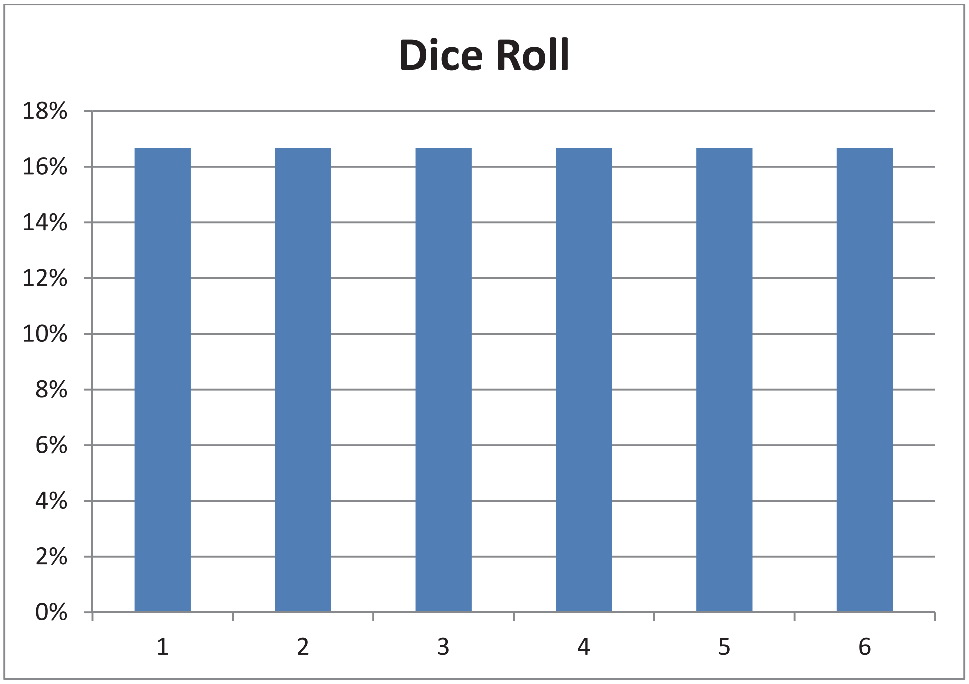


Figure 1. Probability Distribution for the outcome of a single die

A more complicated example of a probability distribution uses the "normal" distribution or bell curve, as seen below. In this example, the average is 100 and the standard deviation is 15. Once the probability distribution is described mathematically, it is possible to perform calculations using that distribution, such as determining the likelihood that the result will be between two values or the likelihood that the result is above a certain value.

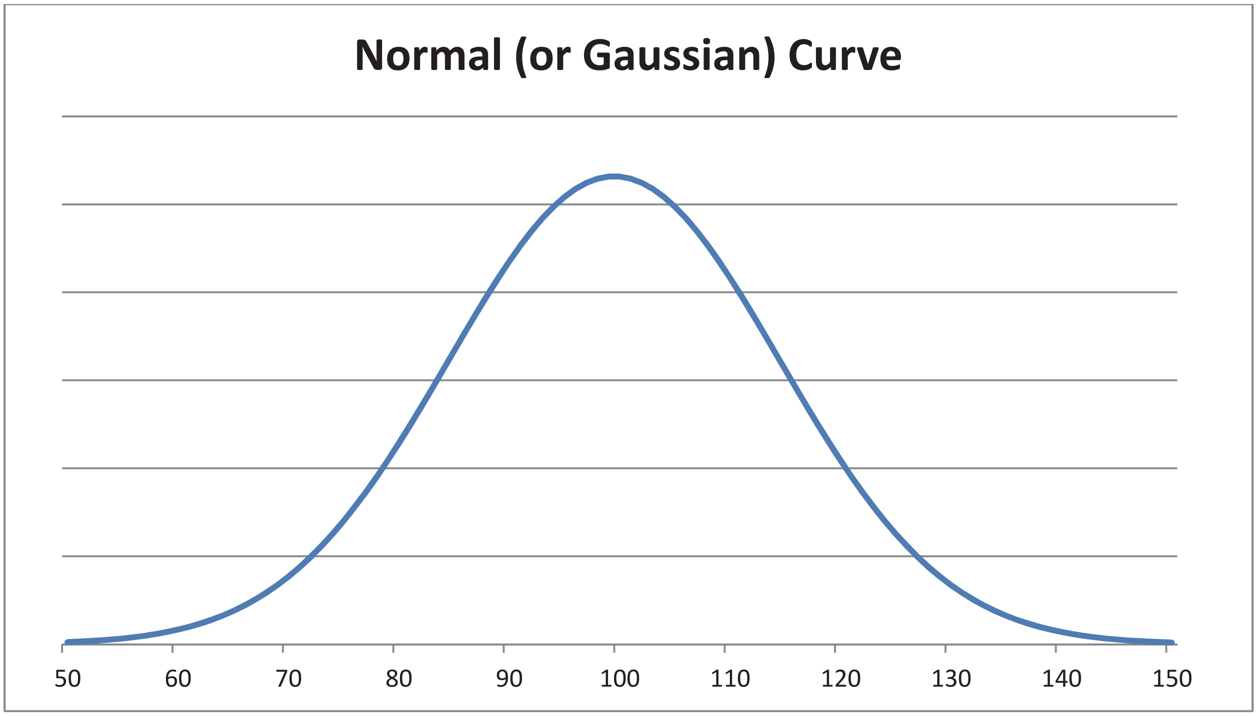


Figure 2. Probability Distribution of the "normal" curve when mean = 100 and standard deviation = 15.

Using the above probability distribution as reference, the likelihood that a result is above 100 is 50%. The likelihood that a value is between 70 and 80 is 6.8%. Another common use of probability distributions is to determine the most likely 90%; frequently used in the expression "90% confidence." With the above probability distribution, 90% of all values are between 75 and 125.

Stochastic

A stochastic method or process is one that incorporates uncertainty of the inputs, which usually leads to uncertainty of outcomes. Stochastic methods frequently use inputs from probability distributions which mimic or simulate the real world. If, for example, a casino were modeling the roll of a single die, it could use a probability distribution like the one shown in Figure 1 as part of a stochastic model. Stochastic models are most suited for use in a situation when multiple independent variables have uncertainty.

Stochastic methods are a contrast to deterministic methods. A deterministic method uses approaches which give the same outcome each time. Imagine that a bag of your favorite candy-coated chocolate was, on average, ½ red and ½ blue. Using a deterministic approach, a bag of 40 candies would always yield 20 red and 20 blue candies. But using a stochastic approach, the likelihood of each candy is considered. In fact, as can be seen in Figure 3 below, the chance of exactly 20 red candies occurring is about 12%. There is actually a 1% chance that 13 red candies will show up. In other words, if the process of distributing red and blue candies was truly random, out of 100 bags of candy, it would expected that one of those 100 bags would have only 13 red candies (and another bag would have only 13 blue candies).

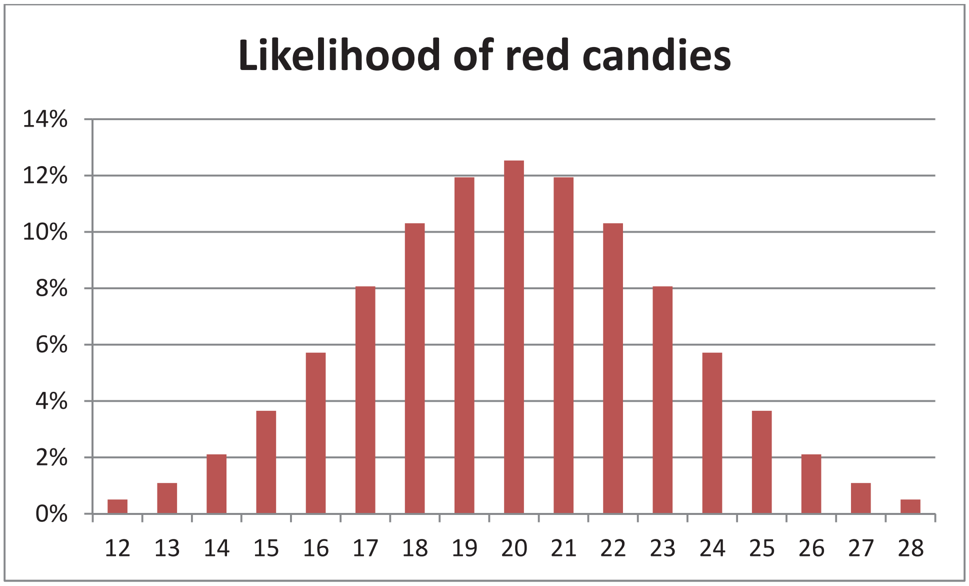


Figure 3. Likelihood of red candies in a 40-candy bag

Stochastic modeling is extremely powerful because it allows the analysis to demonstrate the actual variety of outcomes, rather than single, deterministic outcomes. Note in the candy example above, the deterministic approach would only have been correct 12% of the time, and therefore incorrect 88% of the time.

Model

A model is a set of tools that simulate something else; usually "the real world." Models can range in sophistication from simple to very complex. The sophistication of the model should be commensurate with the circumstance; meaning, complex models are better suited for complex problems. During a model's simulation process the analysis can test hypotheses, quantify results, determine the sensitivity of inputs, understand the likely ranges of outcomes, etc.

Models can be physical models like a miniature version of an airplane tested in a wind tunnel to analyze wind flow characteristics. Models can also be virtual models which are based in computer software. Most of the models that Risk Management groups work with are computerized logical models which process information in a certain fashion with if/then statements and likelihoods given by probability distributions. Computerized models can be simulated many times in a short amount of time which allows the analysis to easily adjust the model. Each model is purpose-built and, although many models appear similar, each element in the model is chosen for the specific reason.

Expected Value

The expected value (EV) of an event is the average outcome given the weighted likelihood of all possible outcomes. When rolling a single die, the EV is 3.5, because there is a 1/6 chance of each of 1, 2, 3, 4, 5, and 6 occurring.

The math behind EVs is: The sum of (all possible outcomes multiplied by the likelihood of that outcome). So for dice the EV is the sum of $(1/6)*1 + (1/6)*2 + (1/6)*3 + (1/6)*4 + (1/6)*5 + (1/6)*6 = 3.5$.

Expected values are very appropriate to use in some settings but can be misleading in others. The most appropriate situations to use expected values are when the variety of outcomes is not too disparate, or when the likelihoods of outcomes are also fairly similar. In the case of dice, the outcomes range from 1 to 6, and the likelihood of each is exactly 1/6. However, in an extreme case such as a nuclear disaster, EV might not be an appropriate technique to utilize. Because the computation of EV multiplies the outcome by probability, those events with small probabilities get diluted even though they have tragic outcomes. Suppose a nuclear plant has a probability of 1 in a billion of a catastrophic failure, and 999,999,999 out of a billion that everything is fine. And further assume that if there were a catastrophic failure it would cause 1,000 deaths. In this case, the EV would be: $(1/1{,}000{,}000{,}000)*(1{,}000) + (999{,}999{,}999)/(1{,}000{,}000{,}000)*0 = 0.000001$. But when the value of 0.000001 is observed it might be easy to forget the devastating possibilities. An EV of 0.000001 is likely much lower than many other risks that utilities confront, but few would suggest that nuclear catastrophes should be ranked low.

For this reason, it is not suggested to use a "one size fits all" approach to either modeling or how the model output is analyzed. Different situations require different statistics and tools, and different communication strategies.

3. Direction Forward

SoCalGas and SDG&E have a plan to address all non-trivial risks. The ultimate goal is to identify, assess, find mitigation for, determine mitigation effectiveness, create a portfolio of mitigation efforts, seek funding levels for mitigations, and carry out the mitigation efforts.

There are quantitative aspects in many of the steps mentioned above. The direction that the utilities are striving toward is to utilize quantitative approaches where appropriate throughout the risk management process. There is subjectivity to what is appropriate, but certainly risks that have numerical data and are significant to the company should eventually have some level of quantification. Risks that have almost no safety impacts may not require quantification. Additionally, it is important to understand the level of sophistication of models is also relative to the importance of the risk; where top risks will have thorough models, and lower risks will not. Not all risks will require Monte Carlo simulations with multiple stochastic inputs.

Model Sophistication

The utilities have already used quantitative risk models to affect business decisions. As the risk management process matures, more and more risks will have quantitative models. The evolution of models can be described loosely as:

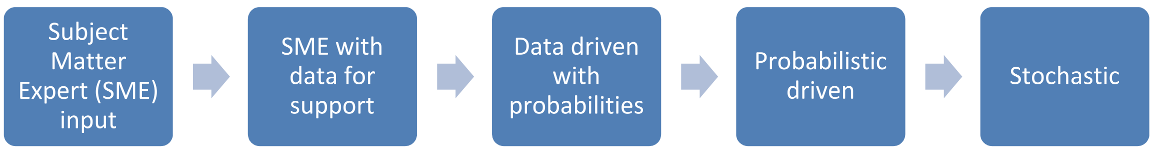


Figure 4. Evolution of Models

In reality, not all models will be able to be categorized exactly as shown above, as the complicated models will have elements from many of them.

Frequently during the evolution of a risk model, it becomes apparent that more data is needed to progress. Obtaining data can sometimes be done quickly or it may take years. In some cases, data specific to the need is not available but data that is similar can be used. In some situations, national organizations collect data that can be used to estimate local data – with the need to understand how the data is related. For example, when SDG&E was analyzing aviation risk, it was determined that National Transportation Safety Board (NTSB) data could be useful. However, the NTSB data contains all sorts of aviation risks, and some amount of filtering was necessary to get the data that was desirable. For example, the aviation data contains helicopter uses such as personal use, which are very different than external load. Luckily, the NTSB data was coded in such a way that filtering could get the data closer to what is appropriate for SDG&E's aviation risk. The same is true for PHMSA[1] data for pipeline risks.

Fault Tree

Most models will utilize a fault tree / decision tree type of logic flow. Fault trees help logically analyze the types of "triggers" that lead to a risk event. For example, note that an electrical outage can occur from many triggers such as vehicle contact, equipment failure, shutoff for safety, etc. A fault tree might list all of the triggers with probabilities. The tree might include several requirements. For example, a transmission outage typically occurs only after at least 2 transmission lines or substations have issues, but can also occur during ISO[2] curtailments. The fault tree shows the necessary steps before the outage occurs.

[1] US Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA).
[2] California Independent System Operator (Cal-ISO or ISO).

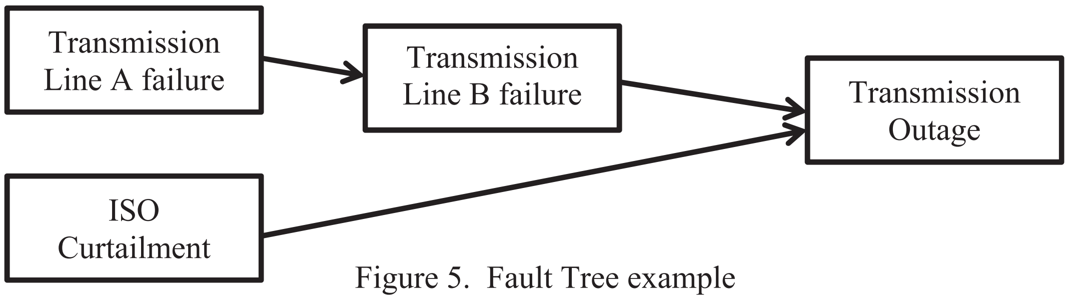


Figure 5. Fault Tree example

Each step on the Fault tree can have a probability associated to it. In stochastic models, the probability of failure may not be a single point, but rather a value drawn from a probability distribution.

Event Tree

Similarly, Event Trees are used to analyze the consequences of a risk event occurring. Using an electrical outage as an example, many negative consequences can occur:

- impact to public safety (*e.g.* traffic lights, hospitals, life support systems, communication);
- loss of valuable asset (*e.g.* food spoilage, industrial processes); or
- loss of productivity.

An Event Tree logically describes consequences in a manner that is conducive to probabilistic analysis. Using "food spoilage" listed in the above consequences for electrical outages, analysis indicates that food spoilage is not either $0 or $250 per customer (for example), but a continuous range of dollar values (possibilities). Historical data helps the analysis determine the characteristics of the probability distribution. One can quickly understand the levels of sophistication that can be applied to just the food spoilage portion of electrical outages. Knowing the number and type of customers is important. Business/commercial customers have different needs than residential. Also, estimating the length of outage affects the consequences. Food may not spoil for at least an hour. To truly understand the likely consequences of food spoilage, several inputs can be estimated/simulated.

Stochastic Analysis

For risks that require sophisticated analysis, probability distributions are commonly used to describe the likelihood of triggers and consequences. Using the food spoilage example from above, a simple probabilistic analysis can be illustrated. Say that a particular distribution circuit is configured in such a way that, due to the location of fuses, if an outage were to occur the following likelihood table would be true:

Customers Affected	Likelihood
5	50%
10	30%
15	20%

Furthermore, to simplify, assume that all customers are residential customers and that the outage will last exactly 6 hours. Assuming that data was available to create an estimate, a fictitious probability distribution of the value of their food spoilage given a 6 hour outage is given as:

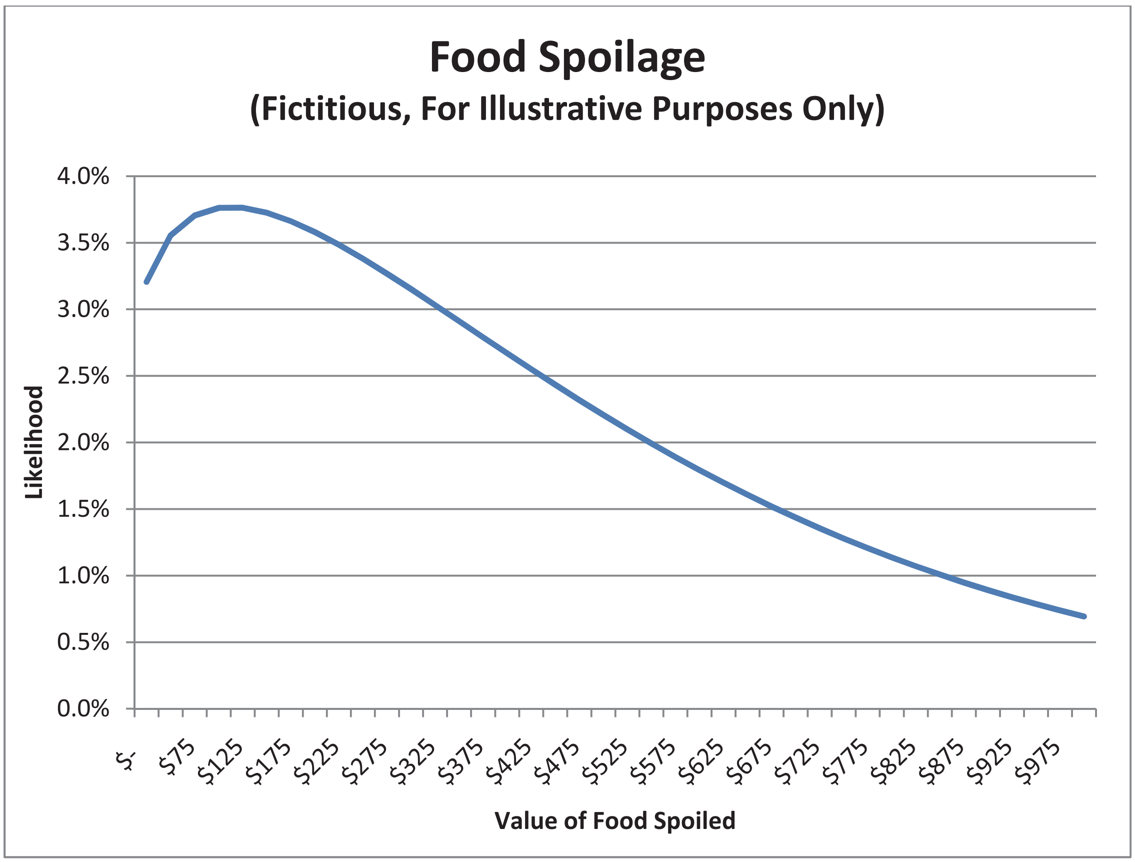


Figure 6. Food Spoilage

So, the first step is to randomly determine the number of customers affected. The second is to randomly determine the amount of food spoilage that each customer experienced. The output from both of these probabilistic inputs, with 2,000 randomized trials, is shown in Figure 7, below:

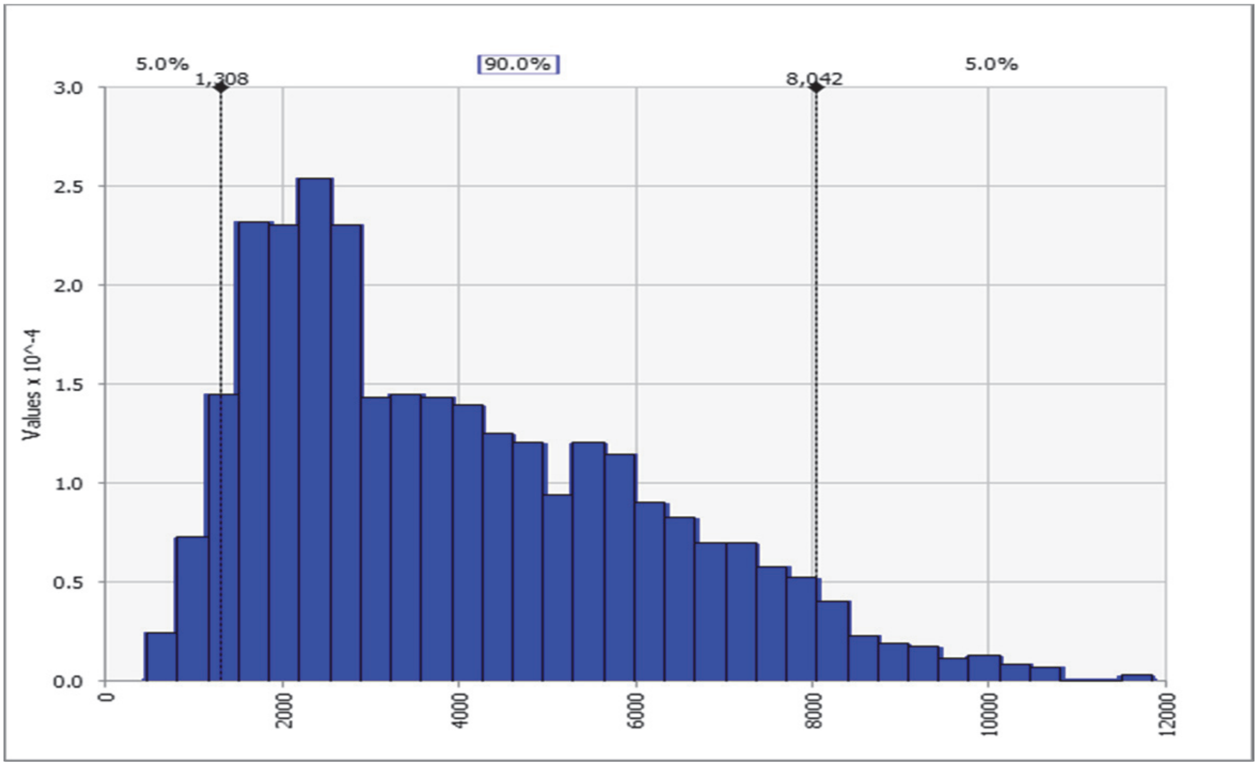


Figure 7. Impact (2,000 trials)

The average amount of the 2,000 trials is $3,985. The P95 (*i.e.* the 95th percentile – or 5th percentile from the worst[3]) is $8,042.

The utilities believe that it is important to consider both the average (expected value) and the extreme data points. In the example above, without the richness of data that is portrayed in the Total Impact, a single value of $3,985 could be misleading.

Interpretation of Model Output

The basics of determining mitigation effectiveness is analyzing the difference in risks before and after the mitigation, then considering the cost and other constraints of the mitigation. For risks that require quantitative modeling, the before and after risk assessments will likely be a distribution of outcomes and not a single point value.

Consider another illustrative example of vehicle collisions, using fictitious data. Suppose analysis can create probability distributions for "Before Mitigation" and "After Mitigation". Here are the two outcomes:

[3] The Company currently uses the" credible worst case" scenario as comparable to the P 95th scenario.

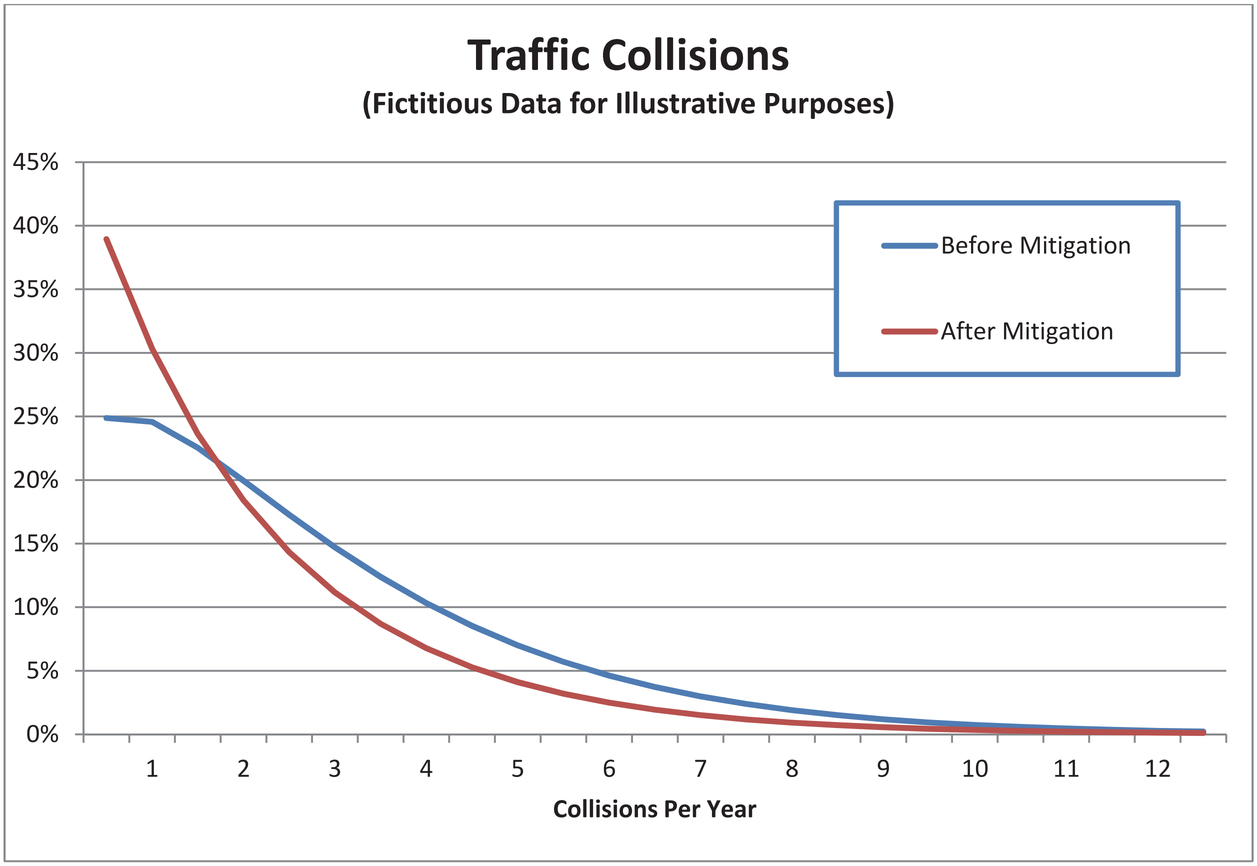


Figure 8. Traffic Collision Example, pre- and post-mitigation

If one were to consider the "average" case, there would be 2.2 instances a year before mitigation, and 1.4 instances per year after mitigation, for a reduction of 0.8, or 36%. But if the P95 case is considered, the values are 7.5 instances per year, to 6 instances per year, for a reduction of 1.5 instances or 20%.

The data is summarized in the following table:

	Before Mitigation	After Mitigation	Change in Collisions	Change in Collisions (%)
50% (Median)	2.2	1.4	0.8	36%
95% (P95)[4]	7.5	6	1.5	20%
Average (Mean)	3.2	2.3	0.9	27%

[4] The current risk reduction is equivalent to the credible worst case which will evolve to the mitigation curves reflected above.

One can see that there is a different result depending on which part of the information that is specified. The effectiveness of the mitigation effort can come down to subjective decisions, or acceptability of risk. If the utility was focusing on ensuring there were no more than 6 collisions per year, the mitigation effort might be considered successful. If the intent of the mitigation was to reduce the "average" amount of collisions, it only reduced the average by 0.9 which, depending on the cost of the mitigation effort, may not be deemed effective.

In short, the full view of the probabilities of outcomes helps the analysis determine different aspects of the issue. If everything is "boiled down" to a single number, it isn't clear if the mitigation is affecting the likely case or the dangerous case.

The path forward for the utilities is to view risks with their entire probability distributions and make appropriate decisions as they arise; as opposed to using a recipe style approach that mandates that only the P95 or the average case is viewed.

Summary of status of quantitative assessments

Using the 2015 Risk Registries, the following table includes asset-associated risks on either the SoCalGas or SDG&E Registries that have high consequence[5] and high frequencies[6] for their safety scores.

Risk Name	Description	Quantitative Assessment Status
Wildfire	The risk of an uncontrolled fire associated to utility equipment	Stochastic models in use
Electric Infrastructure Safety and Reliability	The risk of safety, environmental or reliability events due to degraded or overloaded equipment (i.e. transformers, breakers, relays, pole loading, overhead conductor, underground cable, PCB issues).	Electric reliability probabilistic studies involving underground cable and other equipment. Substation transformer CBM project is in-flight.
Aviation Incident	An aviation incident by our contractor, subcontractors or other third parties who may enter SDG&E's service territory that damages electric transmission, distribution and/or gas transmission facilities and may also result in an employee and/or customer injury or death.	Probabilistic study in use for our contractor and subcontractor flights. Non-utility aviation issues being addressed through studies of marker balls placement.
Cyber Security	A major cyber security incident that causes disruptions to electric or gas operations (e.g. SCADA system) or results in damage or disruption to company operations, reputation, or disclosure of sensitive data.	Risk assessments involving likelihoods and consequences have been undertaken and will continue to expand.

[5] Score of 4 or higher

[6] Score of 4 or higher

Catastrophic Damage involving Gas Infrastructure (Dig-Ins)	Risk of catastrophic damage involving gas infrastructure due to third party activity (dig ins).	Numerical data for likelihoods and consequences is used to create relative risk scores. Future work hopes to integrate probabilistic methods and a more robust quantitative approach.
Distributed Energy Resources (DERs) Safety and Operational Concerns	Risks related to both the intermittency of energy delivery due to PV, and the risk of PV causing safety issues during certain situations.	Quantitative risk assessments involved likelihoods and consequences have been undertaken and continue to expand.

Summary of Direction Forward:

- Identify risks using previously discussed methods.
- Assess risks with varying degrees of quantitative aspects depending on available data and appropriateness of outstanding risk.
- Assess mitigation efforts with varying degrees of quantitative aspects depending on available data and appropriateness of outstanding risk.
- Consider effectiveness of mitigations using a fully probabilistic approach, and choosing the emphasis of the mitigation improvements on a case by case basis.
- View all mitigation efforts in a single portfolio, and rank the items in order of effectiveness; determine the most appropriate level of spending given the real-world constraints that are present.

4. Completed Models

Below are some examples of models that are "complete" in the sense that they are being used by the company for decision making. However, no model is truly complete. Models can always be improved; due to the two reasons that better logic may be implemented, and that new data may become available.

Fire

Background: Wildfire risk is one of the most important risks to SDG&E. The complex nature of the risk is suitable for computerized modeling techniques. The Wildfire Risk Reduction Model (WRRM) was created to focus on equipment failures that lead to ignitions, and how those ignitions spread due to vegetation and weather.

Method: Fault tree and event tree analysis was performed on overhead equipment. This endeavor utilized many different sources of data including Geographic Information System (GIS), electric reliability, ignition, vegetation management. Each distribution pole in SDG&E service territory was considered.

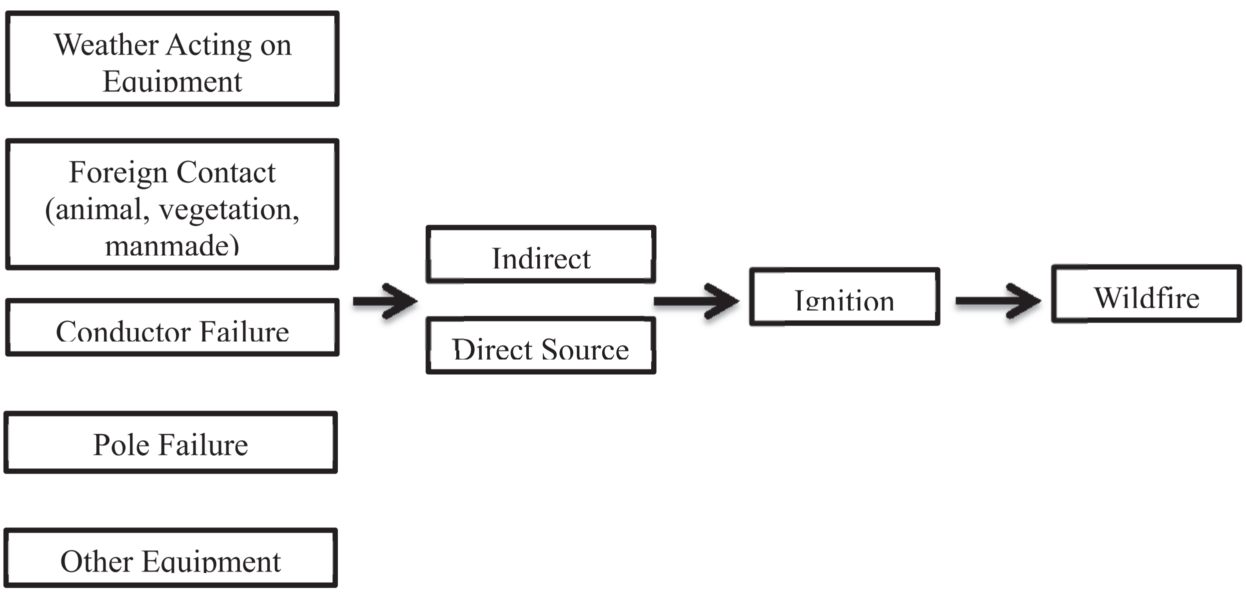
A brief overview of the steps undertaken is as follows:

a) The likelihood of failure at each pole was estimated based on equipment and equipment characteristics.
b) The likelihood of ignition from a failure was estimated based on vegetation and weather conditions.
c) The fire spread was simulated given initial conditions of fuel and weather.
d) The damage to property was estimated using land parcel data.
e) The above steps were used to calculate outstanding (or inherent) risk.
f) The improvements to each individual distribution pole were then assumed, and the data was rerun to understand the risk reduction due to those specific improvements.
g) Calculations were made to determine which poles, and which improvements, lead to the largest reduction of risk per $ spent.

Study: As mentioned elsewhere, each model is different than the others. For the case of fire, due to its importance, SDG&E used a sophisticated approach and sought the assistance from outside contracting. The concepts, data, and framework were developed internally, and the contractors implemented the ideas while adding their own expertise.

The product of the work is called the Wildfire Risk Reduction Model (WRRM, pronounced like the invertebrate). However, WRRM is not just a model, it is a group of endeavors. Firstly, it is a group of data that is stored in a database. The data is geographically/logically related using GIS data. It also utilizes a fire behavior model that the contractors developed. Finally, the data and analysis is summarized in a standalone software package that allows project managers to determine which pieces of equipment to change out.

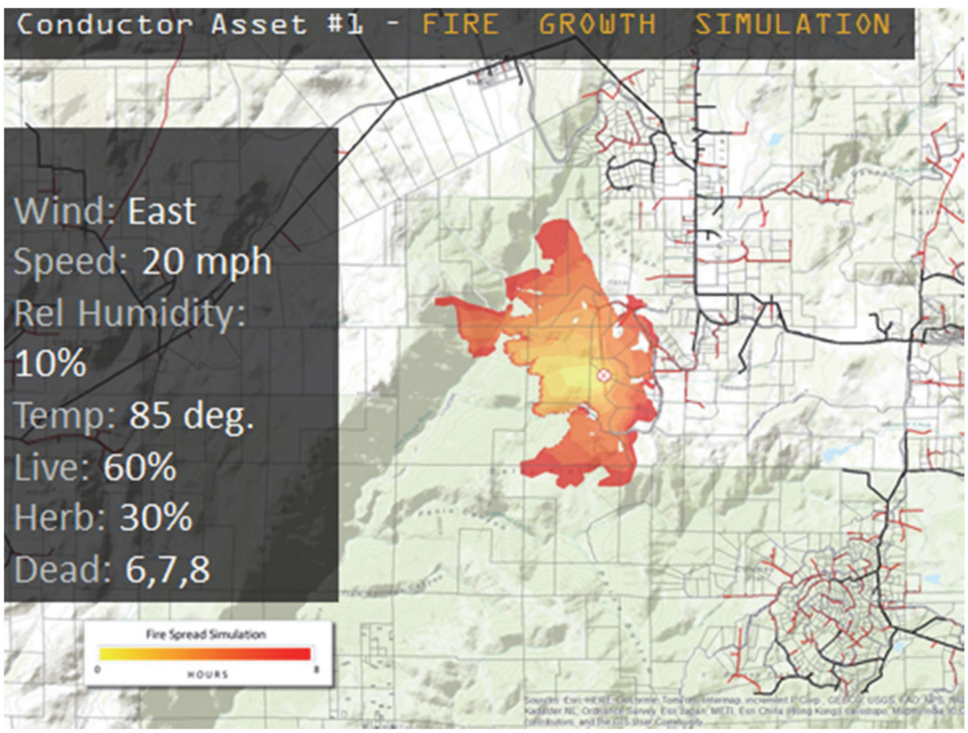
The heart of the model is the fault tree / event tree methodology such as the following:

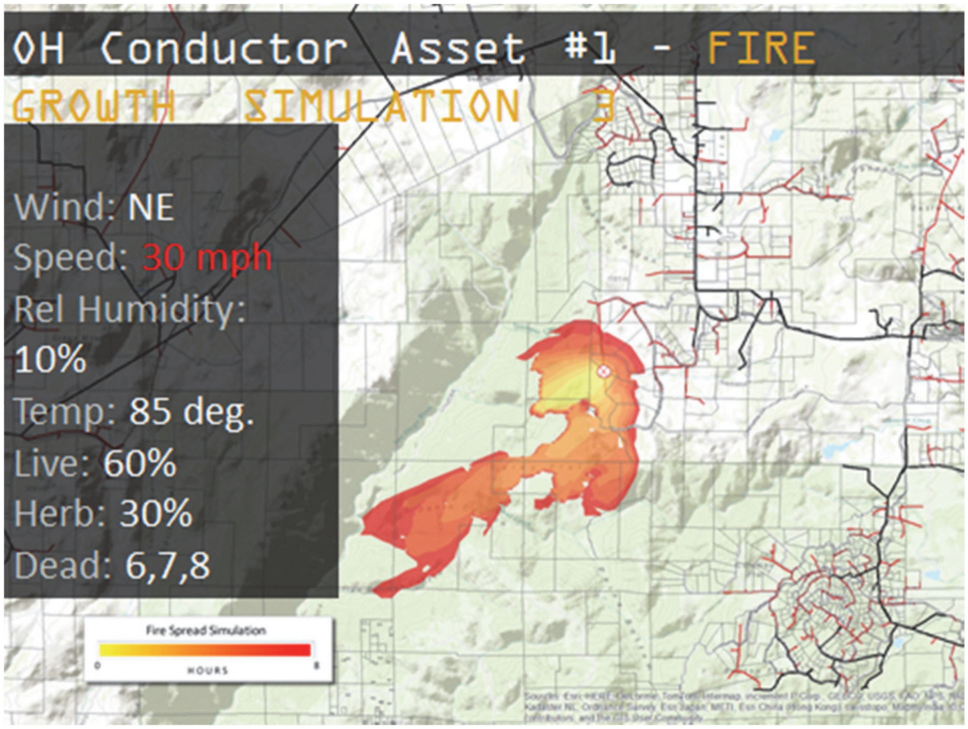


Post-event, the contractor's fire behavior model determines the event tree. There are two very important pieces of data that are used for the fire behavior: weather and fuel. SDG&E has extensive weather data and has simulated weather across its service territory to understand the distribution patterns of wind speed, wind direction, relative humidity, etc. Fuel data, or vegetation, is also well known in SDG&E service territory.

Virtual fires are ignited at each pole, and given initial conditions of weather, the fire model simulates fire growth. Different weather patterns are grouped together and run as a simulation. Over 100 simulations are run at each pole given the different conditions. Then, because the likelihood of the grouped weather pattern is known, weightings are applied to the results of each model that match the likelihoods of each grouping.

Below are two slides that demonstrate the model. Noting the weather conditions in each figure, observe the difference in predicted fire behavior when stronger winds are present.

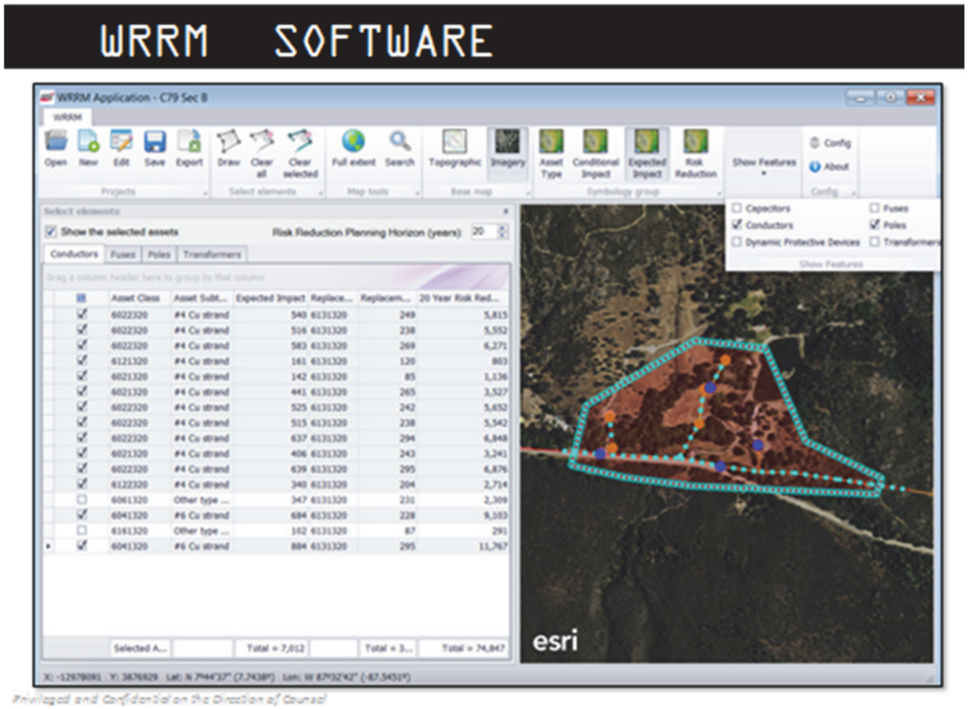




SDG&E chose to use property damage as a proxy for risk, because data supports that when more structures are burned the likelihood of safety and social impacts increases. Publicly available parcel data was used to identify where properties were located. The resulting data of each fire simulation is acres burned, and number of properties damaged. In the end, over 90 million fire simulations were run across SDG&E service territory.

Without overstating it, this analysis is a major breakthrough in risk management, as it fundamentally helps the company understand fire risk. The fire simulations indicate what level of risk currently exists, which locations have the highest risk, and the priority of repair work.

Although the plan for the WRRM is to utilize it in many ways, its first usage is to demonstrate which equipment to replace, in order to lower the likelihood of ignitions. To accomplish this task, the requirement is to estimate the post-renovation likelihoods of failures. Existing equipment has a wide range of types and ages. New construction in fire prone areas will be a standardized set of equipment. Therefore, the incremental improvement to the new construction depends upon the current equipment. Equipment that is known to have higher failure rates will have a larger incremental improvement upon renovation. This information, coupled with the risk at the location, help determine which locations to perform work.



Screenshot of WRRM software that Project Managers use to determine scope of renovation projects.

Future uses of WRRM will include other risk reduction considerations. It may be possible to understand how fire suppression activities lower risk, or how vegetation clearances around structures lower risk. The model could be used to determine the impacts from climate change. There is a myriad of uses for WRRM that will be available to the utility and society in the future.

An exciting new usage for WRRM is already being piloted to assist with real-time fire risk assessments. A version of WRRM called WRRM OPS is being developed that utilizes forecast data and current fuels information to estimate threats. Recall that WRRM utilizes historical weather data to determine areas of interest. WRRM OPS uses specific weather forecasts that predict upcoming wind patterns, temperatures, humidity etc. Because SDG&E has a robust fire preparedness plan during fire weather, the output from WRRM OPS will allow the operations groups to focus on particular geographical areas and alert the community of specific hazards. To elaborate, certain fire weather may be broad in geographic scope, affecting much of SDG&E service territory, but it is also common to have weather that targets only the eastern sections or the northwestern sections. There is also a timing component gleaned from WRRM OPS which gives insight where the risk is as the weather event crosses the service territory.

Both WRRM and the piloted WRRM OPS are world class quantitative tools that dramatically assist in risk management. SDG&E is enthusiastic about these products and is willing to share details with any interested parties.

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Aviation

Background: SDG&E utilizes aviation assets for several business purposes. The main reasons are inspecting equipment, assisting in construction, and assisting in fire suppression activities. One of the aviation assets used was a single engine helicopter. The Aviation Services Department (ASD), in an effort to assist with strategic goals of the company, considered whether the additional costs of owning a twin-engine helicopter would be beneficial.

Method: The entire model was created using Microsoft Excel, R, and @Risk. The work was done completely in-house and consumed approximately 80 to 120 man-hours (though the time was not measured precisely due to multiple projects being undertaken simultaneously). The results were presented to ASD who then processed the findings through its management and the appropriate budget committees.

Study: The Quantitative group of Enterprise Risk Management (ERM) met with ASD to discuss the situation. As with many risk issues, the first task was to quantify existing risk associated to the current helicopter. Because the dataset of helicopter related usage and risk events is small, the situation was appropriate to seek outside information.

As mentioned above, the National Transportation Safety Board (NTSB) has data on helicopter related safety (in addition to vast amounts of data regarding many forms of transportation safety). The data at the NTSB was filtered to create a relevant source of data that was suitable for comparative purposes. Fortunately, the NTSB has data that identifies both single and twin helicopter safety records. NTSB data also indicates the severity of the incident, in terms of fatalities, injuries, and damage to the aircraft.

To fit the NTSB data to SDG&E's purposes, various data for flight conditions were removed. SDG&E flights are typical "low and slow" as well as close to obstructions. These conditions are considered very risky due to the increased likelihood of contacting structures, as well as the reduced ability to recover from various mechanical or external issues. At higher altitudes than commonly flown at SDG&E, or when flying at higher speeds, helicopters have more ability to land using a maneuver known as "autorotation." For these reasons, ASD and ERM applied an increased incident rating to the NTSB data.

For business purposes, it was suitable to analyze the risk from a 10-year perspective, rather than year-by-year. ERM computed risk annually but grouped the years into 10 year segments.

There were 3 inputs that were used stochastically:

- Failure rates/hour;
- Hours flown per year; and
- Consequence of Failure.

Failure rates/hour

Risk events at the NTSB are measured by events per flight hour. Importantly, the events per flight hour statistics vary quite dramatically from year to year. NTSB data goes back approximately 10 years, and each year has a wide distribution of failure rates. For example, a particular accident rate per flight hour changed from 2.98 to 2.30 to 3.10 to 3.96 within 4 consecutive years. There is a near 70% difference from the minimum to the maximum. The variation of the data is yet another reminder that there exist natural distributions of information that are not completely known beforehand. Because of this variation, SDG&E used a distribution of events/flight hour based upon the observed variance in the historical data.

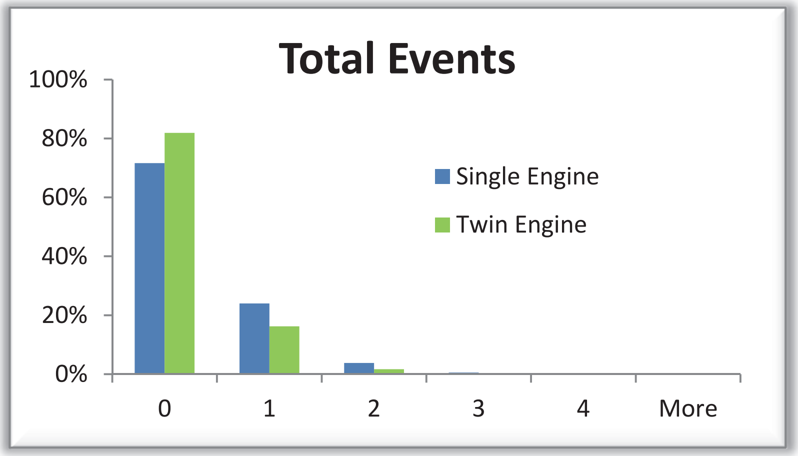
Hours flown per year

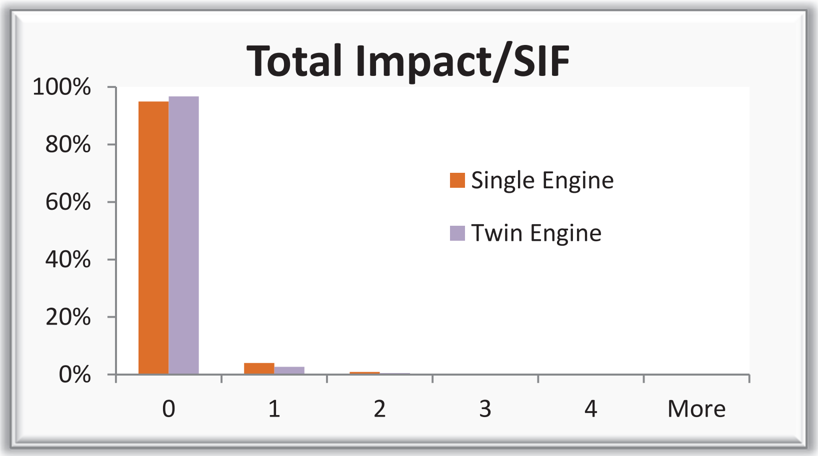
The number of flight hours expected to be flown each year were drawn from a probability distribution that was based on historical information and audited by ASD for reasonableness. The variance of the hours flown per year is not as large as the failure rate/hour, but it nonetheless is an important concept to model. The probability distribution that was chosen provided that 95% of the years that were modeled would have flight hours between 700-1100 hours per year.

Consequence of Failure

The NTSB houses large amounts of information regarding the consequences of helicopter crashes. Some assumptions were made, and a probability distribution was chosen that fit the data the most appropriately. The probability distribution of consequences was monetized and ranged across the range of $0 to $90 million. This distribution had the widest variance of the three inputs and therefore the analysis was most sensitive to this input.

Below is some sample output from the work. The data shows the reduced likelihood and impact from twin-engine helicopters in the conditions under which SDG&E operates:





Medium Pressure Pipeline

Background: SoCalGas and SDG&E have multiple pipeline integrity programs. They are divided into categories based on pipeline pressure, and also the location/purpose of the equipment. For example, there are programs for the meter, service, and pipeline of the system. Each asset has different risk assessment inputs. The Distribution Risk Evaluation and Management System (DREAMS) analyzes medium pressure pipe segments using relative assessments of probabilities and consequences of pipeline risk events.

Method: Assessments are performed at a pipe segment level and are used to determine which segments should be mitigated. Mitigation is usually performed through repair or replacement. Analysis reviews critical inputs to both probability of an event and the consequent of an event. The work is performed in-house, and requires several professionals to collect, receive, and analyze relevant data.

Study: The analysis is broken into two sections; probability and consequence. Steel pipe and plastic pipe are evaluated separately. For steel pipe analysis, the probability calculation is comprised of four weighted factors: age of pipe, wrap of pipe, cathodic protection, and historical leaks. For plastic pipe analysis, the probability calculation comprises three weighted factors: material, construction method, and historical leaks. For both steel and plastic pipe analysis, the coefficients are used to weight the inputs and create a probability score. The maximum potential score is a value of 100.

Next, a consequence score is calculated by using five factors: pressure of line, proximity to structures, population density, pipe diameter, and leak codes. These factors also have coefficients that provide weightings for the consequence score. The maximum consequence score is a value of 50.

The risk score and the consequence score are multiplied together then divided by 10for a max score of 500. Data is updated annually to ensure the most recent leak data, to account for work performed during the year, and other information gleaned from inspections.

The coefficients used for weightings are based on a combination of numerical input and subject matter expertise. Different coefficients are used for plastic pipe versus steel pipe. Internal leak data is used to calibrate the values.

With a given budget allocated specifically to medium pressure pipeline mitigation, projects are risk-prioritized. With the prioritized list, project managers and engineers identify the appropriate mitigation approach, and review other constraints of performing the mitigation. The amount of work is then performed to match the budget.

Although the current methods are not stochastic, the DREAMS program is an example of relative assessments, and has done an excellent job in prioritizing mitigation efforts. There is a plan to review the program and determine if a stochastic approach is warranted. A desired end result for all pipeline integrity programs is to be able to compare across programs to allow for the best portfolio approach of risk mitigation.

Electric Reliability

Background: For many years, SDG&E has utilized quantitative approaches to understand electric reliability issues. As early as the mid-1990s, the CPUC instituted Performance Based Ratemaking (PBR) with SDG&E. During that time, PBRs were used for more than Electric Reliability (such as Customer Satisfaction). In short, the Electric Reliability PBRs are a way to incentivize SDG&E to maintain good reliability, at the cost or reward to its shareholders. The PBRs have very clear definitions and benchmarks. In the electric reliability industry there are calculations that are annually undertaken that are used to state that reliability. One of those calculations is called SAIFI (which stands for System Average Interruption Frequency Index). SAIFI is calculated by determining how many customers experienced an outage during a year then dividing by the number of customers in the electric system. A SAIFI value of 1 means that, on average, each customer experienced one outage that year. One of the PBR incentives might associate .01 SAIFI to a certain amount of money. Currently, in 2016, the PBR states that .01 SAIFI is equal to $375,000. Note that SAIFI is not the only index that is in the current PBR.

To maximize reward – and therefore electric reliability - SDG&E studied reliability using PBR as its measuring stick. SDG&E determined the most effective methods of reliability improvement for the fewest $ spent. The issue of spending fewer $ not only keeps rates down, but it allows more work to be performed each year.

Method: SDG&E performed (and continues to perform) various analysis that seeks to minimize SAIFI per $ spent. These approaches include knowing the likelihood of incidents occurring and the impact of each incident. Failure rates of equipment, likelihood of vehicle contact, aviation contacts, etc. were all studied to determine the best path.

Study: A suite of possible projects is considered by working teams and taken to management for funding.

An example of a particular issue involves the failure of underground cable. Prior to 1983, much of the underground cable installed in SDG&E's service territory had a characteristic that made it fail earlier than expected. Because large amounts of that cable type were installed, there was the potential for severe impacts to electric reliability. Studies were undertaken to identify failure rates of the different kinds of that cable type; looking at size, year installed, manufacturer, etc.

Additionally, SDG&E GIS system allows the analysis to estimate the number of customers affected if a particular piece of cable were to fail. Note that a cable failure will cause a large ground fault that will cause a circuit breaker or fuse (or some other protective device) to operate.

Armed with the likelihood of failure, and with the consequence if a failure occurred, it was possible to estimate the SAIFI impact using the typical before and after mitigation approach. Management then determines the appropriate amount of funding to seek.

Stochastic approaches have been used to validate the above analysis. Monte Carlo simulations were performed that randomly place outages on the electric distribution system, to determine the impacts from the outages. The simulations show that the number of customers experiencing outages match with historical numbers, further indicating the randomness of events; in this case the randomness of the outage. If, for example, SDG&E believed that a particular type of cable will fail 1 out of 10 years per mile, it isn't known which piece of cable will fail. There is nothing deterministic about the failure - the location is not known. The analysis does indicate, however, that given everything else equal, the location of an outage which will affect the most customers is the best place to reduce SAIFI impacts – and therefore improving the customer experience.

Other probabilistic studies involving electric reliability have looked at the sizing of transformers and fuses, the addition of switches and so on.

This forward-thinking view of reliability has won SDG&E the Best in West Region award for electric reliability for 11 years in a row, and during that time has received the National Best reliability award twice.

Additional probabilistic analysis is looking into the relationship between weather and the need for electric line personnel. With a strong understanding of the relationship between weather and electric outages, and accurate weather predictions, personnel decisions can be made to optimize the best electric restoration responsiveness without asking too many crews to standby.

5. In Flight

Transmission pipeline

Discussion: Over the past year, SoCalGas initiated a pilot study with an outside consultant. The study is looking into a fully probabilistic, stochastic analysis of the high pressure gas transmission system. Although much analytical work has been performed, early results are still being considered and adapted to meet the business needs of the utility.

In short, the study focuses on assessing the reliability of pipelines. Probability of failure is estimated for each segment of pipe using various distributions and Monte Carlo simulation. The probability distributions are used in the same manner as described above.

The end result will be the ability to determine existing risk to seek appropriate funding of mitigation and prevention efforts, as well as to be able to rank-prioritize those mitigation efforts to bring the risk down to the desired levels in the most efficient manner.

Electric Infrastructure (Substation Transformers)

Discussion: SDG&E undertook an industry-leading approach when it began a Condition Based Maintenance (CBM) program on its fleet of substation transformers. To this date, many transformers have been updated to allow for real-time monitoring and sophisticated sensing. In general, CBM allows the utility to better understand the actual condition of the equipment, and saves time and resources compared to the traditional Time Based Maintenance – which calls for routine inspection and maintenance with less consideration for the actual condition of the equipment. CBM measures several chemical and physical aspects of the transformer, such as temperature and the presence of undesirable chemicals inside the structure.

CBM will lead to better reliability because some issues will be sensed before they eventually lead to failure. Reliability at the substation transformer level is important due to the large amount of customers potentially affected by a failure. In some cases, the transformers supply power to up to 20,000 customers each. A failed transformer can take very long to replace and causes significant operational concerns during the outage.

CBM should also save money and resources for its maintenance programs. The analogy is similar to a motor vehicle where many people change their oil once every three to five thousand miles. The new technologies can sense when the oil needs to be changed and can dramatically prolong the time between necessary oil changes.

SDG&E is currently collecting data, and has built IT systems to monitor the data. In the next few years, the data will be able to be analyzed in a probabilistic sense to determine when maintenance and potential repair/replacement operations should be undertaken. Working together with national and international consortiums, relationships between failures and CBM data is being considered.

6. Starting Soon

Fleet

While still early, the utilities are considering applying quantitative risks specific to vehicle fleet safety issues. The utilities have a large fleet of vehicles that drive many miles each year. Each time a trip is undertaken there is a chance that something undesirable may occur. The future analysis will likely include safety implications to the public in general, as well as employee safety.

The initial work will analyze current risk, determined by likelihood and consequence, based on available data. Then the utilities will explore mitigation strategies and determine the effectiveness of those strategies.

RAMP Data Collection
(RAMP-E)

November 30, 2016

#310380

Data Collection

1. Introduction

This chapter describes the data relevant to risk mitigation that SoCal Gas and SDG&E collect and areas where the Companies will be augmenting current practices. In Decision 14-12-025, the Commission identified the need for RAMP filings to include information regarding the utilities' steps to "improve the collection of data and provide a timeframe for improvement" for business areas with less data, so that "the utilities can position themselves to make major improvements in risk assessment" for later S-MAP filings.[1] As the Commission has recognized, having historic data available regarding the effectiveness of mitigations and the performance of assets will enhance the management and modelling of risks.

SoCalGas and SDG&E have gathered data on the performance of their systems for many years. For example, SDG&E has an extensive database of electric cable performance; similarly, SoCalGas has PHMSA failure data for incidents within the pipeline industry. In addition to using various internal systems to accumulate data on assets' performance over time, both SDG&E and SoCalGas collaborate with manufacturers, consultants, and various industry consortiums to enhance data collection and analysis. Data from these sources, in concert with subject matter expertise, was used to develop probabilistic risk models (e.g., for assessing wildfires) to support the RAMP.

SDG&E and SoCalGas plan to continue current data collection practices and add to or extend these efforts in several ways to support their risk management processes. For example, the technical working group formed as part of SMAP has been discussing potential metrics that can be used as part of the Accountability Reports. The planned initiatives to improve data collection will support the development and tracking of these measures to monitor risk levels. Below are some examples of data collection improvement efforts for selected risks within the three risk types[2] – electric, gas and cross cutting.

2. Electric

Electric Infrastructure Integrity

SDG&E has been addressing the need for data to determine the affect climate change may have on the integrity of its electric infrastructure. Specifically, current climate science is indicating that the extreme risk scenarios that SDG&E has operated to in the past are changing, and will continue to change in the years and decades to come. The most recent science and vulnerability assessments completed by SDG&E are indicating that climate change will expose the SDG&E electric system to, among other threats, the following:

1 D.16-08-018 at 152.

2 The types of risks included within the RAMP.

- Increase in wildfire activity across Southern California;
- Expansion of high fire risk to coastal canyons/wildland interfaces;
- Increased susceptibility of low-lying substations due to sea level rise; and
- Increase in peak demand for electricity.

In addition to increasing efforts to access data for monitoring the effects of climate change on the integrity of the electric infrastructure, SDG&E is continuing to improve the information available regarding asset performance. For example, extracting data embedded in other records to improve usability. As SDG&E continues to refine its focus on asset classes this information will, at some point in the future, be linked to specific assets. This will make the data available for additional probabilistic analysis.

Construction Quality Assurance/Quality Control

SDG&E's Electric Infrastructure Integrity Risk chapter in its RAMP report discusses a proposed Post-Construction True-Up Quality Assurance and Quality Control (QA/QC) program which provides dedicated personnel, activities, and tools to proactively identify and correct pole loading issues by way of activities including data analytics, engineering, training, and validation or improvement of construction standards and work methods. The proposed program would supplement existing efforts by steadily improving construction quality and placing greater emphasis (identification and timeliness of mitigation) on field follow-up for poles with high risk of failure. *The program would implement additional routine inspections to capture data to further evaluate whether poles meet safety standards.* Upon the discovery of potentially unsafe conditions, timely reinforcements or replacements would enhance risk reduction and safety.

Condition-Based Maintenance

SDG&E is also proposing to expand its Condition Based Maintenance (CBM) infrastructure to include Transmission and Substation Battery assets. These programs will enable *data gathering in order to better understand critical infrastructure integrity by predicting future failures and understanding how to develop and maintain best safety practices when operating these devices*. These systems also enable timely maintenance practices to better ensure asset health.

3. **Gas**

Catastrophic Damage involving Gas Infrastructure (Dig-Ins)

Gas Infrastructure Dig-Ins involving third parties can have serious safety consequences. SoCalGas has collected data on the cause of third party dig-ins. For example, SoCalGas is aware that sixty percent of dig-ins occur when the third party fails to notify SoCalGas by calling 811. Using this data, SoCalGas has put in place risk mitigations to address both third-party actions and internal practices. SoCalGas plans to continue to collect data on dig-ins including determining historic trend information for individual contractor failure to call 811 or compliance with regulations. The actions and timeline to implement further data collection are:

- Collect specific contractor data connected to dig-in data by end of 2018.
- Enhance collection of detailed damage collection data by end of 2018.

- Evaluate effectiveness of corrective actions taken post incident by end of 2019.
- Improve locate and mark reporting by end of 2019.
- Add GIS tagged dig-in data by end of 2019.

4. Cross-Cutting

Workforce Planning

SoCalGas has identified the risk of not having an appropriate workforce with the right skills to meet the business needs due to acceleration of workforce attrition and changing business needs. To evaluate this risk, SoCalGas has collected data through benchmark analysis (e.g., eligibility of SoCalGas employees for retirement), third-party data (e.g., Department of Labor statistics on millennials) and company data (e.g., mobility and promotion data). The data collected has been used to develop workforce planning risk mitigations. SoCalGas' Organizational Effectiveness and Human Resources Services organization will continue to collect data in collaboration with other SoCalGas units to improve the risk analysis for Workforce Planning. Examples of enhanced data collection include:

- Implications and effectiveness of succession planning and knowledge transfer on attrition;
- Emerging new roles related to new business needs and the effectiveness of mobility and promotion practices on filling the roles; and
- Effectiveness of training to counteract employee attrition.

All of these data collection efforts will be aligned with the implementation of the mitigations discussed in the proposed risk mitigation plans described in the risk chapters.

Since data collection is specific to individual risks and/or departments, a timeline for improvement will occur over the next two to four years. SDG&E and SoCalGas will continue to work with the Safety Enforcement Division and parties in the SMAP proceeding to develop a plan to improve data collection efforts.[3]

[3] D.16-08-018, OP 11, pp. 196-97.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Lessons Learned
(RAMP – F)

November 30, 2016

#310390

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Lessons Learned

1. Background

In accordance with Decision (D.) 16-08-018,[1] San Diego Gas & Electric Company (SDG&E) and Southern California Gas Company (SoCalGas) (collectively referred to as the utilities) put forth these lessons learned that can be applied to future utilities' Risk Assessment Mitigation Phase (RAMP) reports. The process of developing this Report enhanced SoCalGas and SDG&E's Enterprise Risk Management (ERM) practices and heightened awareness company-wide with respect to identifying, evaluating, managing, and mitigating risk. The lessons presented below are specific to SoCalGas and SDG&E processes but are intended to assist other utilities as they embark on their future RAMP filings.

2. Lessons Specific to SDG&E and SoCalGas' Processes

The utilities have made significant progress in the evolution of their risk management practices by going through the RAMP process. Some of the identified lessons were incorporated into the annual risk evaluation process and others are longer-term goals. The areas identified are enhancements to the risk evaluation process, data collection, accounting systems and risk reduction benefits. For purposes of this Report, these lessons learned are specific to the utilities' risk management framework for General Rate Case (GRC) purposes.

Risk Evaluation

The risk evaluation and registry process, facilitated by the ERM organization, continues to evolve and has new value-added aspects. Identifying and documenting the risk scenario used to score risks is one such area. The utilities' Subject Matter Experts (SMEs) select a reasonable worst case scenario as the basis of the risk score. The reasonable worst case scenario is not limited to direct experiences from the utilities; rather, it is based on events that have occurred or could reasonably occur at any utility. The scenario clarifies why the risk was scored as it was. This is particularly important because many of the risks have elements that are low consequence/high frequency as well as the opposite, high consequence/low frequency.

Take, for example, the risk of Catastrophic Damage Involving Gas Infrastructure (Dig-Ins). Third-party contacts with underground utility equipment or Dig-ins are rather frequent across the country, but most have little to no serious safety implications (i.e., high frequency/low consequence). A subset of Dig-ins, however, have the potential for significant safety consequences, but the occurrence of those events are less frequent (i.e., high consequence/low frequency). The risk scenario identifies which situation was considered when scoring the risk, which provides context for the score itself and how the proposed mitigations can be effective. In the future, examining and planning for the probability distribution of all Dig-Ins would be an

[1] D.16-08-018 at page 152 requires the utilities to "[i]dentify lessons learned in the current round to apply in future rounds," such that "[l]essons learned by one company will also inform the RAMP filings of the other companies."

improvement over examining one end or the other of the spectrum, low consequence to high consequence.

The utilities also made revisions to their risks and the accompanying scores in 2016. Generally, each company's identified risks are revisited annually to reflect any new facts and information, including events occurring since the last risk registry refresh. This process also includes revising the scope of existing risks and considering the addition of new risks. Broadly scoped risks in 2015 were revised to be more narrowly focused. For instance, a risk may have originally been very general; however overtime, it was realized that the risk was more specific in nature. Then, the risk may be updated to provide for a narrower scope.

Another enhancement in the upgraded risk evaluation process is the SMEs were asked to provide data to explicitly support their risk score, to the extent feasible. This will allow the utilities to identify areas where data collection can be improved as well as provide a data-driven basis for the risk score. This is largely a long-term goal of SDG&E and SoCalGas.

Data Collection

The utilities are currently evaluating increasing the amount of data collected and tracked. The utilities recognize that data collection is related to reporting, benchmarking and metrics as well. In accordance with D.16-08-018, the Safety and Enforcement Division (SED) has convened a technical working group to, in part, develop a plan to enhance data collection efforts.[2] The utilities are active participants in this working group and will adhere to future California Public Utilities Commission (CPUC or Commission) directives on this issue. For more details on data collective, please refer to the chapter within this RAMP Report on Data Collection.

Accounting Systems

The utilities currently present and analyze information in the GRC by cost centers, which tend to follow the organizational structure of the company, and capital budget codes. In the RAMP, rather than the typical cost center and budget code look, the utilities are presenting information based on the identified key safety risks and the mitigations for those risks. These safety risks are generally not limited to a specific organization and can span company-wide. Because the utilities' accounting systems are not configured on a risk or activity basis, gathering historical cost information to establish the baseline costs posed a challenge.

To compile costs according to risk or activity, the utilities considered taking a similar approach to that of the GRC with respect to costs. This consists of pulling accounting information, making adjustments to historical data where applicable, analyzing the data, and estimating costs using a forecasting methodology. The first step of pulling historical accounting information, however, was a challenge because the utilities do not have accounting data available in that manner. Consequently, the utilities first needed to identify all the projects and programs in place to mitigate the RAMP safety risks, determine where the activity was booked and then pull the applicable accounting data.

[2] D.16-08-018 at Ordering Paragraph (OP) 11.

For this Report, the utilities applied a hybrid method for developing costs. That is, when available, accounting information was used, sometimes referred to as a bottoms-up approach. Conversely, when no accounting information could be discerned, high-level assumptions based on SME judgement, also known as a top-down approach, were used.

Given the limitations with the existing accounting systems, as well as accountability reporting requirements[3] following the GRC, the utilities are currently evaluating their accounting systems and/or processes to determine if modifications are needed to incorporate risk-related attributes for tracking purposes. In their next RAMP Report, the utilities hope to employ a cost gathering and evaluation process in line with the one used to prepare their GRC.

Quantification of Risk Reduction

For this Report, the utilities are quantifying risk reduction for the first time and are providing early stage risk reduction calculations for proposed mitigation plans. Because the quantification of risk reduction is new territory for SDG&E and SoCalGas, many assumptions were used in the benefit calculations that the utilities may be able to improve upon in the future. Experience and a history of quantifying benefits are expected to improve the utilities' ability to analyze risk spend efficiency and to align investment decisions with risk benefits in future years.

3. Advice for Other Utilities

The discussion below highlights areas where utilities may wish to explore process and timing improvements in their future RAMP filings.

Scope of Risks

In determining mitigations,[4] SDG&E and SoCalGas considered two alternative approaches: (1) include mitigations that address all impact areas associated with the risk (e.g., reliability); or (2) include only safety-related mitigations. Initially, the utilities considered taking the first approach, presenting all applicable mitigations associated with each risk rather than primarily those that are safety-related. In essence, the mitigations would have been all-inclusive (i.e., the mitigations would represent all impact areas). In other words, the key risks would be selected

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[3] D.14-12-025 at OP 1 requires an Accountability Spending Report.

[4] The utilities present this Report at the mitigation level consistent with the Commission's directives. *See* D.14-12-025 at 32. There are three levels of detail with respect to the risk mitigation plans:

1. Risk –the least granular, highest level that provides information for a particular risk at a portfolio level.
2. Mitigation – projects and programs that have been grouped into higher level categories (i.e., mitigations) based on similarity, dependency or because they address the same drivers or consequences.
3. Project/Program – the most granular, details review of the specific projects and programs the utility is or proposes to perform.

The mitigation level provides details about the intent of the mitigation activities without presenting overwhelming amounts of information on each project or program.

based on a safety-related threshold;[5] however, once the risk was included in the RAMP, all the activities that mitigate the risk would be presented.

However, the RAMP is based on Senate Bill 705 which stated that "the commission and each gas corporate place safety of the public and gas corporation employees as the top priority."[6] This safety focus was echoed in D.16-08-018: "Overall, the utility should show how it will use its expertise and budget to improve its safety record."[7] Further, the utilities chose to go with the second approach based on feedback from SED, that safety mitigations and those reliability activities that also have a safety impact should be included, and because addressing all mitigations could render the RAMP report unnecessarily long. Moreover, the additional length would not provide much benefit, because safety and reliability benefits are often challenging to separate. Consequently, SoCalGas and SDG&E selected for inclusion in the RAMP risks that received a score of four (4) or more in the Health, Safety, and Environment category, as described in more detail in the Overview and Approach section of this Report. While SDG&E and SoCalGas recommend this approach, the other utilities should decide early in the process as to which mitigations should be included in their respective RAMP submittals.

SDG&E and SoCalGas also recommend that other utilities going through the RAMP process should, at the beginning, group projects/programs into mitigations that address the same drivers or consequences, go together and/or have dependencies. For example, one mitigation trains personnel for an activity. Another mitigation performs the work after personnel is trained. Those two items are dependent on each other and, therefore, should be grouped into one mitigation at the beginning of the RAMP process. However, if you are not thinking of mitigations in terms of their risk reduction, you will likely keep them separate. This was the case for SDG&E and SoCalGas, where the utilities determined mitigations toward the beginning of the RAMP process. However, when the risk spend efficiency efforts began, not all the mitigations were grouped in a way that was optimal for risk reduction purposes. Identifying dependencies at the beginning of the process could help to improve the resulting analysis.

Lastly, some of the activities presented in the risk chapters help to mitigate multiple risks. With regard to these overlapping activities, SDG&E and SoCalGas recommend that the other utilities either allocate on a percentage basis the costs associated with the overlapping mitigations or make a determination of the most fitted risk to include the costs. The RAMP is not a venue to

[5] Pursuant to D.14-12-025 at 31, "the purpose of the RAMP is to examine the utilities' assessment of key risks and proposed programs for mitigating those risks." Consistent with this purpose, the utilities first determined the "key" safety risks to include in this Report. The threshold to determine which risks to include was agreed upon by stakeholders during the workshop process in the context of the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002 and subsequently adopted in D.16-08-018 (Interim S-MAP Decision). D.16-08-018 at p. 151. It should be noted that this RAMP Report was developed concurrently while A.15-05-002 was pending before the Commission. Shortly thereafter, mitigations for those "key" risks were identified for 2015 (baseline) and the proposed plan.

[6] D.14-12-025 at p. 16.

[7] D.16-08-018 at p. 151.

request funding, but rather to present the risk assessment approach utilized by the utility into the GRC process; therefore, SDG&E and SoCalGas determined that presenting mitigations and their costs in all applicable chapters would be the most accurate and complete way to demonstrate the entirety of the costs and risk reduction benefits associated with the mitigations. SDG&E and SoCalGas have discussions in the risk chapters to explain these overlapping mitigations. For example, security guards help to mitigate the risk of Workplace Violence as well as any physical security concerns, and where an activity mitigates more than one risk, in order to show a complete mitigation plan, the utilities included that activity in all the applicable risks. However, this process presented challenges because the mitigations were determined rather early on in the process, while the risk reduction was completed toward the later part of the RAMP process. In essence, because 100% of the risk reduction for an overlapping mitigation was included, 100% of the costs needed to be included in each risk. SDG&E and SoCalGas may explore alternative methodologies of demonstrating these overlaps in their next RAMP filing.

Process Improvements

Generally, the utilities have been doing GRCs in the same way for decades. The RAMP process is new and requires significant efforts to socialize the intent and requirements throughout each company. Many of the RAMP teams were comfortable with SDG&E's and SoCalGas' risk evaluation methodology (i.e., the 7X7 matrix) as it has been used for several years, specifically with discussing why the risk scores were assigned. However, the process of developing the RAMP Report was uncharted territory. As mentioned above, gathering cost information by mitigation was challenging, as was attempting to quantify risk reductions for the mitigations. The change management efforts were notable and should not be overlooked.

For other utilities developing a RAMP Report, SDG&E and SoCalGas recommend the following:

- Provide frequent communication with teams and management – SDG&E and SoCalGas had frequent touch points with the RAMP teams through standing weekly meetings, All Hands Meetings, etc.
- Give guidance to teams as early as practical – although items come up throughout the process, the more guidance provided at the beginning the better.
- Hold planning sessions early in process to provide an opportunity to:
    - Understand the risks and related mitigations;
    - Ask why mitigations have been included in the risk mitigation plans;
    - Gain insights as to how SDG&E and SoCalGas can strengthen the RAMP Report; and
    - Understand the next steps regarding the development of the RAMP Report.
- Feedback and participation is critical and best known when there is still time to make revisions, if necessary, to the Report.

- To the extent it is possible, having the cost estimates complete prior to commencing risk reduction efforts help to eliminate potential duplicative work, especially if there is a number change after the risk spend efficiency has been calculated.
- Provide considerable time for quantifying the risk reduction – risk reduction is a new concept that is not necessarily intuitive. It is very challenging for the subject matter experts to determine the amount of risk reduction that can be achieved by implementing a particular mitigation. For example, what is the "benefit" or how much is risk reduced by implementing a public awareness campaign? This is difficult to address qualitatively, let alone attempt to quantify. SDG&E and SoCalGas originally had planned to spend six to eight weeks for the risk reduction calculation process, which proved to require more time.
- Manage expectations regarding risk reduction – not all mitigations are designed to reduce the risk score. Some mitigations are compliance-related while others are needed to prevent the risk from increasing, and are needed just to maintain status quo. This is important for all parties to understand.

SDG&E and SoCalGas expect that as the RAMP process matures, so will the utilities' showings. The utilities will continue to learn both from their experience as well as from the other utilities.

Risk Assessment Mitigation Phase
Risk Mitigation Plan

Catastrophic Damage Involving Third Party Dig-Ins
(Chapter SCG-1)

November 30, 2016

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Executive Summary

The Catastrophic Damage Involving Third Party Dig-Ins (Dig-Ins) risk relates to the potential impacts from dig-ins resulting from third-party activities.

To assess this risk, Southern California Gas Company (SoCalGas) first identified a reasonable worst case scenario, and scored the scenario against five residual impact categories (e.g., Health, Safety, Environmental; Operational & Reliability, etc., discussed in Section 4). Then, SoCalGas considered as a baseline, the SoCalGas mitigations in place for Dig-Ins in 2015 (discussed in Section 5) and estimated the costs (summarized in Section 7). SoCalGas identified the following controls as of 2015: (1) Training consisting of two programs associated with locate and mark; (2) Locate and Mark consisting of three activities that relate to performing or supporting locate and mark work; and, (3) Damage Prevention Public Awareness includes a variety of activities including, for example, billboards, safety events, social media, etc.

These controls focus on safety-related impacts (e.g., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability.

Based on the foregoing assessment, SoCalGas proposed future mitigations (discussed in Section 6). For Dig-Ins, SoCalGas proposed to continue the four control categories from its 2015 baseline. In addition, SoCalGas proposed enhancements within each category as well as incremental programs that aim in reducing frequency. The enhancements include, for example, increased resources to perform locate and mark activities in anticipation of increase demand due to new legislation; standardizing locating equipment providing uniformity and enabling focused employee training; and issuing smart devices to capture photographs of location marks.

Next, SoCalGas developed the risk spend efficiency (sometimes referred to as RSE). The RSE is a new tool that SoCalGas developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The RSE was determined using four mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Incremental Public Awareness (incremental mitigations)
2. In-Field Activities and Public Awareness (current controls)
3. Incremental Admin-side Analysis (incremental mitigations)
4. In-Field Activities and Improvements (incremental mitigations)

Finally, SoCalGas considered two alternatives to the proposed mitigations, and in the final section of this chapter, SoCalGas explains the reasons those alternatives were not included into its proposal.

Risk: Catastrophic Damage Involving Third Party Dig-Ins

1 Purpose

The purpose of this chapter is to present the mitigation plan of Southern California Gas Company (SoCalGas or Company) for the risk of a dig-in, caused by third party activities, which results in catastrophic consequences (e.g., dig-ins on underground piping and facilities referred to herein as Dig-Ins). In many cases, people or companies excavate in the vicinity of buried utility infrastructure without realizing the infrastructure is there.[1] These third party excavation activities can vary based on project size. An example of small excavation activity is a homeowner performing landscaping work in their yard. Larger excavation activities include farmers grading/tilling their land, construction companies digging in roadways or performing other underground infrastructure work.

This risk is focused on the more serious results of third party damage that lead to a release of natural gas with the possibility of hazard to life and property. The release of natural gas may not just occur at the time of the damage. A leak or rupture may also occur after the infrastructure has been damaged and reburied but becomes weakened over time. As mentioned above, typically contractors and homeowners do not intentionally damage underground substructures. This risk is limited to those cases where there is no intent to damage the gas infrastructure.

This risk is a product of SoCalGas' September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used as base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SoCalGas and San Diego Gas & Electric (SDG&E) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of the utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[2] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, the

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[1] A discussion of potential dig-ins drivers is provided in Section 3.2.
[2] Commission Decision (D.) 14-12-025 at p. 31.

RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

2 Background

Across the spectrum, third party damage to pipelines can range from minor scratches or dents, to ruptures with an uncontrolled release of natural gas. Serious consequences may be realized if an event occurs because of this risk. For example, if a leak or rupture occurs, an ignition of the released gas could cause an explosion and/or fire where people nearby could be seriously injured.

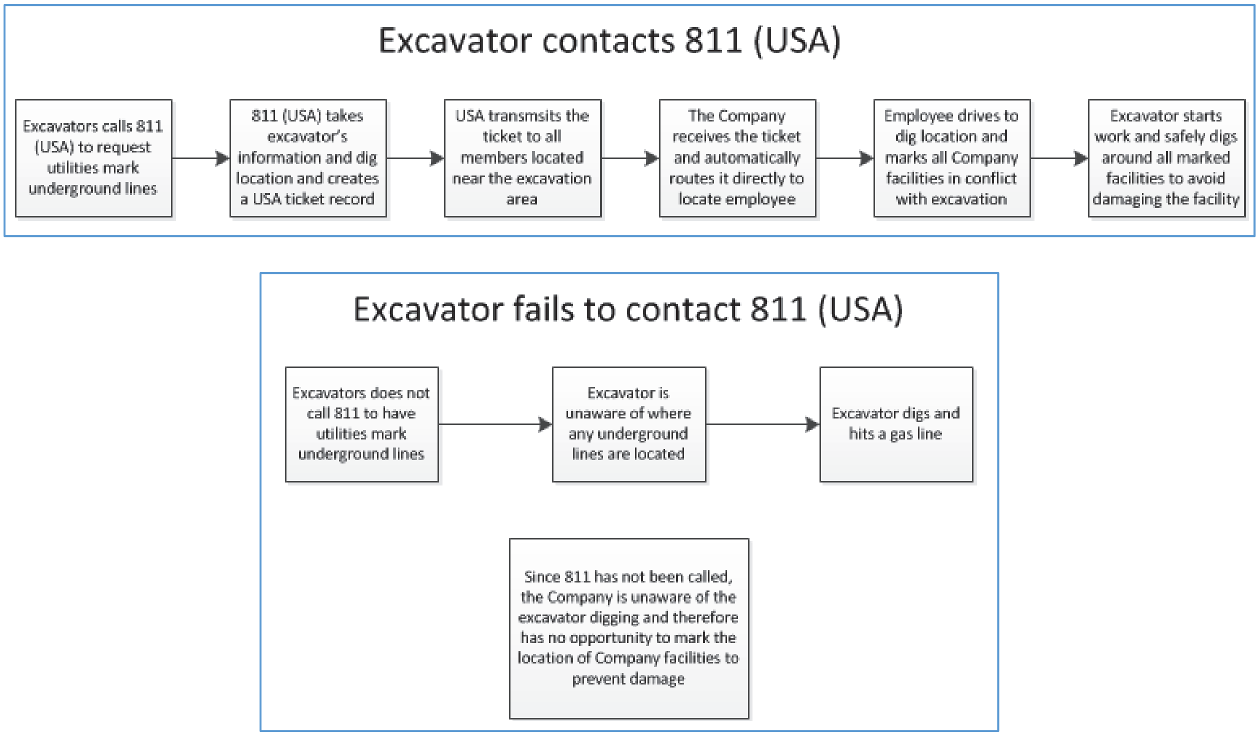
Past incidents substantiate these risks:

- In 2015 a Pacific Gas and Electric Company (PG&E) High Pressure Transmission line was ruptured when an excavator failed to schedule a standby for farm work near Bakersfield, California. The excavator proceeded to dig over the Transmission facility and struck the line causing an explosion that killed the excavator, destroyed the excavation equipment, and damaged buildings miles away.
- In 2015 a PG&E High Pressure Transmission line was ruptured when an excavator failed to call 811 in Fresno, California. The excavator was grading over the Transmission facility and struck the line causing an explosion that killed the excavator, and injured several others.

Under State Law, third parties planning excavation work have the responsibility of contacting the Regional Notification Center for their area, also known as 811, Underground Service Alert (USA), or DigAlert, at least two (2) full working days prior to start of their construction excavation activities. Once a third-party makes the contact, the Regional Notification Center will then issue a USA Ticket notifying local utilities and other operators of the location and areas to be inspected for potential conflicts with the pending excavation work. Operators are required to mark their underground facilities via aboveground identifiers (e.g. Paint, chalk, flags, whiskers) to designate where underground utilities are positioned, thus enabling third parties, like contractors and homeowners, to know where these structures are located. The law also requires third party excavators to use careful, manual (hand digging) methods to expose substructures prior to using mechanical excavation tools.

Figure 1 below illustrates the sequence of events that may occur when a third party contacts 811 (USA) prior to conducting excavation work or the sequence when they do not.

Figure 1: Excavation Contact Process Flow



As can be seen from the above flow charts, while there may be more steps when a third party calls 811 prior to commencing the excavation work, it is more likely to result in a positive outcome compared to when a call is not made. Having third-parties call 811 before digging is critical and can significantly reduce the likelihood of a potential event if the correct processes are followed.

SoCalGas operates and manages a natural gas system of over 95,000 miles of Distribution pipe and 3,485 miles of Transmission pipe within its 20,000 square mile service territory. This large piping network, and large service territory exposes the Company to potential dig-in related issues.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-004, "SoCalGas is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand, analyze and categorize risks."[3] The Enterprise Risk Management (ERM) process and lexicon that SoCalGas has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of

[3] A.15-05-002, filed May 1, 2015, at p. JMD-7.

quantification within its evaluation and prioritization of risks.[4] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Dig-Ins risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SoCalGas and SDG&E in A.15-05-004, SoCalGas classifies this risk as a gas, operational risk as shown in Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	GAS	HIGH PRESSURE (>60 PSIG)
OPERATIONAL	GAS	MEDIUM PRESSURE (≤60 PSIG)

3.2 Potential Drivers[5]

When performing the risk assessment for Dig-ins, the Company identified potential indicators of risk, referred to as drivers. These include, but are not limited to the following:

1. **Third party contractors or homeowners/renters do not call a one-call center for locate and mark prior to their excavation.**

   Despite the creation of Regional Notification Centers to make it easy for the public to have underground infrastructure located and marked, and large advertising campaigns to alert the public of the need for doing so, incidents are still occurring where excavations are conducted without calling the one-call center for locating and marking underground utility infrastructure. Third party failure to contact the Regional Notification Center prior to excavating is the leading contributor of damages to Company pipelines. Third parties can damage or rupture underground pipelines and potentially cause property damage, injuries or even death if gas lines are not marked; and lines cannot be marked if the regional notification center is not contacted.

   This risk driver is the most frequent root cause of dig ins as it accounts for approximately 60% of dig-in damage to buried Company facilities. When an excavator chooses to dig without calling 811, the excavator assumes a risk that is out of the Company's control. Without receiving an 811 ticket, the Company has no opportunity to mark its facility within the area of excavation.

[4] Testimony of Diana Day, Risk Management and Policy, submitted on November 14, 2014 in A.14-11-003.
[5] An indication that a risk could occur. It does not reflect actual or threatened conditions.

2. **Company employees performing locate and mark tasks do not mark the underground gas infrastructure correctly.**

   The Company or a Company Contractor, in some cases, inaccurately marks its facilities due to incorrect operations, such as mapping/data inaccuracies, equipment signal interference, and human error. When this happens, third parties are not provided accurate knowledge of underground substructures in the vicinity of their excavations and the risk of damaging or rupturing gas pipelines increases.

3. **Excavator fails to comply with excavation laws or best practices in the vicinity of located underground gas infrastructure.**

   Damages often occur because the excavator fails to follow excavation legal requirements and best practices after calling USA. California State law (see Government Code 4216 et. seq.) requires the excavators to perform several duties so that underground facilities are not damaged; for example:
   - Delineate the work location – The excavator is required to identify the excavation area with white markings so that the utility marks are provided in the correct area. If the excavator fails to delineation the work area, there is a risk that all facilities may not be marked.
   - Confirm all utilities have been marked – Before the excavation can start, the excavator must confirm all utilities listed on the USA ticket have marked or have communicated that there is no conflict with the proposed excavation. If the excavator does not perform this duty, the excavator risks digging into a line that has not yet been marked.
   - Dig with care around marked facilities – Before using any power operated excavation equipment or boring equipment, the excavator is required to hand expose to the point of no conflict 24 inches on either side of the marked underground facilities to determine the exact location of these structures. If excavators do not use care when digging near natural gas pipelines they put themselves and others at risk for injuries. The Company has an extensive public awareness program in place to educate contractors and homeowners about the dangers of not following safe excavation laws and best practices.
   - Call for remarks if the marked facilities are no longer visible – When the excavator can no longer see the USA marks in the area of excavation, the excavator is required to call all utilities back to remark their facilities. If the excavator continues excavation work without requesting remarks from the utilities, there is a risk that a previously marked facility could be damaged.

4. **Company does not respond to a one-call center request (e.g., USA) in the required timeframe.**

   The Company may not respond to USA requests within the required time frame (within two working days of notification, excluding weekends and holidays, or before the start of the excavation work, whichever is later, or at a later time mutually agreeable to the operator and the excavator). This may happen because of, e.g., human error, poor communication, or system failures.

In these cases, third parties may not know that the locate and mark activity was not performed. They, therefore, may wrongly assume that not seeing any markings at their excavation site indicates there is no gas infrastructure nearby. Without the marked gas infrastructure, third parties can damage or rupture the infrastructure if they are performing excavation activities near pipelines.

5. **Company does not perform "standby" duties when a third party is excavating in the vicinity of a high pressure (>60 psig) gas pipeline.**

   Because high pressure pipelines (those that operate over 60 psig) pose a higher risk of hazard to life and property when damaged or ruptured, additional precautions are taken by the Company to observe excavation activities in the vicinity of these facilities. Qualified Company personnel are required to be present during excavation activities within 10 feet of any high pressure gas line (the presence commonly referred to as "stand-by"). The stand-by presence allows for redundancy via a Company representative should the third party not follow proper protocol during the excavation (e.g., not hand excavate near the pipeline), or the marks are determined to be inaccurate. Stand-by presence increases the excavator's awareness of all excavation requirements near the high pressure facility. These instances are given high priority since the impacts of an incident in these cases could be significant.

Table 2 below maps these five specific risk drivers to the larger driver categories in the taxonomy.

Table 2: Operational Risk Drivers

Driver Category	Dig-Ins Driver(s)
Asset Failure	Not applicable
Asset-Related Information Technology Failure	Not applicable
Employee Incident	• Company employees performing locate and mark tasks do not mark the underground gas infrastructure correctly • Company does not respond to a one-call center (e.g., USA) request in the required timeframe • Company does not have personnel perform "standby" duties when a third party is excavating in the vicinity of a high pressure (>60 psig) gas pipeline
Contractor Incident	• Excavator fails to comply with excavation laws or best practices in the vicinity of located underground gas infrastructure • Excavator does not call USA at least two working days before starting excavation work • Excavator begins work without notifying the Company, and as a result the Company does not perform "standby" duties during excavation near a high pressure (>60 psig) gas pipeline
Public Incident	• Third party contractors or homeowners/renters do not call a one-call center for locate and mark prior to their excavation • Excavator fails to comply with excavation laws or best practices in the vicinity of located underground gas infrastructure • Excavator begins work without notifying the Company, and as a result the Company does not perform "standby" duties during excavation near a high pressure (>60 psig) gas pipeline
Force of Nature	Not applicable

3.3 Potential Consequences

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

- Fatalities or severe injuries and property loss.
- Major outage.

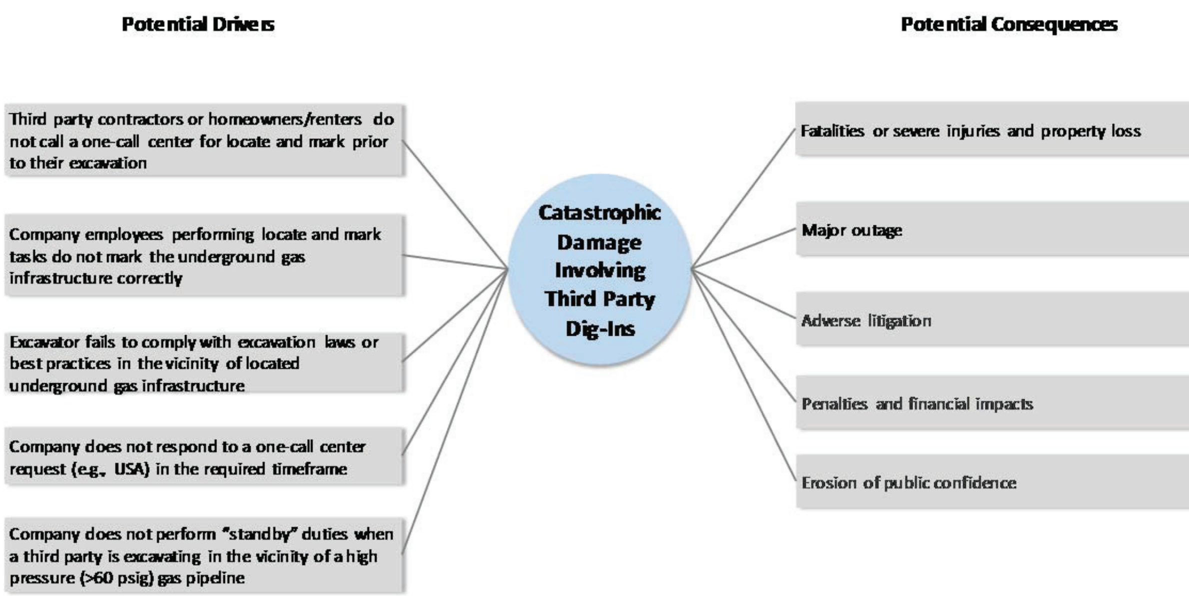
- Adverse litigation.
- Penalties and financial impacts.
- Erosion of public confidence.

These potential consequences were used in the scoring of Dig-Ins that occurred during the SoCalGas' 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown in Figure 2 is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SoCalGas applied this framework to identify and summarize the information provided above.

Figure 2: Risk Bow Tie



4 Risk Score

The SoCalGas and SDG&E ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Dig-Ins as one of the enterprise risks. During the development of the risk register, subject matter experts (SMEs) assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a dig-in can occur. For purposes of scoring this risk, SMEs used a reasonable worst case scenario to apply the impact and frequency. The scenario represented a hypothetical situation that could be expected to happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The SMEs selected a reasonable worst case scenario to develop a risk score for Dig-Ins and the scenario selected to assess the Dig-Ins risk is:

- A natural gas pipeline ruptures due to third-party excavation work in a populated business district during business hours, which results in fatalities, injuries, and substantial property damage.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, SMEs then evaluated the frequency of occurrence and potential impact of the risk using SoCalGas' 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[6] Using the levels defined in the REF, the SMEs applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the Dig-Ins risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, SoCalGas included this risk in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	4	3	4	5	233,365

[6] D.16-08-018 Ordering Paragraph 9.

4.3 Explanation of Health, Safety, and Environmental Impact Score

Dig-ins have led to fatalities and injuries; for instance, consider the two instances in 2015 discussed in Section 2.[7] Accordingly, this risk was scored a 6 (severe) in the Health, Safety, and Environmental impact category.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, the following scores were assigned to the remaining residual risk categories.

- **Operational and Reliability:** Based on the scenario of a dig-in that results in a pipeline rupture, a score of 4 (major) was given in the Operational and Reliability impact category. This is due to past experience where dig ins have resulted in major outages. Depending on the location of the damage, thousands of customers could lose service. The potential for one critical customer to lose service, especially in a business district, is far more likely to occur even in a less critical incident. Finally, loss of service over many days is not uncommon with these types of events, which may occur every 2-3 years.
- **Regulatory, Legal, and Compliance:** Next, a score of 3 (moderate) was given in the Regulatory, Legal and Compliance impact category because the controls and oversight SoCalGas already has in place indicate that current efforts address this risk.
- **Financial:** Finally, a score of 4 (major) was given to the Financial impact category due to potential costs associated with a catastrophic event and the likelihood of multiple lawsuits and high value settlements.

4.5 Explanation of Frequency Score

Based on the reasonable worst case risk scenario of a Dig-In, a score of 5 (extensive) was given for how likely this event is to occur. Although catastrophic dig-in related events have not recently occurred in SoCalGas' service territory, the risk of a catastrophic dig-in related incident exists because of the frequency with which dig ins occur. Damage occurs in the Company's service territory every three hours based on the 2,800 damages in 2015. Approximately 60% of these damages did not have a USA Ticket.

The graph provided below illustrates the number of significant gas pipeline excavation incidents in California over a 20-year period, from 1996-2015.[8]

[7] http://seuc.senate.ca.gov/sites/seuc.senate.ca.gov/files/12-17-15_background.pdf.
[8] The information is from the Pipeline and Hazardous Materials Safety Administration website: http://www.phmsa.dot.gov/pipeline/library/data-stats/pipelineincidenttrends .

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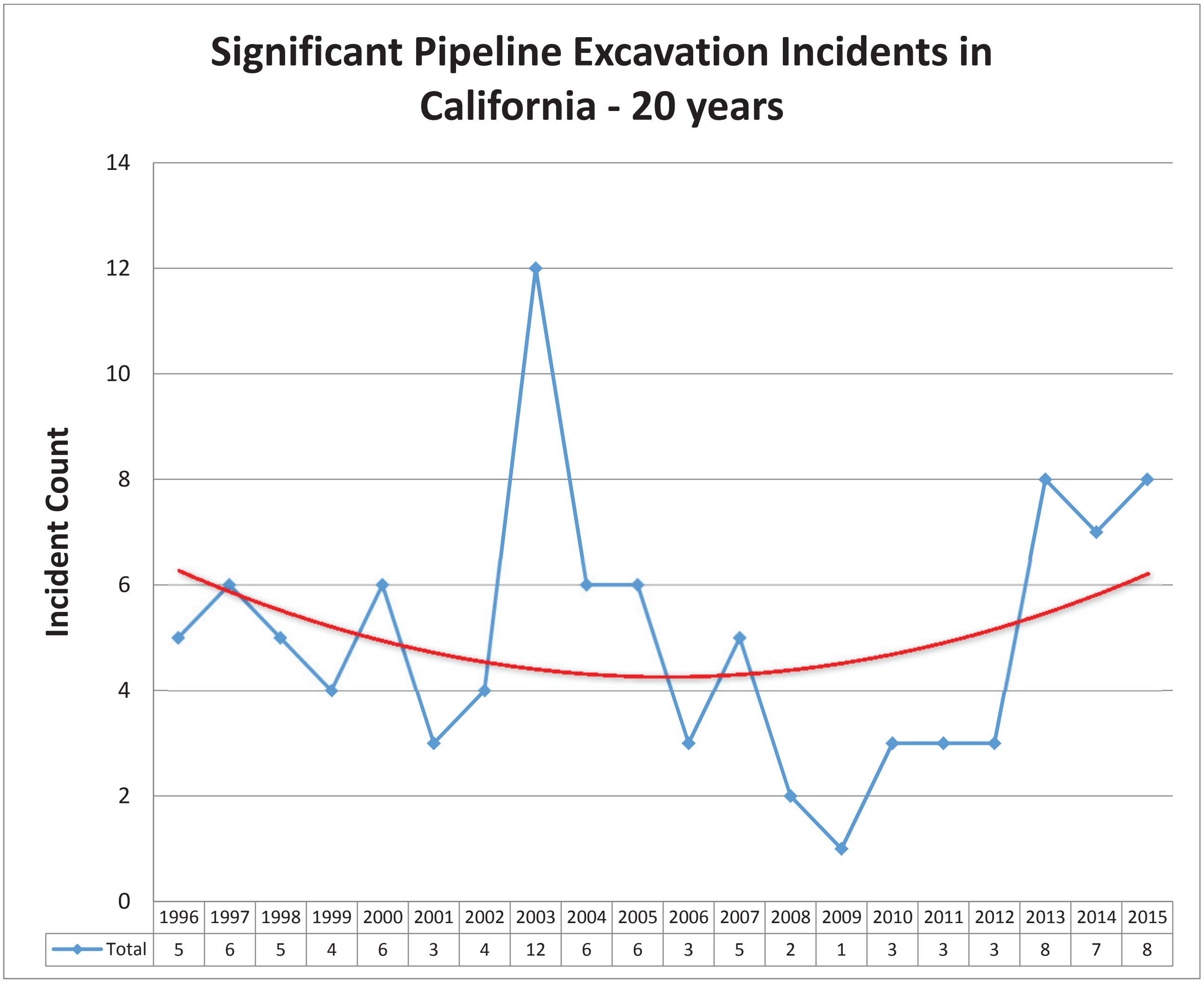


As shown above, the significant incidents involving gas pipelines in California are on the rise. Significant incidents are defined as:

1. Fatality or injury requiring in-patient hospitalization.
2. $50,000 or more in total costs, measured in 1984 dollars.
3. Highly volatile liquid releases of five barrels or more or other liquid releases of 50 barrels or more.
4. Liquid releases resulting in an unintentional fire or explosion.

Thus, the potential for a catastrophic event is high, and due to the current damage rate, the probability of this type of event occurring once every 1-3 years is reasonable, if further mitigations are not put in place.

5 Baseline Risk Mitigation Plan[9]

As stated above, the Dig-Ins risk involves impact to gas infrastructure arising from third party dig-ins. The 2015 baseline mitigations discussed below include the current evolution of the utilities' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include activities to comply with laws that were in effect at that time.

These controls focus on safety-related impacts[10] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[11] as well as controls and mitigations that may address reliability.[12] Accordingly, the controls and mitigations described in this section and in Section 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed risk mitigation plans are intended to address various events and is not limited to the reasonable worst case risk scenario used for the Risk Score (Section 4).

1. Training

This mitigation consists of two programs that provide employees the tools to perform activities associated with locate and mark: (1) Locate and Mark training and (2) Locate & Mark Operator Qualification. Adequately preparing employees by offering educational opportunities and resources gives them the knowledge to implement State and Company policies and procedures in a safe manner. This, in turn helps, SoCalGas operate and maintain its system as well as protect employees, contractors and the public from the likelihood of an event attributable to this risk.

Locate and Mark Training consists of approximately three days of classroom and hands-on training at a centralized training facility. This is a mandated activity in order to comply with Operator Qualification requirements and to provide the basic knowledge to satisfactorily perform this critical task. Training schedule is dependent on annual demand.

Locate and Mark Operator Qualification training provides demonstrated knowledge and competency to perform locate and mark activities. It is mandated by the U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) in Title 49 CFR Part 192, Subpart N – Qualification of Pipeline Personnel (192.801 through 192.809). Specifically, this enhanced training "requires pipeline operators to document that certain employees have been adequately trained to recognize and react to abnormal operating conditions that may occur while performing specific tasks."[13] Employing resources that are formally trained to be aware and react to unusual pipeline conditions

[9] As of 2015, which is the base year for purposes of this Report.
[10] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[11] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[12] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.
[13] http://www.phmsa.dot.gov/pipeline/tq/oq.

allows SoCalGas to potentially protect against an adverse event before its occurrence. Locators are qualified at the end of training and then every five years. This certification is an industry standard qualification program.

2. Locate and Mark Activities

This control is comprised of three activities that are related to performing or supporting locate and mark work: (1) Locate and Mark, (2) Pipeline Observation (stand-by), and (3) Staff Support. Verifying that SoCalGas is executing such tasks safely can reduce the potential of an event occurring.

The first activity is Locate and Mark, which is the actual work performed by SoCalGas gas operations required to respond to over 700,000 USA notifications per year. To do this activity, SoCalGas physically goes to the job site, locates any and all pipelines in the vicinity of the excavation, and marks its location appropriately. Knowing the location of the pipeline allows the third-party to avoid that area or carefully perform the excavation work to avoid contact with the pipeline. This activity is mandated by State Law (California Government Code 4216) and Federal law (the Code of Federal Regulation (CFR) Title 49 part 192.614). This control activity also includes all locators, their Supervisor time, vehicles, tools, Mobile Data Terminals (MDTs), Geographical Information System (GIS)-related costs, Ticket routing systems, Dispatch support, locating materials, fees to Regional Notification Centers and quality assurance.

The second Locate and Mark activity is Pipeline Observation (stand-by). In accordance with Title 49 CFR 192.935, Pipeline Observation (stand-by) is a mandated activity that requires a qualified Company representative to be present anytime excavation activities take place near a covered pipeline segment. Furthermore, the Company requires this activity for all pipelines operating at high pressure (pressure above 60 psig) which is an industry best practice. This activity occurs daily in both Distribution and Transmission operations. The purpose for this function is to decrease the likelihood of an event occurring that otherwise could have been prevented by having another pair of qualified eyes observing the work being done. This is a best practice in the gas industry and is critical to the safety of employees, contractors and the public.

The third activity is staff support. Support staff consists of one SoCalGas employee who is responsible for developing and maintaining policies, processes and procedures that guide and direct locators in properly performing their assigned tasks in compliance of Federal and State regulations. Staff is engaged daily in supporting operations by interpreting policies, tracking compliance, evaluating locate and mark tools and technologies, and providing refresher training as requested. This is a critical activity that allows the Company to meet or exceed State and Federal requirements and align with industry best practices when applicable.

3. Damage Prevention Public Awareness

Public Awareness is mandated pursuant to Title 49 CFR 192.616. Its purpose is to develop and implement a continuing public education program focused on use of the one-call notification system, hazards associated with the unintended release of gas; physical indications that an unintended release of gas has occurred; steps that should be taken to protect public safety in the event of gas release; and procedures for reporting unintended releases of gas. SoCalGas utilizes multiple channels for this communication such as billboards, bill inserts, radio announcements, bumper stickers, safety events, press releases, social media, and sponsorships to capture a vast audience.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. The Company's proposed mitigation plan consists of expanding some baseline activities as well as incremental programs that aim in reducing the frequency of a Dig-In.

1. Training

SoCalGas is proposing to continue this baseline activity with little to no changes. As discussed in Section 5, training is critical and aims to proactively reduce the potential of a dig-in based on factors that SoCalGas can control (e.g., mismarks).

2. Locate and Mark Activities

As discussed in Section 5, this mitigation includes the work of performing Locate and Mark, Staff Support and Pipeline Observation (standby). SoCalGas is proposing to increase the three activities.

a. Locate and Mark

Over the last 5 years, USA tickets have increased by 32%. This growth is forecast into the future as the current California excavation law gains additional enforcement and existing public awareness efforts increase excavators' awareness of digging laws. In 2016, the California Governor signed Senate Bill (SB) 661 which established an enforcement Board that is authorized to take action against those parties who violate the excavation law. The amendments are expected to compel more excavators to call USA which will add upward pressure to an already increasing ticket volume in the State. As a result, more employees will be needed to perform locate and mark activities in order for the Company to meet increasing USA ticket demands and prevent marking delays.

b. Support Staff

A management team is needed to analyze the excavation reporting collection and data to identify trends and develop continuous improvement action plans. The team will be specialized in targeting excavation trends needing the most attention and will have a presence in the field to meet with excavators on the jobsite and provide safe digging education. The team will also work with internal stakeholders to improve internal locate and mark activities and provide incident investigation support. One example of the team's activities will be to identify ways to prevent excavators from digging without a USA ticket since 60% of the Company's damages are due to the excavator failing to call USA.

c. Pipeline Observation (standby)

As discussed in 2.a., above, with the rise in USA tickets, external focus and new laws, SoCalGas is anticipating that there will be an increased need for pipeline observation. Pipeline observation helps to verify that employees and contractors are performing the work safely and following Company procedures. The proposed plan assumed that the Company's standby activities will grow in the year 2019.

3. <u>Public Awareness</u>

The Company is looking for ways to bring more awareness to 811 through additional sponsorships and partnerships across the service territory. Current public awareness efforts involve a variety of methods for educating excavators and potential excavators about the excavation laws and best practices. These methods include bill inserts, media campaigns, prevention industry memberships, sponsorships, radio advertising, internet advertising, billboard advertising, safety meetings, and more. The proposed public awareness efforts will increase the volume of current efforts and explore new creative ways to saturate the message into targeted audiences.

4. <u>Prevention and Improvements</u>

This mitigation includes incremental activities that will allow SoCalGas to proactively manage and mitigate the likelihood of Dig-Ins. Projects and programs included in this mitigation are: Standardize Locating Equipment, Issue Smart Devices to Locators, and Automated USA Ticket Prioritization.

a. Standardize Locating Equipment

Currently, the Company may use a variety of locating equipment to find the location of the Company's buried facilities in the excavation area. By having several locating units, there is a risk that an employee may not fully understand each unit which could result in an inaccurate field mark. Standardizing the locate and mark equipment will improve locator knowledge and experience with the equipment. It will also enable more focused training dedicated to one tool instead of several tools. Having a standardized locating device specifies the Company's best practice of using only one approved tool to mark its facilities. Along with improved equipment training, the equipment has advanced technology that is expected to improve marking accuracy.

b. Issue Smart Devices to Locators

This new mitigation will allow SoCalGas to proactively manage and mitigate the likelihood of Dig-Ins. Photographs are a common practice across the industry to protect companies from liability and enhance quality of locate and mark activities. Smart devices will give the Company the capability to capture photographs of location marks at the USA ticket location. The photographs will provide additional documentation for each USA ticket thus offering quality assurance options not currently available. These additional quality audits will improve marking accuracy.

c. Automated USA Ticket Prioritization

Some excavations may take priority over others because they are identified as more of risk and as such require additional response from the Company. For instance, if the excavation is within 10 feet of a high pressure facility, the Company must have a standby person at the site to watch the excavation near the facility. Currently the Company identifies ticket priorities using a manual process that may lend itself to human error. The Company is proposing to automate the prioritization process using complex algorithms based on ticket and GIS information. The prioritization will allow the Company to consistently take appropriate measures in a timely effort. This will improve identification when high-pressure facilities may be involved in which case a standby would be needed.

5. Analysis

Timely reporting of excavation incidents is a critical component of the continual improvement process. The reporting system is the basis for all excavation incident analysis. The Company is proposing to upgrade its reporting systems to improve timely data capture by using automated escalations, reduce data entry error by implementing improved data validation, improve system accessibility by making the system available across multiple platforms, and reduce reporting times by automating the reporting process. The upgraded reporting system will enable the Company to quickly analyze accurate data to make course corrections as trends are identified.

7 Summary of Mitigations

Table 4 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) addressed by a certain control activity, and the 2015 baseline costs for Dig-Ins. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SoCalGas does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

SoCalGas
A Sempra Energy utility

Table 4: Baseline Risk Mitigation Plan[14]
(Direct 2015 $000) [15]

ID	Control	Risk Drivers Addressed	Capital[16]	O&M	Control Total[17]	GRC Total[18]
1	Training*	• Company employees do not mark the underground gas infrastructure correctly • Company does not respond to a one-call center request in the required timeframe	n/a	$140	$140	$140
2	Locate and Mark Activities*	• Company employees do not mark the underground gas infrastructure correctly • Company does not have personnel perform "standby" duties	n/a	21,880	21,880	21,880

[14] Recorded costs were rounded to the nearest $10,000.
[15] The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[16] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[17] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[18] The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[16]	O&M	Control Total[17]	GRC Total[18]
3	Public Awareness*	• Third parties do not call prior to their excavation • Excavator fails to comply with excavation	n/a	950	950	950
	TOTAL COST			$22,970	$22,970	$22,970

* Includes one or more mandated activities

The mitigations and costs presented in Tables 4 and 5 mitigate the risk of dig-ins. Some of the activities also mitigate other risks presented in this RAMP Report; specifically, Records Management included GIS-related costs. Employee, Contractor, Customer, and Public Safety, as well as Workforce Planning, also included costs for Operator Qualification and Locate and Mark Training. Additionally, Catastrophic Damage Involving a High-Pressure Gas Pipeline Failure and Catastrophic Damage Involving a Medium-Pressure Gas Pipeline Failure have costs associated with Operator Qualification for specific personnel. Because these activities benefit Dig-Ins as well as the other aforementioned risks, the costs and benefits are being included in all applicable RAMP chapters.

A description of the costs provided in Table 4 is as follows:

1. <u>Training</u>
   The costs represent the student or employee labor time of attending the training, as well as materials and instructor time. Given that SoCalGas does not account for employees' time in a manner that explicitly provides details about the time spent per employee on training, high level cost estimates where used.

2. <u>Locate and Mark Activities</u>
   The costs associated with Pipeline Observation (stand-by) and Staff Support are primarily labor. The Locate and Mark mitigation costs, as described in Section 5, include labor as well as locating equipment (such as warning mesh, chalk, copper wire, and marker balls) and supporting technology.

3. <u>Public Awareness</u>
   This mitigation includes estimated costs for excavator education, advertising and media expenses, promotional, instructional and educational materials, and labor associated with supporting these activities.

Table 5 summarizes SoCalGas proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SoCalGas is identifying potential ranges of costs in this plan, and is not requesting funding approval. SoCalGas will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 5, the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 5: Proposed Risk Mitigation Plan[19]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[20]	2019 O&M	Mitigation Total[21]	GRC Total[22]
1	Training*	• Company employees do not mark the underground gas infrastructure correctly • Company does not respond to a one-call center request in the required timeframe • Company does not have personnel perform "standby" duties	n/a	$140 - 150	$140 - 150	$140 - 150
2	Locate and Mark Activities*	• Company employees do not mark the underground gas infrastructure correctly • Company does not	n/a	23,290 - 25,740	23,290 - 25,740	23,290 - 25,740

[19] Ranges of costs were rounded to the nearest $10,000.
[20] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SoCalGas' Test Year 2019 GRC Application.
[21] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[22] The GRC Total column shows costs typically represented in a GRC.

		have personnel perform "standby" duties				
3	Public Awareness*	• Third parties do not call a one-call center prior to their excavation • Excavator fails to comply with excavation laws	n/a	1,090 - 1,210	1,090 - 1,210	1,090 - 1,210
4	Prevention and Improvements	• Third parties do not call a one-call center prior to their excavation • Excavator fails to comply with excavation laws • Company employees do not mark the underground gas infrastructure correctly • Company does not respond to a one-call center request in the required timeframe	6,170 - 6,880	120 - 130	6,290 - 7,010	6,290 - 7,010
5	Analysis	• Third parties do not call a one-call center prior to their excavation • Excavator fails to comply with excavation laws	6,570 - 8,030	n/a	6,570 - 8,030	6,570 - 8,030
	TOTAL COST		$12,740 - 14,910	$24,640 - 27,230	$37,380 - 42,140	$37,380 - 42,140

	Status quo is maintained
	Expanded or new activity
*	Includes one or more mandated activities

1. Training
   SoCalGas does not expect a significant change in this activity when compared to the historical financial information. Therefore, the basis for the forecasted costs is the five-year historical average of 2011 to 2015. A range was then developed because the amount of Locate and Mark training and Operator Qualifications may vary on an annual basis.

2. Locate and Mark Activities
   The three projects/programs in this mitigation (Locate and Mark, Support Staff and Pipeline Observation) are being expanded in 2017-2019.
   - Locate and Mark - The increased costs are labor-related and are based on employee classification wages related to each additional employee. A range was identified to provide flexibility with respect to the employee classification.
   - Support Staff - The incremental costs are forecasted for a typical management salary for eight employees. A range was identified to provide flexibility with respect to the level of employee and the desired expertise.
   - Pipeline Observation - The costs are based on the 2015 recorded costs, and a percentage increase in standby work based on the forecasted increase in USA tickets.

3. Public Awareness
   The basis of the forecasted costs is 2015 recorded data. SoCalGas then assumed that the expanded public awareness efforts would be about a 5% increase annually for years 2017-2019. However, due to the different channels SoCalGas may use for effective messaging and communication, a range was developed for this activity.

4. Prevention and Improvements
   The three projects/programs in this mitigation (Standardize Locating Equipment, Issue Smart Automated USA Ticket Prioritization) are being expanded in 2017-2019. Costs were estimating using a zero-based forecast methodology because these are all new activities. Accordingly, a range was developed to provide flexibility as these projects and programs will be new.
   - Standardize Locating Equipment - The costs associated with this mitigation are based on GIS and KorTerra development and upgrades.
   - Issue Smart Devices to Locators - The costs include forecasts for the acquisition of the initial smart device and ongoing monthly telecommunications service contracts.
   - Automated USA Ticket Prioritization - The costs and range are forecasted based on previous IT projects with similar scope.

5. Analysis
   The forecasted costs and range for upgrading the reporting systems is based on SME knowledge of prior IT projects with similar scope.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent.[23] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[24]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts.

[23] D.16-08-018 Ordering Paragraph 8.
[24] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.

4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[25] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure shows the RSE calculation.

Figure 3: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 6 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SoCalGas analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Dig-Ins risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

The Proposed Risk Mitigation Plan in Section 6 identified five mitigations:

1. Training
2. Locate and Mark Activities
3. Public Awareness
4. Prevention and Improvements

[25] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

5. Analysis

For purposes of calculating Risk Reduction, the Company further combined these five mitigations into four groups, based on their applicability to the potential dig-in risk drivers, the inter-dependencies of their components, and whether they were current controls or incremental mitigations, as follows:

(a) In-Field Activities (e.g., dig-in prevention) and Public Awareness (current controls) – includes mitigations 1, 2, 3, and 4
(b) In-Field Activities and Improvements (incremental mitigations) – includes mitigations 1, 2, and 4
(c) Incremental Public Awareness (incremental mitigations) – includes mitigation 3
(d) Incremental Admin-side Analysis (incremental mitigations) – includes mitigation 5

- **Current In-field Activities and Public Awareness (Group a)**

This mitigation grouping combines current Public Awareness (mitigation 1), Locate and Mark (mitigation 2), and other Dig-In Prevention activities (mitigation 4), as they are inter-dependent. For example, if public awareness activities were discontinued, there would be far fewer, if any, calls for locate and mark; conversely, if locate and mark activities were discontinued, public awareness alone would not be effective in reducing dig-ins. The Company's analysis addressed each activity separately to identify their respective contributions to risk reduction and then combined the results to determine the overall risk reduction from this mitigation grouping.

- Analysis of Public Awareness activities: According to information in "Reliability-based Prevention of Mechanical Damage to Pipelines (PR-244-9729)," 60% of the people who are very likely to call when they are aware of the option to call in are responsible for 40% of the dig-ins. With an implied 40% of the people responsible for 60% of the dig-ins, the people who don't call cause 2.25 times the dig-ins than those who do. In the data provided by SoCalGas, there were 1174 dig-ins where there was a call and 1672 incidents from failure to notify the one-call center. Multiplying the 1174 by 2.25 increases the total number of dig-ins by approximately 50%. As such, 51.6% was used for an estimate of the risk increase if funding for this mitigation were discontinued.
- Analysis of Dig-In Prevention activities: The assessment of the risk reduction contribution from current dig-in prevention activities was based on the analysis for incremental dig-in prevention, which is discussed below. Current dig-in prevention is assumed to have the same risk spend efficiency as the incremental dig-in prevention, discussed below. The risk spend efficiencies of these mitigations were combined weighted by their costs.

- **Incremental In-field Activities and Improvements, Incremental Public Awareness, and Incremental Admin-side Analysis (Groups b-d)**

To assess the risk reduction contributions for the incremental mitigations in Groups b-d, SoCalGas used its dig-in incident database, which categorizes dig-in damages by cause. First, for each mitigation grouping the SMEs identified the proportion of damages by cause category, and then tied them to each of the mitigation groups (b-d). Next, SoCalGas then totaled the damages within each mitigation grouping. SMEs then estimated the effectiveness of each mitigation in reducing the likelihood of dig-ins in each respective mitigation group (e.g., the extent to which in-field work mitigations affected the in-field work share of the total dig-ins). Summing the resultant number of reduced dig-ins by category and dividing by the total dig-ins yielded that category's effectiveness shown below:

- Incremental In-field dig-in prevention and improvements was determined to have a risk reduction effectiveness of 12%.
- Incremental Admin-side Analysis was determined to have a risk reduction effectiveness of 7%.
- Incremental Public Awareness was determined to have a risk reduction effectiveness of 3%. This mitigation was subsequently reduced by 50%, anticipating that the additional public awareness outreach would capture the lowest hanging fruit and have diminishing returns, though it still received the largest risk spend efficiency score.

8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SoCalGas calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

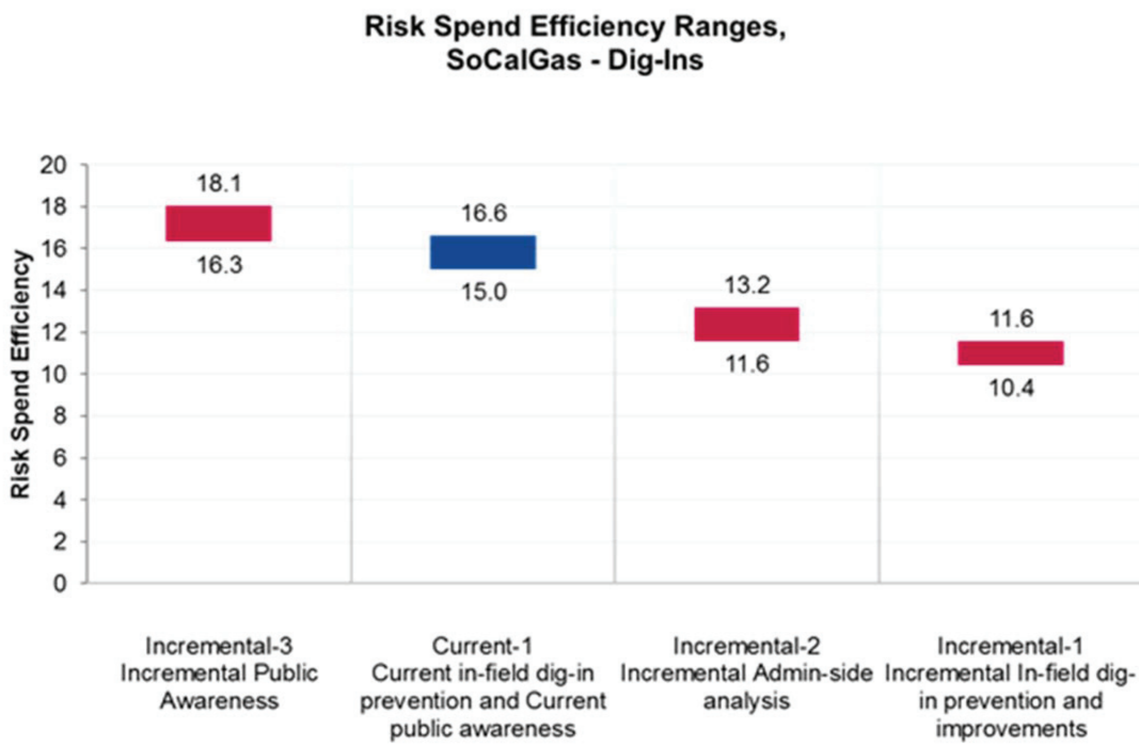
1. Incremental Public Awareness (incremental mitigations)
2. In-Field Activities and Public Awareness (current controls)
3. Incremental Admin-side Analysis (incremental mitigations)
4. In-Field Activities and Improvements (incremental mitigations)

Figure displays the range[26] of RSEs for each of the SoCalGas Dig-In risk mitigation groupings, arrayed in descending order.[27] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

[26] Based on the low and high cost ranges provided in Table 5 of this chapter.

[27] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 4: Risk Spend Efficiency



9 Alternatives Analysis

SoCalGas considered alternatives when developing the proposed plan for the Dig-Ins risk. These alternatives took into account the Company's current operating environment assuming constraints negotiated under the Company/Union Bargaining agreement. Costs and likelihood of success were also considered.

9.1 Alternative 1 – Centralize Locate and Mark

SoCalGas considered whether to centralize all Locate and Mark work under a single dedicated organization. This would allow for a more focused approach to performing Locate & Mark activities. Currently, SoCalGas' Gas Operations department uses the Energy Technician Distribution (ETD) classification to perform Locate & Mark as well as other duties.

This alternative was not chosen for the following reasons. First, centralizing Locate and Mark would eliminate the flexibility to use ETD employees for other tasks when needed. Second, creation of a centralized Locate & Mark organization would also most likely require incremental management resources. Accordingly, the proposed plan is preferred because this alternative could limit operational flexibility and add incremental costs for additional resources.

9.2 Alternative 2 – Add Contractors

SoCalGas also considered supplementing Locate and Mark resources with contractors. However, the ETD classification is "fenced in" per the Company/Union contract agreement. Separating Locate and Mark work from the ETD classification to be contracted out would require negotiations with and acceptance by the Union. The proposed plan is preferred and this alternative was not selected for these reasons.

Risk Assessment Mitigation Phase

Risk Mitigation Plan

Employee, Contractor, Customer, and Public Safety

(Chapter SCG-2)

November 30, 2016’

310318

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Executive Summary

The purpose of this chapter is to present the mitigation plan of Southern California Gas Company (SoCalGas or the Company) for the risk to Employee, Contractor, Customer, and Public Safety. The Employee, Contractor, Customer, and Public Safety risk covers the risk of conditions and practices which may result in severe harm to employee, contractor, customer, and/or public safety such as driving, customer premises, and appliance conditions, as well as non-adherence to company safety policies, procedures, and programs. SoCalGas' 2015 baseline mitigation plan for this risk consists of eleven controls:

1. Health and safety policies including an Environmental and Safety Compliance Management Program (ESCMP).
2. Mandatory employee skills training.
3. Employees receive supplemental training, retraining, and refresher training. Employees participate in annual reviews of safety- and risk-related policies and procedures (e.g., Gas Standards, defensive driving training, ergonomic training, etc.).
4. Assign, plan, and monitor work contracted to third-party contractors so that it is performed in conformance with contractual quality standards.
5. Conduct ongoing Quality Assurance (QA) activities, job observations, and field rides to assess employee work practices; provide performance feedback and coach employees in their work practices to verify conformance to policy.
6. Undertake activities to educate employees, contractors, and the public on gas safety topics. Heighten customer and public awareness of potential gas hazards via various communication channels, including electronic and hard copy educational materials and community activities.
7. Include standard health, safety, and environmental requirements in purchase and service contracts; conduct due diligence reviews of third-party waste disposal sites; administer industrial hygiene, hazard communication, and safety data sheet programs.
8. Safety, Wellness, and Emergency Services support staff provide services to positively influence safety culture and safety best practices, administer Department of Transportation (DOT) drug testing requirements, assist employees with wellness issues, and administer utility emergency response and incident reporting.
9. Use equipment and programs to protect the safety and well-being of employees (e.g., Personal Protective Equipment (PPE), uniforms, Hearing Conservation, and Respiratory Protection); use equipment and intrinsically safe non-capital tools to conduct safety-related work.
10. Conduct regular inspections and surveys of both above-ground and below-ground gas pipelines and facilities to assess their integrity. (Many of these risk mitigation activities are also addressed in the Catastrophic Damage Involving Medium-Pressure or High-Pressure Failure risks.)
11. Inspect and investigate gas leaks at customer facilities where unusual consumption is identified to detect potentially hazardous conditions; address employee, contractor, customer, and public safety concerns.

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the California Public Utilities Commission (CPUC or Commission) in Decision (D.) 16-08-

018 as well as controls and mitigations that may address reliability. SoCalGas' proposed mitigation plan comprises both baseline and new mitigation activities.

The 2015 baseline mitigations will continue to be performed in the proposed plan to, in most cases, maintain the current residual risk level. In addition, SoCalGas proposes to expand and add new mitigation activities in the 2017 to 2019 timeframe. The incremental activities are as follows; those mitigations that do not have incremental activities are anticipated by SoCalGas to be consistent with their historical levels.

1. Policy, procedures, standards and ESCMP
2. Employee skills training
    a. Expand "Situation City" training props at Skills Training facility
    b. Expand Skills training classes by 10% to include wellness and fitness training (45 minutes/day)
    c. Expand initial training courses that currently include Smith System® Defensive Driver training by 1 day
    d. Conduct Smith System® Defensive Driver training for employees who drive on company business less than 3,000 miles annually (10% of eligible drivers per year)
3. Employee refresher training
    a. Expand in-vehicle defensive drivers training to one day per employee per year
4. Contractor management and traffic control
    a. Close-call, near-miss, and lessons learned program for contractors
    b. Increased contractor inspections and audits
    c. Increased oversight of construction contractors
    d. Improved analysis of construction contractor inspection information
    e. Membership fees for ISNetworld (contractor safety and Operator Qualification (OpQual) performance evaluation service)
5. QA, job observations, field rides, and job monitoring
    a. Additional inspectors to audit employees in jobs not currently in the QA program
6. Safety communications and first responder liaison
    a. Program to update customer contact information to get premise access for pipeline and facility inspections
7. Environmental services monitoring
8. Safety, Wellness, and Emergency Services activities and programs
    a. Implementation of DMV Pull Notice Program for all fleet vehicle drivers (currently only commercial drivers)
    b. Telematics system to provide in-cab feedback to fleet vehicle drivers
    c. Emergency responder website with external access features and security
    d. High-frequency radio system for emergency communications
    e. Safety engineers for contract reviews, safety training, and incident investigations
9. PPE and safety equipment
    a. Deployment of new drop-test tool for low flow measurements
    b. Deployment of confined space monitoring systems for field personnel

c. Technology to mitigate risks associated with intermittently electrified facilities
d. Upgrades to Nomex coveralls and fresh air equipment
e. Deployment of lone worker safety systems in remote areas

10. Gas facility and pipeline inspections
    a. Increased costs associated with full implementation of the program to inspect above-ground Meter Set Assemblies (MSAs), pipelines, and facilities
11. Safety-related field orders (leaks, appliance check, and unusual use, etc.)
    a. Data analytics and field investigations based upon Advanced Meter information
    b. Increased inspections (Natural Gas Appliance Testing (NGAT)) associated with energy efficiency programs

Next, SoCalGas developed the risk spend efficiency (sometimes referred to as RSE). The risk spend efficiency is a new tool that SoCalGas developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The RSE was determined using the proposed mitigations and resulted prioritizing mitigation activities.

Finally, SoCalGas considered three alternatives to the proposed mitigations for the Employee, Contractor, Customer, and Public Safety risk, and summarizes the reasons that the three alternatives were not selected as a proposed mitigation.

Risk: Employee, Contractor, Customer, and Public Safety

1 Purpose

The purpose of this chapter (or plan) is to present the mitigation plan of SoCalGas for the risk to Employee, Contractor, Customer, and Public Safety. The Employee, Contractor, Customer, and Public Safety risk covers the risk of conditions and practices which may result in severe harm to employee, contractor, customer, and/or public safety such as driving, customer premises, and appliance conditions, as well as non-adherence to company safety policies, procedures, and programs.

This risk is a product of SoCalGas' September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring successfully for many years within the Company. SoCalGas and San Diego Gas & Electric Company (SDG&E) (collectively, the Companies) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the Companies have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the Companies do not currently track expenditures in this way, so the baseline amounts are the best effort of each company to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the Commission and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety-related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the Companies take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the Companies have made efforts to identify those costs.

[1] D.14-12-025 at p. 31.

2 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-004, "SoCalGas is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[2] The Enterprise Risk Management (ERM) process and lexicon that SoCalGas has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, SoCalGas is committed to increasing the use of quantification within its evaluation and prioritization of risks.[3] This includes identifying leading indicators of risk. Sections 2 – 8 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, potential drivers, and potential consequences of the Employee, Contractor, Customer, and Employee Safety risk.

2.1 Risk Classification

Consistent with the taxonomy presented by SoCalGas and SDG&E in A.15-05-004, SoCalGas classifies this risk as a cross-cutting risk as shown in Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
CROSS-CUTTING	PEOPLE	EMPLOYEE CONDUCT

2.2 Potential Drivers[4]

When performing the risk assessment for Employee, Contractor, Customer, and Public Safety, SoCalGas identified potential indicators of risk, referred to as drivers. These include, but are not limited to:

- **Deviation from policies or procedures, fundamental safety principles, or general safety rules, or other legal or regulatory safety requirements** – SoCalGas' Company policies and procedures are defined in Gas Standards. Similarly, the Company's general safety rules are defined in the Employee Responsibilities section of the Illness and Injury Prevention Program (IIPP). An employee or contractor not adhering to such Company safety policies and procedures could result in a safety-related event.

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[2] A.15-05-004, filed May 1, 2015, at p. JMD-7.
[3] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[4] An indication that a risk could occur. It does not reflect actual or threatened conditions.

- **Workplace hazards posed to employees** – Unsafe work environments, including work locations, roadways and parking places, customer premises, gas equipment condition, PCBs, lead from paint, asbestos, fumigation chemicals, etc. could lead to a safety event.
- **Gas hazards are not identified or untimely response to identified gas hazards** – Hazards, such as damage to gas infrastructure and facilities, could cause an unpredictable environment and thus, can lead to a safety incident.
- **Effective corrective actions to prevent a reoccurrence are not instituted** – If an issue is identified and no corrective actions to remedy the situation are completed, a safety incident could result.
- **Motor vehicle laws or safe driving practices are not followed** – Non-adherence to the law and or other applicable safety practices could result in a safety incident.

2.3 Potential Consequences

If one of the risk drivers listed above were to occur resulting in an incident, the potential consequences, in a worst reasonable case scenario, could include:

- Employee and/or public injuries or fatalities;
- Property damage;
- Operational and reliability impacts;
- Adverse litigation and related penalties; and
- Erosion of public confidence.

These potential consequences were used in the scoring of Employee, Contractor, Customer, and Public Safety that occurred during SoCalGas' 2015 risk registry process. See Section 3 for more detail.

2.4 Risk Bow Tie

The risk "bow tie," shown in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SoCalGas applied this framework to identify and summarize the information provided above.

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Figure 1: Risk Bow Tie

3 Risk Score

The SoCalGas and SDG&E ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Employee, Contractor, Customer, and Public Safety as one of the enterprise risks. During the development of the risk registry, subject matter experts (SMEs) assigned a score to this risk, based on empirical data to the extent it was available and/or using their expertise, following the process outlined in this section.

3.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a public safety event can occur. For purposes of scoring this risk, SMEs used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The SMEs selected the following reasonable worst case scenario to develop a risk score for Employee, Contractor, Customer, and Public Safety:

- Employees and/or contractors did not follow a policy or procedure that results in fatalities – whether an employee, contractor, customer, or a member of the public. This could also have operational and regulatory impacts, and litigation and financial costs could also stem from this type of occurrence.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

3.2 2015 Risk Assessment

Using this scenario, SMEs then evaluated the frequency of occurrence and potential impact of the risk using SoCalGas' 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[5] Using the levels defined in the REF, the SMEs applied empirical data to the extent it was available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 2: Risk Score
Table provides a summary of the Employee, Contractor, Customer, and Public Safety risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 2: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	4	3	4	5	233,365

3.3 Explanation of Health, Safety, and Environmental Impact Score

The assessment of the score provided in the Health, Safety, and Environmental impact area is based upon the risk scenario, which is expected to result in fatalities. Consequently, a score of 6 (Severe) in this category was selected due to the potential for life-threatening injuries or a fatality that involves an employee, contractor, customer, or member of the public.

3.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SoCalGas gave the other residual impact areas each a score for the following reasons:

- **Operational and Reliability:** The potential for an operational disruption impacting more than 10,000 customers, one critical location or customer, or temporarily disrupting gas service as defined in the 7X7 Risk Matrix was assessed as very likely. The risk scenario describes a fatality, which could be the result of an explosion to a company gas facility, which would cause

[5] D.16-08-018 Ordering Paragraph 9.

operational impacts until such time as the facility is repaired. Accordingly, SoCalGas scored this risk a 4 (Major).

- **Regulatory, Legal, and Compliance**: The safety incident selected would likely result in a Cal Occupational Safety and Health Administration (OSHA) investigation and, depending on the outcome, a financial consequence. This warrants the score of a 3 (Moderate).
- **Financial:** A score of 4 (Major) was given for this impact area because a fatal event could potentially result in litigation, which in turn has monetary impacts. Although rare, some legal outcomes involving other companies have resulted in financial impacts as great as $20 million per instance. However, the risk scenario used to score the impact area at SoCalGas was a $1 – $10 million financial impact, as this would be reflective of a reasonable worst case scenario.

3.5 Explanation of Frequency Score

SMEs used empirical data to the extent available to determine the frequency of an event occurring due to an employee or contractor not following policies or procedures. Based on the examples listed in the Potential Drivers section, these scenarios are assumed to occur once every 1-3 years as defined in SoCalGas' 7X7 matrix, which justifies a score of 5 (Frequent).

4 Baseline Risk Mitigation Plan[6]

At SoCalGas, the safety of employees, contractors, customers, and the public in the communities it serves is a core value. The Company safety culture has evolved over more than 140 years, and underpins the Company's programs, policies, procedures, guidelines, and best practices. SoCalGas endeavors to foster a work environment where employees are focused on and engaged in sustaining a culture that emphasizes safety – from initial employee training, to the installation, operation, and maintenance of utility infrastructure, and the commitment to provide safe and reliable service to customers. This allows the Company to be proactive and accountable in the safe delivery of natural gas and supporting services. The Company encourages its employees at all levels to raise pipeline infrastructure, customer safety, and employee safety concerns and to offer suggestions for improvement.

SoCalGas provides employees with training to perform their job responsibilities. The Company further reinforces the need to follow the procedures in which employees were trained by including safety performance measures and results in employees' performance appraisals. SoCalGas regularly assesses its safety culture[7] and encourages dialogue between employees and management as a means of identifying and managing safety risks. In addition to the reporting of pipeline and occupational safety incidents, management has created multiple methods for employees to report Close Calls and Stop-the-Job situations. A "Close Call" is a circumstance "where no property was damaged and no personal injury sustained, but where, given a slight shift in time or position, damage or injury easily could have occurred."

In addition to promoting safety within the Company, SoCalGas also seeks to supplement its workforce by using contractors who are also committed to safety. SoCalGas, through its contractor safety management activities, endeavors to monitor the occupational and pipeline safety records and performance of contractors and utilize contractors that meet the Company's safety standards. Contractors are informed of operational, regulatory, and procedural changes affecting their work. Two-way communication between the Company and its contractors positions all parties to learn about safety issues, share lessons learned, draw from near miss events, and convey the outcomes of incident analysis. All parties leverage the information shared as a means to preventing future incidents.

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[6] As of 2015, which is the base year for purposes of this Report.
[7] SoCalGas uses the National Safety Council Barometer Safety Culture Survey, the Employee Engagement Survey, and other participative programs to surface workforce culture as it pertains to safety.

In order to create a focus on critical mitigating policies, programs, and activities, this risk analysis uses a decision tree. The answers to the questions that follow determine if a mitigating policy, program, or activity is included in this risk assessment:

1. **Is the <u>primary</u> driver behind this policy, program, or activity the safety of employees, contractors, or the public?**
   (*If "yes" include it, if "no", go to Q2.)*
2. **Does this policy, program, or activity serve to identify the actions that should be taken to ensure the safety of employees, contractors, or the public?**
   (*If "yes" include, if "no", go to Q3.)*
3. **Is this policy, program or activity driven by regulatory safety policy (OSHA, PHMSA, DOT, or CPUC)?**
   (*If "yes" include, if "no", go to Q4.)*
4. **Does this policy, program or activity educate or alert employees, contractors, customers, or the public to potential safety hazards?**
   (*If "yes" include, if "no", exclude.)*

The above questions provided the initial threshold assessment determining the scope of this risk. Details about the 2015 controls and mitigations that are included are discussed in the Base Year Activities and Baseline Costs section that follows. Key assumptions regarding what is not included in this chapter, or were considered out of scope, include:

- Activities performed to satisfy customer service requests (even though safety tasks are performed when completing the service request) are excluded. Although work elements within some service requests are performed for safety purposes, if the service request (work order) was not generated to specifically address safety, that service request was not included.
- Activities performed to maintain, repair, or operate the gas pipeline infrastructure are excluded. These activities are captured in other RAMP risk chapters.
- Computer systems (both hardware and software) used to support operations performed to mitigate safety hazards are excluded.
- Lease costs for motor vehicles used to support operations performed to mitigate safety hazards are excluded.
- The capital equipment used to mitigate safety hazards (and associated depreciation expenses) are excluded.

As stated above, the Employee, Contractor, Customer, and Public Safety risk entails an employee and/or contractor who does not adhere to Company policies or procedures which then results in a safety-related incident. The 2015 baseline mitigations discussed below include the current evolution of the SoCalGas' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time.

Workforce planning systems and processes are in place to determine personnel and business associate needs. Once employee or contractor candidates are identified, they are screened to verify they are qualified to perform the work assigned them. The qualifications include formal training, on-going refresher training, and procedural reviews both in the classroom and at the jobsite. More details on workforce planning are discussed in the RAMP chapter of Workforce Planning.

Although employees and contractors are equipped to perform their work, substandard work can occur. When identified, the source of error is addressed. Unfortunately, these errors sometimes result in injury to employees, contractors, or the public. Similar to the CPUC, whose Overarching Safety Mission states "we are striving to achieve a goal of zero accidents and injuries across all the utilities,"[8] SoCalGas continues to explore more effective methods for eliminating human error.

SoCalGas' 2015 risk controls consist of the following eleven mitigations:

1. Health and safety policies including an ESCMP.
2. Mandatory employee skills training.
3. Employees receive supplemental training, retraining, and refresher training. Employees participate in annual reviews of safety- and risk-related policies and procedures (e.g., Gas Standards, defensive driving training, ergonomic training, etc.).
4. Assign, plan, and monitor work contracted to third-party contractors so that it is performed in conformance with contractual quality standards.
5. Conduct ongoing QA activities, job observations, and field rides to assess employee work practices; provide performance feedback and coach employees in their work practices to verify conformance to policy.
6. Undertake activities to educate employees, contractors, and the public on gas safety topics. Heighten customer and public awareness of potential gas hazards via various communication channels, including electronic and hard copy educational materials and community activities.

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[8] http://www.cpuc.ca.gov/uploadedfiles/cpuc_public_website/content/safety/visionzero4final621014_5_2.pdf.

7. Include standard health, safety, and environmental requirements in purchase and service contracts; conduct due diligence reviews of third-party waste disposal sites; administer industrial hygiene, hazard communication, and safety data sheet programs.
8. Safety, Wellness, and Emergency Services support staff provide services to positively influence safety culture and safety best practices, administer DOT drug testing requirements, assist employees with wellness issues, and administer utility emergency response and incident reporting.
9. Use equipment and programs to protect the safety and wellbeing of employees (e.g., PPE, uniforms, Hearing Conservation and Respiratory Protection); use equipment and intrinsically safe non-capital tools to conduct safety-related work.
10. Conduct regular inspections and surveys of both above-ground and below-ground gas pipelines and facilities to assess their integrity. (Many of these risk mitigation activities are also addressed in the Catastrophic Damage Involving Medium-Pressure or High-Pressure Failure risks.)
11. Inspect and investigate gas leaks at customer facilities where unusual consumption is identified to detect potentially hazardous conditions; address employee, contractor, customer, and public safety concerns.

These controls focus on safety-related impacts[9] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018,[10] as well as controls and mitigations that may address reliability.[11] Accordingly, the controls and mitigations described in Sections 4 and 5 primarily address safety-related impacts. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Employee, Contractor, Customer, and Public Safety-related incidents, not just the scenario used for purposes of risk scoring.

SoCalGas' existing safety programs and safety culture, however, are continuously evolving. SoCalGas assumes that this evolution will continue into the future. For example, in May of this year, 6,609 employees (80% of the employee population) took part in a survey that measured employee perceptions about the safety culture at SoCalGas. The survey was administered by the National Safety Council (NSC), an independent nonprofit organization that has been around for over 100 years. In its report, the NSC described SoCalGas' safety culture as "world-class," and among the top 6% of the 580 companies that have taken the NSC survey.

These results are a tribute to the commitment and personal leadership of front-line employees and supervisors, including all of the Local Safety Committee members and Safety Champions, who work very hard to embed safety as a core value in SoCalGas' work culture. A close look at the results demonstrates that SoCalGas has made improvements in many areas since the last safety culture survey was conducted in 2013.

According to the NSC, SoCalGas scored high in all six areas of safety excellence covered by the survey, including:

- **Organizational Climate** items probe general conditions that interact with the safety program to affect its ultimate success, such as teamwork, morale, and employee turnover (SoCalGas scored in the top 7%);

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[9] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[10] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[11] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

- **Management Participation** items describe ways in which top and middle management demonstrates their leadership and commitment to safety in the form of words, actions, organizational strategy, and personal engagement with safety (SoCalGas scored in the top 7%);
- **Supervisory Participation** items consider six primary roles through which supervisors communicate their personal support for safety: leader, manager, controller, trainer, organizational representative, and advocate for workers (SoCalGas scored in the top 7%);
- **Safety Support Climate** items ask employees across an organization for general beliefs, impressions, and observations about management's commitment and underlying values with regard to safety (SoCalGas scored in the top 7%),
- **Employee Participation** items specify selected actions and reactions that are critical to making a safety program work. Emphasis is given on personal engagement, responsibility, and compliance (SoCalGas scored in the top 11%), and
- **Safety Support Activities** items probe the presence or quality of various safety program practices. This focuses on communications, training, inspection, maintenance, and emergency response (SoCalGas scored in the top 13%).

An important benefit to conducting the NSC safety culture survey is that the results enable SoCalGas employees to identify meaningful, measurable, and actionable improvement opportunities that can help improve safety performance. These types of risk mitigation activities, while important, are not listed as alternatives to those presented within this chapter because SoCalGas has assumed they will continue.

1. <u>Policies, Procedures, Standards and Environmental and Safety Compliance Management Program.</u>

There is a clear assignment of officer level accountability and organizational responsibilities at all levels and dedicated Health and Safety and Environmental Services professional staffs to guide/support the operating groups on a daily basis. Activities are performed to promote safe employee work facilities and environments that are hazard free and compliant with regulatory rules or the law. This includes monitoring of Health and Safety and Environmental regulatory changes at the federal, state, and local levels.

SoCalGas has formal procedures, processes, and standards it maintains. These materials provide guidance to employees and document that manner in which work is to be performed. Systems are in place to track employee training, OpQual certification, facility site inspections (Uniform Building Code requirements per Assembly Bill (AB) 32) and administration of the Company's Environmental and Safety Compliance Management Program (ESCMP). ESCMP is an environmental, health, and safety management system to plan, set priorities, inspect, educate, train, and monitor the effectiveness of environmental, health, and safety activities in accordance with the internationally accepted standard, ISO 14001. SoCalGas also conducts self-assessments and inspections for potentially hazardous environmental factors, investigates environmental exposure incidents, and monitors Proposition 65 compliance activities.

2. Employee Skills Training

Training is an integral part of how SoCalGas mitigates the Employee, Contractor, Customer, and Public Safety risk. New hires, transfers, or newly assigned employees must complete and pass initial mandatory training. Smith System® defensive driver's training is included in this requirement for positions where the employee is expected to drive more than 3,000 miles per year on Company business. Activities associated with skills training provided to employees are included in this category.

3. Employee Refresher Training

Safety and environmental meetings are important to SoCalGas and, therefore, are scheduled on a regular basis. Safety and environmental meetings include: Weekly reviews of relevant policies and procedures, safety tailgates to discuss workplace hazards, work plans and responsibilities, safety stand-downs to discuss safety incidents, close calls, bulletins or other safety topics, safety committee meetings to develop and present material on various safety topics, and dialogue meetings with Company and department leadership. Employee refresher training and procedure reviews are included in this category.

4. Contractor Management and Traffic Control

Contractor selection is based upon specific Company needs and contractor qualifications. Contractor safety records are examined prior to selection. Job requirements are specified in the Company's contracts with third parties, and contractors are required to meet all legal, regulatory, and contractual requirements. Contractor work performance is monitored during the course of their work for the Company. Activities associated with contractor qualification, selection, and oversight are included in this category.

5. QA, Job Observations, Field Rides, and Job Monitoring

SoCalGas maintains a QA program to assess the work quality of many of its field personnel. Job observations and field rides are conducted by management personnel based upon Behavior Based Safety (BBS) principles. SoCalGas' BBS program is a proactive approach to safety and health management, focusing on principles that recognize at-risk behaviors as a frequent cause of both minor and serious injuries. The purpose of the job observation and field ride process is to reduce the occurrence of at-risk behaviors by modifying an individual's actions through observation, feedback, and positive interventions aimed at developing safe work habits. Employees are also provided feedback and coaching so that their work conforms to policy and procedure.

6. Safety Communications and First Responder Liaison

SoCalGas prepares and distributes safety-related communications for employees, contractors, customers, and the general public. Safety-related messages are delivered using multiple communication channels, including bill inserts, print, radio, web, and social media. Messages include, but are not limited to, carbon monoxide safety, fumigation safety, furnace safety, and pipeline safety (which is part of federal pipeline safety regulations). Emergency Management provides safety and basic operational information about SoCalGas facilities as they relate to First Responder operations and activities. Activities associated with developing and distributing materials that educate people on gas safety are included in this category.

7. Environmental Services Monitoring

The Company's Environmental Services department works closely with third-party contractors to evaluate compliance with all applicable laws and regulations pertaining to the environment. The Industrial Hygiene staff interfaces with contractors and administers the Safety Data Sheet (SDS) program so that only approved chemicals are introduced into the workplace. Activities associated with environmental and industrial hygiene activities are included within this category.

8. Safety, Industrial Hygiene, Wellness, and Emergency Services/Programs

The costs associated with the Safety, Wellness, and Emergency Services department operations are included in this category. SoCalGas' Safety, Wellness, and Emergency Services department manages its overall Health and Safety framework through an organization dedicated to employee, contractor, customer, and public safety.

Safety Services

The Safety Services department functions to:

- Reduce or eliminate incidents resulting in injury, property damage, or outages;
- Raise awareness of safety concerns and incidents through programs, regular safety campaigns, and communications;
- Provide oversight and regulatory guidance to confirm adherence to policies and procedures; and
- Provide resources to integrate safety into everyday business decisions to promote the importance of safety to the overall organization's success.

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Safety Services has developed policy and training programs including, but not limited to:

- Injury and Illness Prevention Program;
- Emergency Action Plan and Fire Prevention;
- Job observations;
- Incident investigation and analysis;
- Defensive driving;
- Body mechanics;
- Ergonomics;
- Contractor safety;
- Hazard communication;
- Confined spaces;
- Asbestos and lead;
- Hearing conservation, respiratory protection, and PPE; and
- Public safety and substance abuse awareness and prevention programs.

Safety Services supports field safety compliance audits, major safety programs, communications, management, and statistical analysis. In an effort to reduce or eliminate incidents, the department provides safety training, conducts job observations, investigates and analyzes incidents, assists with the development of corrective actions, and promotes defensive driving, body mechanics, and ergonomically protective workplaces.

SoCalGas establishes leading indicators to support injury prevention. One mechanism for capturing leading indicators is by conducting a periodic Safety Barometer Survey to assess the overall health of our safety climate and identify areas of opportunity that can help eliminate injuries and improve our focus and commitment to safety. The goal of this assessment is to increase employee participation in, and contribution to, SoCalGas' ongoing efforts to continually improve its safety performance. The Safety Services department interprets and advises field operations regarding safety-related rules and regulations, and provides reviews of potential legislation that would impact field operations.

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Safety Services provides operational support by conducting compliance audits, sponsoring company-wide safety programs, developing and conveying safety communications, managing incidents, and performing statistical analysis. The department conducts job observations, incident investigation and root cause analysis, promotes defensive driver training, body mechanics training, and ergonomics training. The Safety Services department interprets and advises field operations regarding safety-related rules and regulations and provides reviews of potential legislation that could impact field operations. Safety Services works with field operations to prevent incidents, perform self-audits; identify corrective actions following incidents, and conduct safety training. Safety Services is responsible for compliance with safety regulations, as well as establishing and managing programs, policies, and guidelines for the safety of employees. The Safety Services department also manages company-wide Occupational Health Nurse (OHN) services. Occupational health nursing is a specialty practice that delivers health and safety programs and services to employees. The practice focuses on promotion and restoration of health, prevention of illnesses and injuries, and protection from work-related and environmental hazards.

Employee Assistance Program (EAP) and Wellness

The EAP and Wellness department promotes the physical and mental well-being of all Company employees. EAP and Wellness is committed to providing health and wellness programs to motivate and promote safe and healthy lifestyles by providing programs, resources, information, and supportive services. EAP and Wellness coordinates on-site employee assistance services for employees and work groups including:

- Health and Education Seminars (Stress Management, Weight Management, Nutrition, Heart Disease, High Blood Pressure, etc.);
- Fitness Subsidy Program (Company subsidy for gym membership);
- Annual Flu Immunizations;
- Video and Book Lending Library;
- Health Screenings (e.g., Body Fat, Cholesterol, Blood Pressure, Carotid Artery, Abdominal Aneurysm);
- Work-site programs (e.g., Weight Watchers, Yoga, Walking Class, Chair Massages, Reflexology);
- Special Events (Health Fairs, Walk-a-thons, Blood Drives);
- Educational pamphlets/brochures on a variety of health and wellness topics;
- Administration of the Substance Abuse Awareness and Drug and Alcohol Testing Program; and
- Employee Assistance Programs.

The EAP and Wellness department also serves as a liaison during CPUC, DOT, California Highway Patrol (CHP), or Cal/OSHA related audits or citations. The DOT-regulated and non-regulated Company Drug and Alcohol (D&A) testing programs are administered by the EAP and Wellness department. The department also provides oversight of all pre-employment, random, and other required D&A testing of employees in safety sensitive positions at SoCalGas per DOT regulations. In addition, this group addresses unique and highly complex employee issues which include, but are not limited to:

- Workplace substance abuse;
- Rehabilitation case management; and
- Mental health behaviors affecting job performance, critical incidents, and fitness for duty determination.

Emergency Services
The Emergency Services department manages company-wide emergency preparedness via the maintenance of Emergency Response Plans and Business Resumption Plans. Emergency Services is responsible for emergency incident reporting, maintenance of mutual assistance plans, staffing the Emergency Operations Center, conducting Incident Command Center (ICS) and Incident Management System (IMS) training, and coordinating liaison meetings with First Responders. The Emergency Response Plan, along with referenced documents and procedures, outlines how the Company prepares for, responds to, and recovers from gas-related emergencies. The Emergency Response Plan has three major elements:

- Emergency Preparedness;
- Crisis Management; and
- Business Resumption.

The Emergency Services department is also responsible for the following activities:

- Complying with governmental regulations for emergency planning;
- Training employees to know their specific role, duties, and responsibilities;
- Establishing relationships and providing emergency response information to other emergency organizations;
- Facilitating inter-organizational assistance;
- Coordinating proper communications – both internal and external;
- Using effective emergency management technology;
- Conducting training and exercises;

- Engaging in Continuous Improvement; and
- Supporting internal and external educational efforts.

9. PPE and Safety Equipment

SoCalGas provides its employees with the PPE required to safely perform work (e.g., flame-retardant suits, eye protection, gloves, etc.). Additionally, job-specific small tools are provided as required to perform work safely. A Tools and Materials (T&M) Committee is in place to review and evaluate proposed changes and support continuous improvement. The T&M Committee works closely with potential suppliers and various operations work groups to verify needs are effectively met. The Company maintains processes and procedures so that employee hearing and respiratory functions are not impaired due to exposure to harmful environmental conditions. When work is performed that could expose customers or the public to injury, controls are implemented to mitigate risk. The costs associated with equipment and specific occupational safety programs are included in this category.

10. Gas Facility and Pipeline Inspections

SoCalGas inspects its pipeline systems pursuant to Gas Pipeline Safety Rules and Regulations (49 CFR 191-193 and General Order (GO) 112). These requirements compel each operator of a Distribution/Transmission system to conduct periodic leakage surveys in accordance with the guidelines outlined in § 192.723 Distribution systems: Leakage surveys and § 192.706 Transmission lines: Leakage surveys. As described in the RAMP chapters of Catastrophic Damage Involving a High-Pressure or Medium-Pressure Pipeline Failure, SoCalGas maintains and operates its pipelines pursuant to safety regulations, including, but not limited to, implementation of the following:

- Leak Surveys
- Pipeline Patrols
- Exterior Corrosion Control
- Internal Corrosion Control
- Valve Inspection
- Underground Vaults
- Pipeline Crossings
- Pressure-Relief Devices

Maintenance or repair activities are not included in this mitigation. It is included in the RAMP chapters of Catastrophic Damage Involving a High-Pressure Pipeline Failure, Catastrophic Damage Involving a Medium-Pressure Pipeline Failure, and Catastrophic Event Related to Storage Well Integrity.

11. <u>Safety-Related Field Orders (leaks, appliance check and unusual use, etc.)</u>
Customers call SoCalGas' call center for many reasons. Some of those reasons are safety related, including:

- Gas Leaks (customers report smelling gas odor);
- Checks of Appliance Operational Safety;
- Read and Verify orders (those associated with unusual gas usage);
- Fumigation;
- Carbon monoxide (CO) testing[12]
- Energy Diversion Investigations – Meter tampering and meter bypass investigation and remediation. Bypasses or unauthorized attachments create unsafe conditions. These connections present the potential for fire or explosion involving SoCalGas employees, law enforcement, firefighters, city or county officials, occupants of the residence, and/or community.

Specific current risk mitigation activities within in this category include: (a) Customer Contact Center and field response to reported gas leaks; (b) Customer service operations (CSO) safety checks; (c) Investigation of unusual gas consumption conditions; (d) Natural Gas Appliance Tests – checks for the safe functioning of gas appliances after energy efficiency work is performed.

[12] SoCalGas conducts CO testing on homes weatherized through the Energy Savings Assistance (ESA) Program in accordance with Statewide Energy Savings Assistance Program Installation Standards and the Statewide Energy Savings Assistance Program Policy and Procedures Manual. CPUC directives order SoCalGas to charge the costs for the NGAT program to base rates rather than to the public purpose funds.

5 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 4 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. In addition, SoCalGas proposes to expand and add new mitigation activities in the 2017 to 2019 timeframe. The incremental activities are as follows; those mitigations that do not have incremental activities are anticipated by SoCalGas to be consistent with their historical levels.

1. Policy, procedures, standards, and ESCMP
2. Employee skills training
    a. Expand "Situation City" training props at Skills Training facility
    b. Expand Skills training classes by 10% to include wellness and fitness training (45 minutes/day)
    c. Expand initial training courses that currently include Smith System® Defensive Driver training by 1 day
    d. Conduct Smith System® Defensive Driver training to employees who drive on company business less than 3,000 miles annually (10% of eligible drivers per year)
3. Employee refresher training
    a. Expand in-vehicle defensive drivers training to one day per employee per year
4. Contractor management and traffic control
    a. Close-call, near-miss, and lessons learned program for contractors
    b. Increased contractor inspections and audits
    c. Increased oversight of Transmission, Storage, Engineering, and Pipeline Integrity contractors
    d. Improved analysis of construction contractor inspection information
    e. Membership fees for a contractor safety and OpQual performance evaluation service
5. QA, job observations, field rides, and job monitoring
    a. Additional inspectors to audit employees in jobs not currently in the QA program
6. Safety communications and first responder liaison
    a. Program to update customer contact information to get premise access for pipeline and facility inspections
7. Environmental services monitoring
8. Safety, Wellness, and Emergency Services activities and programs
    a. Implementation of DMV Pull Notice Program for all fleet vehicle drivers (currently only commercial drivers)
    b. Telematics system to provide in-cab feedback to fleet vehicle drivers

   c. Emergency responder website with external access features and security
   d. High-frequency radio system for emergency communications
   e. Safety engineers for contract reviews, safety training, and incident investigations
9. PPE and safety equipment
   a. Deployment of new drop-test tool for low flow measurements
   b. Deployment of confined space monitoring systems for field personnel
   c. Technology to mitigate risks associated with intermittently electrified facilities
   d. Upgrades to Nomex coveralls and fresh air equipment
   e. Deployment of lone worker safety systems in remote areas
10. Gas facility and pipeline inspections
    a. Increased costs associated with full implementation of the program to inspect above-ground MSAs, pipelines, and facilities
11. Safety-related field orders (leaks, appliance check and unusual use, etc.)
    a. Data analytics and field investigations based upon Advanced Meter information
    b. Increased inspections (NGAT) associated with energy efficiency programs

These incremental projects and programs are further described below.

2a. Broaden "Situation City" Skills Training

Construct additional props, equipment types, working environments, and hazardous condition simulation capabilities at the skills center training facility to broaden employee exposure to real-world conditions. Increase class size and provide mobile class rooms to meet changing needs. Expand hands-on crew training as well as provide varied training locations for field representatives. Provide additional digging sites and operating conditions. Provide a strong connectivity to meet the computer activity and needs in the situation city vicinity. These changes would enable the Company to better prepare students for work in different environments, with different equipment, and on a wider variety of infrastructure components so they do not make inappropriate decisions in the work environment.

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2b. Integrate Wellness and Fitness Training into Skills Training

Expand skills training periods by 10% (the equivalent of 45 minutes per day) for wellness and fitness training. Currently, all new hires are expected to attend, demonstrate proficiency, and pass initial training for most field-related entry level positions in the Company. This enhancement is designed to introduce wellness and fitness training (e.g., body mechanics, hydration, nutrition, sleep, stretching, cardio exercises, weight training, etc.) into the existing curriculum. By integrating the wellness and training curriculum into the skills training program, the Company anticipates employees would develop work methods and a lifestyle that would enable them to avoid future bodily injury.

2c. Expand Initial Smith System Defensive Driving

Expand initial training by one day (the current initial training periods vary by position – from 10 to 30 days) for all new hires or office employees who bid into jobs that require driving. This change in practice should help new employees improve their driving skills and more consistently apply defensive driver principles. As a consequence, the additional training should enable the Company to decrease the number of controllable motor vehicle incidents that occur at the Company and improve the safety of employees, customers, and the general public. By expanding initial Smith System Defensive Driving training, the Company would be better able to break engrained driving habits, reinforce what it means to be a “professional” driver, and familiarize employees with the operation of vehicles that can be very different from those with which they are familiar (e.g., many Company vehicles are significantly larger in size than employees’ personal “compact” vehicles). A pilot study performed in the Meter Reading department in 2014 and 2015 yielded an average reduction in Controllable Motor Vehicle Incident (CMVI) rates of approximately 20% per year (from 5.69 CMVIs per million miles driven in 2013 to 3.43 CMVIs per million miles driven at year-end 2015).

2d. Expand Smith System of Defensive Driving to Employees Driving less than 3,000 miles per year

Currently, the Company has a policy of requiring employees who drive more than 3,000 per year to complete a 1-day Smith System of Defensive Driving® class, and also complete a 1-hour Smith System of Defensive Driving refresher course annually. This mitigation expands the program to those who drive on company business, but less than 3,000 miles per year (~2,500 employees). The cost forecast is based upon 10% of eligible employees being trained each year. Implementing this program would better equip our drivers to drive safely (9 of the 327 CMVIs that occurred in the 2014-2015 period involved employees who drive less than 3,000 miles annually). By expanding its current training program, the Company would also expand its safety culture when it comes to defensive driving and safe driving practices. This would aid in facilitating peer-to-peer coaching and feedback programs, including "Close Call" reporting.

3a. Expand In-Vehicle Instruction to 1 day per field employee (4,500 employees) per year

Currently, Smith System of Defensive driving does not include a complete familiarization with an employee's assigned vehicle. Many of the Company's vehicle incidents involve hitting stationary objects. This safety program enhancement involves augmenting defensive driver coaching with "refresher" training that focuses upon defensive driving principles and application of those principles while operating a motor vehicle. The "refresher" course would include eight hours of in-vehicle demonstration, practice (with coaching and feedback) and an in-vehicle testing to confirm knowledge transfer and skill acquisition. The aforementioned pilot test conducted by the Meter Reading department demonstrated positive results. The Meter Reading department, however, differs from other SoCalGas field operations because meter reader turnover has been about 100% per year. In the organizations where employees work for longer periods, annual "1-day refresher" training is expected to positively impact rates, albeit not by 20% as it did for meter readers. By expanding the time spent reinforcing defensive driving practices, supervisors would be better able to simulate day-to-day driving conditions, conduct demonstrations, simulate "what if" conditions, and observe employees in different situations. When supervisors spend only a short time with employees, employees may often exhibit only their "best" driving behaviors.

4a. Close Call, Stop-the-Job, and Lessons Learned Program for Contractors

Contractors need to actively promote reporting of occupational and pipeline safety Near Misses, Close Calls, and Stop-the-Job situations. The experience gleaned from these incidents as well as from the findings from safety incident investigations need to be shared with other contractors and with Company personnel to better avoid future incidents. It has been difficult to get contractors to share what may have gone wrong on their jobs because it can be embarrassing, lead others to perceive them not to be safety-focused, or potentially reduce the amount of work requested of them. By expanding the Company's existing programs to include contractors, the Company's safety culture can be broadened. With a common platform for sharing and learning, the identity of contractors reporting what may have gone wrong can be protected.

4b. Increased Distribution Contractor Inspections and Audits

In addition to existing periodic contractor audits, there is a need for an expanded program for conducting on-site and in-field contractor inspections and audits – at both contractor job sites and Company construction offices to assess compliance with safety and quality protocols. More frequent hands-on observation of contractor operations would enable the Company to have greater confidence each member of the contractor workforce has a process safety mindset and consistently employs safety best practices.

These inspections and audits would enrich safety exchanges and provide a more meaningful platform for process safety improvement. The costs associated with this risk mitigation enhancement are based upon the addition of two FTEs for contractor audits. It is estimated that these two FTEs would be able to complete 500 – 1,000 site visits annually.

4c. Increased Oversight of Transmission, Storage, Engineering, and Pipeline Integrity Contractors

Similar to the enhanced Distribution department contractor oversight program described above, SoCal Gas would expand the existing Inspection and Audit program scope to include work performed by Transmission, Storage, Engineering, and Pipeline Integrity contractors. The quarterly review meetings currently conducted with Distribution contractors would be extended to include the contractors performing work for these additional departments. These meetings would facilitate program level conformance discussions regarding safety, quality, compliance, and cost management, identify opportunities for improvement and facilitate the development of implementation plans. The costs associated with this risk mitigation enhancement are associated with the addition of 3 FTEs.

4d. Improved Analysis of Contractor Construction Inspection Information

Detailed pipeline construction contractor inspection data is currently discussed with contractors at quarterly performance review meetings. This data needs to be tracked over time so trends can be identified and reviewed in more comprehensive manner. A database that maintains safety-related inspection information would provide greater completeness and consistency – both for each contractor and across all contractors. More efficient data collection processes, in-depth analysis, and follow-up with contractors would enhance process safety and assist in avoiding injuries.

4e. Contractor Safety Performance Screening and Monitoring

Implement an established program for evaluating and monitoring the safety performance of potential and existing contractors. Acquire rights to use a screening, pre-qualifying, and monitoring system that would provide the Company information regarding how well contractors meet health and safety requirements. ISNetworld would help the Company in pre-qualifying contractors based on pre-defined criteria (i.e., injury rates, safety incidents, OSHA citations, experience modification rate, etc.). Improve contractor oversight by maintaining current contractor information and (posted) job evaluations. The system would enable the Company to share industry performance data and safety metrics via their benchmarking efforts with other companies.

5a. Add QA auditors to monitor the performance of employees working in job classifications not currently audited
The Quality Assurance function involves sampling completed field work to better assess employee work quality and compliance with Company policies and procedures. Since 2014, a QA program has been initiated within Distribution Operations to more formally assess how well the Leakage Survey and Locate and Mark functions are performed. The results of this QA effort show improved consistency in adherence to policies and processes and a reduction in work errors. By expanding QA audits to include the Transmission and Storage department operations, as well as additional Gas Distribution activities, the Company would improve adherence to its standards, work methods, and safety rules. The costs associated with this risk mitigation activity are based upon an additional five FTEs. However, the role and breadth of QA within various operational departments is being further evaluated; the incremental funding request is within the scope of the upcoming GRC filing and is subject to change.

6a. Program to update customer contact information for premises access
This mitigation would improve facility access processes supporting leakage survey and inspection of above-ground pipelines. With the recent automation of the meter reading function, it has not been necessary for customers to provide the Company with regular access to its meters (although this is a regulatory requirement) for up to 36 months. This program would provide additional time for Company representatives to collect e-mail addresses and mobile phone numbers from customers when handling all types of live calls. With this information SoCalGas would be able to contact customers in a timely manner, inspect facilities to identify any pipeline hazards, and take prompt corrective action. Without facility access, hazardous conditions may go undetected and potentially injure customers or the public.

8a. DMV Pull Notice Program for all fleet vehicle drivers
The Employer Pull Notice (EPN) program is currently used to monitor the driving records of the Company's commercial drivers (approximately 250 employees). The EPN is designed to promote driver safety through the ongoing review of driver records. Exception reporting includes: failure to appear in court, accidents, suspensions/revocations, and any other action taken against the driving privilege. Expanding this program to include all drivers (approximately 4,250 additional drivers) of SoCalGas fleet vehicles would increase driver accountability, and help the Company evaluate that its employees are legally qualified to operate a motor vehicle on Company business.

8b. Vehicle telematics system to provide in-cab feedback to fleet vehicle drivers
Telematics systems provide real-time safety feedback to drivers via the identification and communication of at-risk behaviors. These systems have been implemented at other California utilities, including Southern California Edison Company and Pacific

Gas & Electric Company. Pilot testing of various telematics systems at SoCalGas have resulted in improvements in participant driving behaviors (as measured by reductions in driver alerts). A survey of 28 drivers who participated in SoCalGas' most recent pilot test of telematics technology revealed that 91% increased their attention to driving.

This technology is expected to improve driving safety, reduce motor vehicle incidents, and help protect both employees and the public. People who use this technology report that it keeps them focused on driving when they are behind the wheel. This is important in enabling people to react quickly when the unexpected occurs. Additionally, the technology reinforces adherence to the speed limit, which can reduce the severity an incident if it does occur. Furthermore, telematics technology reinforces a defensive driver mindset, which can aid in avoiding accidents and injuries.

8c. Emergency Responder website with external access features and security

Currently, First Responder briefings are only conducted live. Manual logs are used to record the First Responders who have attended live training. The proposed website would enable the Company to post training materials for First Responders, track website traffic, and provide opportunity for data analytics. The website would allow SoCalGas to post quizzes and track results. Additionally, the website would enable the Company to securely post files (maps, pipeline information, Pipeline Association for Public Awareness brochures, etc.) that First Responders can download for ease in identifying the location of gas lines. This capability would be particularly important when responding to brush fires.

8d. High-frequency radio system for emergency communications

The radio system being proposed is designed to keep public health, public safety, and critical industry operations and leadership connected to First Responders in the field in the event of an emergency. The radio network involves "one-touch" communication to interconnect other radio users in the event land-line, cellular, or other communication services are non-functional. This system would enable the Company's Emergency Operations Center to communicate with its headquarters offices, district offices, and the city, county, and state Office of Emergency Management and any other Operations Centers that implement this technology.

8e. Safety Engineers for contract reviews, safety training, and incident investigations

Safety Engineers are needed to perform detailed contract reviews and to actively participate in contractor governance. This program is expected to enhance the Company contractor safety program by adding four to six safety professionals to engage in supervisor and QA representative development and participate in all incident investigations. As a result of this program, field supervisors would be able to more rapidly develop and maintain the skills needed to positively influence safety culture and prevent injuries.

9a. Drop test tool for low flow measurements

With the installation of its automated metering infrastructure, SoCalGas plans to deploy technologies currently used by others in the industry to leak test customer-owned gas pipes prior to turning on gas service. The Low Flow Meter (LFM) would enable more accurate leak tests to be conducted than possible using the current 2-minute clock test. Use of the LFM process would require more time to complete than the current 2-minute clock test method. The more accurate LFM process would be adopted as the standard leak test method at SoCalGas in late 2016. When the LFM process cannot be used due to MSA configuration (e.g., under house meter set), a 5-minute clock test would become the default method used within the Company. While the 5-minute clock test is not as accurate as the LFM, it is more accurate than the 2-minute clock test method currently employed.

9b. Confined space air monitoring system for field personnel

This program would involve replacement of the current confined space and H_2S monitoring equipment system-wide. Affected departments include: Transmission, Storage, M&R, Gas Operations, Operations Training, and various other support services departments. Age-related equipment failures currently present a potential risk to the safety of employees working in gaseous atmospheres warranting acquisition and deployment of new equipment. The new equipment and associated training would encompass both regular and occasional users who have been identified as performing duties in confined spaces or where the potential for H_2S exposure exists.

9c. Technology to mitigate risks associated with intermittently electrified facilities

Field personnel are currently required to test for electricity using an approved voltage tester prior to making physical contact with an MSA. No further testing is currently performed if voltage is not detected at the time of the test. Situations have occurred when the MSA has subsequently become energized when an appliance, solar panel, or other device that is improperly grounded cycles on. There is also the potential for stray current or damage to an electrical facility to cause an MSA to become intermittently energized. New equipment designed to detect changes in voltage and provide an audible and/or visual real-time alarm to employees can prevent field personnel from contacting an electrified MSA. The new equipment and associated training would be provided to all employees who perform duties at an MSA.

9d. Upgrade Nomex coveralls and fresh air equipment

Field personnel working in Immediately Dangerous to Life or Health (IDLH) environments or in flammable atmospheres must wear gas extraction suits and a Supplied Air Respirator (SAR) with an escape bottle or a Self-Contained Breathing Apparatus (SCBA). The manufacturer of the currently used SAR kits no longer supports the equipment. System-wide replacement of the SAR kits with SCBA kits prior to failure would create consistency among operating groups. The fire resistant gloves currently used with the gas extraction suits provide minimal dexterity making it difficult for field personnel to handle small tools and equipment. Replacement of these gloves would reduce the risks associated with working in potentially hazardous atmospheres for extended periods of time.

9e. Lone worker safety system

Lone worker communications technology provides safety monitoring capability for employees who typically work alone in remote locations. The system typically employs 3G and satellite communications. The technology provides features such as: True Fall Detection; no-motion detection; emergency latch; silent alert, worker check-in, etc. It can be configured to include indoor location technology for those who work alone indoors. The devices transmit electronic alerts regarding emergency situations to a 24-hour call center that monitors communications and reacts accordingly. The system would provide the Company the ability to better monitor the safety and security of its employees and provide a means for employees to contact the Company should the need arise when they are working in remote locations.

10a. Increased costs for inspection of above-ground pipe and facilities

Meter readers historically performed the DOT-mandated above-ground pipe atmospheric corrosion inspection function for MSAs. Many of the meter reader inspections were conducted when meter readers were located a long distance from the gas facilities. The virtual elimination of manual meter reading due to deployment of an advanced metering infrastructure (AMI) resulted in the need to transition the function to a new organization comprised of employees at a higher skill and wage level than the meter readers who previously performed the work. This organization now has sole responsibility for performing the DOT-mandated every-3-year inspections. At the same time, the Company increased the scope of the inspections to include more safety elements that can only be conducted when the person performing the inspection is in close proximity to the facility. Facility access challenges have resulted in an increase in costs. These costs have exceeded pre-AMI deployment forecasts.

11a. Data Analytics and field investigations based upon Advanced Meter information
Advanced Meter data analytics enable the Company to identify unusual gas consumption patterns that require field investigation and downstream follow-up work. The AMI system monitors and reports tamper alarms that can indicate when there has been meter tampering. By investigating either of the aforementioned conditions, Company personnel can identify root causes and take action to avoid public injury or property damage and potentially gas theft. This program includes a data analytics staff and the field personnel needed to investigate and address potentially unsafe conditions, such as equipment failures, gas leaks at unoccupied facilities, or unsafe energy diversion activities.

11b. Increased inspections (NGAT) associated with energy efficiency programs
Following the completion of energy efficiency work, gas appliance inspections are conducted to verify conditions are safe for building occupants. The frequency of NGAT is expected to increase in proportion to the forecast increase in energy efficiency work.

6 Summary of Mitigations

Table 3 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for Employee, Contractor, Customer, and Public Safety. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SoCalGas does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 3 were estimated using assumptions provided by SMEs and available accounting data.

Table 3: Baseline Risk Mitigation Plan[13]

(Direct 2015 $000)[14]

ID	Control	Risk Drivers Addressed	Capital[15]	O&M	Control Total[16]	GRC Total[17]
1	Policy, procedures, standards, and ESCMP*	• Deviation from policies or procedures, or other legal, regulatory, or safety requirements • Workplace hazards posed to employees • Gas hazards are not identified or untimely response to identified gas hazards • Effective corrective actions to prevent a reoccurrence are not instituted • Motor vehicle safe driving practices are not followed	n/a	$5,300	$5,300	$5,300
2	Employee skills training*	• Deviation from policies or	n/a	11,470	11,470	11,470

[13] Recorded costs were rounded to the nearest $10,000.
[14] The figures provided in Tables 3 and 4 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[15] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the “baseline” costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[16] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[17] The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[15]	O&M	Control Total[16]	GRC Total[17]
		procedures, or other legal, regulatory, or safety requirements • Workplace hazards posed to employees • Gas hazards are not identified or untimely response to identified gas hazards • Motor vehicle safe driving practices are not followed				
3	Employee refresher training*	• Deviation from policies or procedures, or other legal, regulatory, or safety requirements • Workplace hazards posed to employees • Gas hazards are not identified or untimely response to identified gas hazards • Motor vehicle safe driving practices are not followed	1,050	8,840	9,890	9,890
4	Contractor management and traffic control*	• Deviation from policies or procedures, or other legal, regulatory, or safety requirements • Gas hazards are not identified or untimely response to identified gas hazards • Effective corrective actions to prevent a reoccurrence are not instituted	4,570	6,910	11,480	11,480

ID	Control	Risk Drivers Addressed	Capital[15]	O&M	Control Total[16]	GRC Total[17]
		• Motor vehicle safe driving practices are not followed				
5	QA, job observations, field rides, and job monitoring	• Deviation from policies or procedures, or other legal, regulatory, or safety requirements • Workplace hazards posed to employees • Gas hazards are not identified or untimely response to identified gas hazards • Effective corrective actions to prevent a reoccurrence are not instituted • Motor vehicle safe driving practices are not followed	60	6,270	6,330	6,330
6	Safety communications and first responder liaison*	• Workplace hazards posed to employees • Gas hazards are not identified or untimely response to identified gas hazards • Effective corrective actions to prevent a reoccurrence are not instituted	n/a	3,830	3,830	3,830
7	Environmental services monitoring*	• Deviation from policies or procedures, or other legal, regulatory, or safety requirements • Workplace hazards posed to	n/a	900	900	900

ID	Control	Risk Drivers Addressed	Capital[15]	O&M	Control Total[16]	GRC Total[17]
		employees • Gas hazards are not identified or untimely response to identified gas hazards				
8	Safety, industrial hygiene, wellness, and emergency services/programs*	• Deviation from policies or procedures, or other legal, regulatory, or safety requirements • Workplace hazards posed to employees • Gas hazards are not identified or untimely response to identified gas hazards • Effective corrective actions to prevent a reoccurrence are not instituted • Motor vehicle safe driving practices are not followed	n/a	7,800	7,800	7,800
9	PPE and safety equipment*	• Workplace hazards posed to employees	n/a	2,580	2,580	2,580
10	Gas facility and pipeline inspections*	• Gas hazards are not identified or untimely response to identified gas hazards	480	54,200	54,680	54,680
11	Safety-related field orders* (leaks, appliance check and unusual use, etc.)	• Gas hazards are not identified or untimely response to identified gas hazards	n/a	20,250	20,250	20,250
	TOTAL COST		$6,160	$128,350	$134,510	$134,510

* Includes one or more mandated activities

While all the controls and baseline costs presented in Table 3 mitigate the Employee, Contractor, Customer, and Public Safety risk, some of the controls also mitigate other risks presented in this RAMP Report. The risks that are also impacted by Employee, Contractor, Customer, and Public Safety mitigation activities include:

- Catastrophic Damage Involving Gas Infrastructure (Dig-Ins);
- Catastrophic Damage Involving High-Pressure Pipeline Failure;
- Catastrophic Damage Involving Medium-Pressure Pipeline Failure;
- Catastrophic Event Related to Storage Well Integrity;
- Climate Change Adaptation;
- Workforce Planning;
- Workplace Violence; and
- Records Management.

Risk mitigation activities performed to address the aforementioned risks may also serve to mitigate the Employee, Contractor, Customer, and Public Safety risk.

Pipeline and other facility *inspection* activities (performed to identify the need for maintenance), were included as risk mitigation activities addressing this risk. Activities associated with the maintenance or replacement work on pipelines or other utility infrastructure were *not* included as costs associated with the Employee, Contractor, Customer, and Public Safety risk. In this risk mitigation, "Locate and Mark" activities were not considered to be "inspections." Although these activities are driven by regulatory safety policy and impact public safety, the "Locate and Mark" activities were deemed to be most closely associated with "Catastrophic Damage Involving Gas Infrastructure (Dig-Ins)," and the costs are quantified in that chapter.

The costs associated with 2015 risk mitigation activities were developed using historical (2011 – 2015) information. Where possible, SoCalGas used accounting data based upon Internal Orders (I/Os), cost centers and capital budget codes. In some cases Federal Energy Regulatory Commission (FERC) accounts were referenced. Where 2015 activities were only a subset of I/Os, cost centers, or budget codes, SMEs used high level assumptions, such as an assumed percentage of costs within the I/O, cost center, or budget code. For new risk mitigation activities, a zero-based approach was used to forecast most costs.

Table 4 summarizes SoCalGas' proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SoCalGas is identifying potential ranges of costs in this plan, and is not requesting funding approval. SoCalGas will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 4, SoCalGas used a 2019 forecast provided in ranges based on 2015 dollars.

Table 4: Proposed Risk Mitigation Plan[18]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[19]	2019 O&M	Mitigation Total[20]	GRC Total[21]
1	Policy, procedures, standards, and ESCMP	• Deviation from policies or procedures, or other legal, regulatory, or safety requirements	n/a	$4,710 - 5,760	$4,710 - 5,760	$4,710 - 5,760
2	Employee skills training	• Workplace hazards posed to employees	n/a	12,090 - 16,530	12,090 - 16,530	12,090 - 16,530
3	Employee refresher	• Gas hazards are not	2,850 - 3,480	10,500 -	13,350 - 16,310	13,350 -

[18] Ranges of costs were rounded to the nearest $10,000.
[19] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018, and 2019 are the forecast years for SoCalGas' Test Year 2019 GRC Application.
[20] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[21] The GRC Total column shows costs typically represented in a GRC.

	training	identified or untimely response to identified gas hazards		12,830		16,310
4	Contractor management and traffic control	• Effective corrective actions to prevent a reoccurrence are not instituted	8,270 - 10,110	8,290 - 10,130	16,560 - 20,240	16,560 - 20,240
5	QA, job observations, field rides, and job monitoring	• Motor vehicle safe driving practices are not followed	160 - 190	6,000 - 7,330	6,160 - 7,520	6,160 - 7,520
6	Safety communications and first responder liaison	• Deviation from policies or procedures, or other legal, regulatory, or safety requirements	n/a	3,700 - 4,530	3,700 - 4,530	3,700 - 4,530
7	Environmental services monitoring	• Workplace hazards posed to employees	n/a	980 - 1,200	980 - 1,200	980 - 1,200
8	Safety, industrial hygiene, wellness, and emergency services/programs	• Gas hazards are not identified or untimely response to identified gas hazards	2,030 - 2,480	11,760 - 14,380	13,790 - 16,860	13,790 - 16,860
9	PPE and safety equipment	• Motor vehicle safe driving practices are not followed	2,260 - 2,770	4,090 - 5,000	6,350 - 7,770	6,350 - 7,770
10	Gas facility and pipeline inspections	• Deviation from policies or procedures, or other legal,	n/a	77,720 - 91,360	77,720 - 91,360	77,720 - 91,360

		regulatory, or safety requirements				
11	Safety-related field orders (leaks, appliance check and unusual use, etc.)	• Workplace hazards posed to employees	n/a	20,930 - 25,580	20,930 - 25,580	20,930 - 25,580
	TOTAL COST		15,570 - 19,030	160,770 - 194,630	176,340 - 213,660	176,340 - 213,660

(white box)	Status quo is maintained
(shaded box)	Expanded or new activity
*	Includes one or more mandated activities

The incremental risk mitigation costs were forecast based upon both the labor and non-labor required to perform the function. Where training is proposed, the cost forecast includes incremental student time and also instructor time, if required. Where a system, technology, tool, or material is required, costs were based upon vendor estimates.

7 Risk Spend Efficiency

Pursuant to D.16-08-018, the Companies are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[22] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[23]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 6). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

7.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores, and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

7.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts.

[22] D.16-08-018 Ordering Paragraph 8.
[23] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

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Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.

4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (see Table 2 in this chapter) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[24] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

7.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 6. They multiplied the risk reduction developed in subsection 7.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 4 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

7.2 Risk Spend Efficiency Applied to This Risk

SoCalGas analysts used the general approach discussed in Section 7.1, above, in order to assess the RSE for the Employee, Contractor, Customer, and Public Safety risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

The Company used two standard metrics it current tracks to estimate the potential risk reduction of the proposed mitigations: OSHA Recordable Incident rates and CMVI rates. OSHA Recordable Incident rates reflect the number of OSHA Recordable Incidents per 200,000 hours while conducting Company work. CMVI incident rates reflect the number of Controllable Motor Vehicle Incidents per 1,000,000 miles driven during Company operations. These metrics are suitable for use at this point in time, as

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[24] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

OSHA Recordable Incident and CMVI data are commonly available – both internally and externally across utilities. This supports a data-driven and comparable assessment.

For purposes of quantifying the potential risk reduction, SoCalGas organized both the current controls and incremental mitigations into two groups, respectively: ones that address work-related incidents that do not involve motor vehicles and one that addresses motor vehicle incidents. Analysts used historical safety performance and incident trends in combination with subject matter expertise as the basis for estimating risk reduction from these mitigations.

- ***Current 2015 Controls that Address Occupational Incidents***

The risk reduction from current controls was measured by considering the change in likelihood (i.e., risk frequency) of an incident if those controls were no longer in place. By examining industry OSHA Recordable Incident rates, management assumed without current controls, SoCalGas' OSHA Recordable Incident rate would increase to the worst rate in the industry. Based on 2011-2015 data, SoCalGas' average OSHA Recordable Incident rate was at 3.6 while the peer utility with the greatest rate in 2015 was at 8.1, which is 123% greater than SoCalGas' rate. Additionally, without current controls, SoCalGas assumes it would lose the average 2.6% improvement rate seen since 2007. Lastly, a time component was added that assumes three years must pass before SoCalGas would reach the worst state. As a result, the estimated percentage increase in risk frequency is approximately 40%.

- ***Incremental Mitigations that Address Occupational Incidents***

The risk reduction from SoCalGas' incremental mitigations was determined by examining the data trends in the OSHA Recordable Incident rates achieved through continuous improvement efforts and past investments over the years. As mentioned, SoCalGas has seen a 3-year average improvement rate of 2.6% since 2007 and is anticipating an increase in that improvement rate based on incremental mitigations SoCalGas is proposing to implement. The impact of incremental activities was based on SME input with an estimated increase of 50% in the rate of improvement. The estimated potential reduction in risk frequency is approximately 4%.

- ***Current Controls that Address Motor Vehicle Incidents***

Similar to the OSHA Recordable Incident benchmarking, an estimated percentage increase in risk frequency was calculated based on the assumption that if current activities were not in place, SoCalGas' CMVI rate would increase to the worst CMVI rate in the industry. Based on 2011-2015 data, SoCalGas' average CMVI rate was at 3.4 and the peer utility with the greatest CMVI rate in 2015 had a CMVI rate of 7.6[25] which is 125% greater than SoCalGas' rate. A time component was added that assumes three years must pass before SoCalGas would reach the worst state. The estimated potential increase in risk frequency is approximately 40% if current controls were discontinued.

[25] Outliers were excluded.

- ***Incremental Mitigations that Address Motor Vehicle Incidents***

The risk reduction from proposed mitigations was estimated based on SME input about the impact of these activities on Controllable Motor Vehicle Incidents. Based on SME input, an estimated decrease of 5% was used to calculate the potential reduction in risk frequency relating to Controllable Motor Vehicle Incidents.

7.3 Risk Spend Efficiency Results

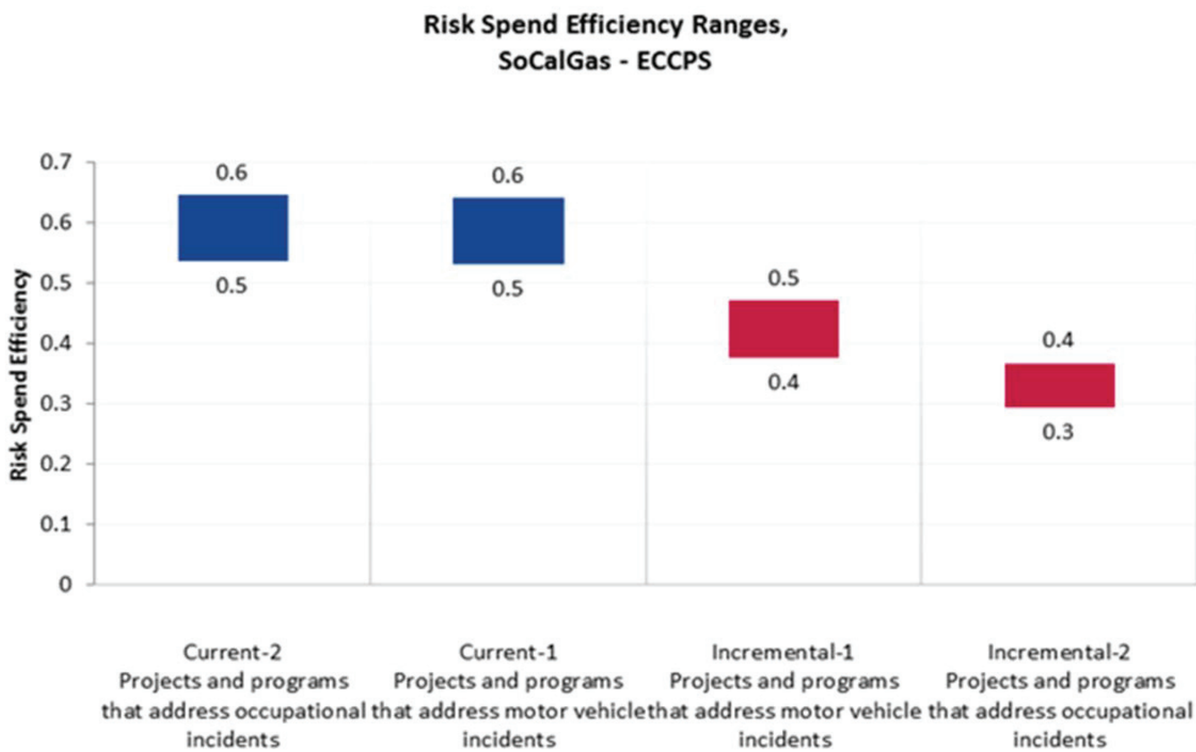
Based on the foregoing analysis, SoCalGas calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Projects and programs that address occupational incidents (current controls)
2. Projects and programs that address motor vehicle incidents (current controls)
3. Projects and programs that address motor vehicle incidents (incremental mitigations)
4. Projects and programs that address occupational incidents (incremental mitigations)

Figure displays the range[26] of RSEs for each of the SoCalGas Employee, Contractor, Customer, and Public Safety risk mitigation groupings, arrayed in descending order.[27] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

[26] Based on the low and high cost ranges provided in Table 4 of this chapter.
[27] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 3: Risk Spend Efficiency



8 Alternatives Analysis

SoCalGas considered alternatives when developing its proposed plan. These alternatives were dismissed in favor of the proposed plan as discussed below. Anything less than the baseline activities was not considered to be a viable alternative because the Company wants to build upon its successes and avoid taking a step backward when it comes to the safety of employees, contractors, customers, or the public.

8.1 Alternative 1 – Increasing the Frequency of Refresher Training

As seen in the sections above, training is a significant mitigation activity for this risk. Therefore, SoCalGas considered increasing the frequency of refresher training as an alternative to the proposed plan. For example, SoCalGas could review specific policies and procedures with employees more often than once per year. Providing more frequent training could engrain the subject matter further into the participants' minds.

This alternative was dismissed when compared to the proposed plan. Annual safety policy and standards reviews have been shown to be effective based on the gradual decline in SoCalGas' OSHA Recordable incident rate. Expanding the scope of training or reducing the period between policy reviews across the board would require additional resources and increase costs, yet are not expected to yield significant benefits. The exception to this lies in the specific areas of defensive driving, wellness and fitness, where SoCalGas believes more can implemented to help avoid injuries, particularly in the area of sprain and strain injury prevention and motor vehicle incident prevention.

8.2 Alternative 2 – Modernizing Training Techniques

SoCalGas considered modernizing its safety training techniques to include more videos, computer simulations, and computer-based training delivery channels. Many of the current trainings are administered using face-to-face or hands-on deliveries. Web-based channels could have benefits, such as greater accessibility and cost savings efficiencies in the long term.

At this time, SoCalGas' proposed plan is preferred to this alternative. All training is kept current pursuant to mandated regulations. When dealing with safety, enabling participants to understand and treat the subject matter with the utmost importance is key to the success of the training, particularly for drivers' training and other proposed enhancements to training in this Report. Such an emphasis may be more difficult to achieve through web-based delivery. Nonetheless, SoCalGas continues to consider new techniques and process improvements. Further, SoCalGas currently believes that the cost of large scale modernization of safety training would not provide added risk reduction.

8.3 Alternative 3 – Updating to Technologically Advanced Fleet

SoCalGas considered replacing its current vehicle fleet with vehicles equipped with the latest safety technology (vehicle guidance, blind spot assist, attention assist, etc.) but instead opted for risk-reduction alternatives that involve behavior modification and reinforcement. SoCalGas believes this approach may be more effective in influencing safety culture than engineering approaches that address a single risk factor at a time.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Cyber Security
(Chapter SDG&E-7/SCG-3)

November 30, 2016

SDGE SoCalGas
A Sempra Energy utility A Sempra Energy utility

TABLE OF CONTENTS

Executive Summary

The purpose of this chapter is to present the mitigation plan of the San Diego Gas & Electric Company (SDG&E) and Southern California Gas Company (SoCalGas) (collectively, the Companies) for the risk of Cyber Security. The Cyber Security risk involves a major cyber security incident that causes disruptions to electric or gas operations (e.g., SCADA system) or results in damage or disruption to company operations, reputation, or disclosure of sensitive data. The Companies' 2015 baseline mitigation plan for this risk consists of five controls aligned with the control functions in the National Institute of Standards and Technology (NIST) Cyber Security Framework:

1. Identify;
2. Protect;
3. Detect;
4. Respond; and
5. Recover.

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the California Public Utilities Commission (Commission or CPUC) in Decision (D.) 16-08-018, as well as controls and mitigations that may address reliability. The Companies' proposed mitigation plan comprises both baseline and new mitigation activities.

Based on the foregoing assessment, the Companies proposed future mitigations. For Cyber Security, the Companies proposed to continue the five control categories, identified above, but included enhancements within each category. The enhancements include:

1. Identify
    - Compliance Records Management – implement a system of recordkeeping dedicated to compliance records to better support regulatory auditing.
    - Enterprise Threat Intelligence – automate distribution of threat intelligence to business and system owners to improve Cyber Security risk awareness and engagement.

2. Protect
    - Web Applications and Database Firewalls – improve protective capabilities for web applications and databases to reduce the likelihood and impact of an incident.
    - Host-Based Protection – improve host-based protections for direct attacks and to prevent attackers from pivoting to a host from a neighboring host.

3. Detect

    - Insider Threat Detection/Prevention – leverage emerging technologies to improve the detection of insider threat activities and the related risk impacts.

- Perimeter Tap Infrastructure Redesign – improve the performance and visibility into network traffic to limit impacts of incidents.

4. Respond
   - Incident Response Secure Collaboration – implement a secure, out-of-band communication capability to coordinate and support incident response activity.
   - Security Orchestration – automate and support enhancements to the workflow related to responding to and analyzing escalated events to better manage and learn from cyber events.

5. Recover
   - Information Security technology backup and recovery – refresh backup and recovery for sensitive information security systems so as to return to a safe and secure risk posture.

The risk spend efficiency (RSE) was developed for Cyber Security. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The set of corporate measures that are in place is assumed to reduce the likelihood of experiencing such an event from what the likelihood would be otherwise. The risk reduction calculation is based on internal self-assessment results, and these results are further based on the judgment of subject matter experts (SMEs).

The benefits assessment for this risk was completed at a risk portfolio level, where the migration activities (within the five functional control areas) were combined and assessed as one aggregated mitigation. Because cyber threats are in a constant evolutionary state, corporate countermeasures also evolve over time and are generally lagging. Since countermeasures are designed to match known threats, all of them are categorized as baseline, so only one set of security measures was analyzed.

The benefits assessment addresses the mitigations at both Companies, collectively.

Risk: Cyber Security

1 Purpose

The purpose of this chapter (or plan) is to present the combined mitigation plans of the Companies for the risk of Cyber Security. This risk is a major cyber security incident that causes disruptions to electric or gas operations (e.g., SCADA system) or results in damage or disruption to company operations, reputation, or disclosure of sensitive data.

This risk is a product of the Companies' September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Companies. The Companies take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the Companies have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the Companies do not currently track expenditures in this way, so the baseline amounts are the best effort of the company to benchmark both capital and operations and management (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the Commission and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that the Risk Assessment Mitigation Phase (RAMP) be focused on safety-related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the Companies take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the Companies have made efforts to identify those costs.

Electric and gas operations, safety systems, information processing, and other utility functions are increasingly reliant on technology, automation and integration with other systems. The complex interoperation of these systems and the rapid changes that occur in the industry in response to climate,

[1] D.14-12-025 at p. 31.

cost and other drivers create a risk situation where inadvertent actions or maliciously motivated events can potentially disrupt core operations or disclose sensitive data, among other serious consequences. In addition, the functioning of society relies on safe and reliable energy delivery. The magnitude and likelihood of the Cyber Security risk is a documented concern at the national level, exemplified by Executive Order 13636 of February 21, 2013, titled "Improving Critical Infrastructure Cybersecurity."

This risk assessment focuses on responding to, and mitigating potential drivers and the potential resulting events of which the company is aware. However, the Companies strive to implement mitigations to address those instances (drivers and/or events) that may be unknown to the company. The mitigation approach is to leverage a framework of cyber security controls across the enterprise, with emphasis on key systems and data in order to address evolving threats and vulnerabilities. This approach considers all systems as potential weak points, which may provide an attacker a foothold within the enterprise or, through an error, create a situation to disrupt energy delivery, expose sensitive information, or cause other potential adverse events.

The assessment does not address Cyber Security risk mitigations performed by other groups within the business and Information Technology organizations. In particular, recovering and restoring energy delivery is addressed by other risks areas and departments.

The internal organization responsible for managing this risk is primarily the Information Security (IS) department, which resides in the Information Technology organization. The mitigations discussed in this chapter focus on those activities performed or supported directly by the department as a shared service for SDG&E, SoCalGas, and Sempra Energy, the parent company of SDG&E and SoCalGas. The Information Security department addresses cyber security risks potentially impacting the energy distribution information technology infrastructure and customer and business information systems.

As mentioned above, Cyber Security is a shared service since it supports SDG&E, SoCalGas and Sempra Energy. Generally, for accounting purposes, enterprise capital-funded solutions are booked to SoCalGas, while the bulk of the staffing resources and non-labor O&M costs are booked in SDG&E. Activities specific to electric appear in the SDG&E mitigation plan and activities attributed to the gas systems are addressed in SoCalGas' mitigation plan.

2 Background

In general, the Companies' Information Security Cyber Security program addresses Cyber Security at the enterprise level, using the industry standard NIST Cyber Security Framework[2] as a guide for best security risk management practices. Cyber security programs addressing this risk are not mandated; however, a cyber security program based on best practices, like the NIST framework, also should be in compliance with any forthcoming mandates. Should requirements or mandates change, the best practices followed by the program would be reviewed and updated to assess compliance.

In response to Executive Order 13636, the NIST Cyber Security Framework was developed through collaboration between the Federal government and the private sector, to address and manage Cyber Security risk cost-effectively based on business needs. The Framework supports the application of Cyber Security risk controls and best practices to reduce and manage Cyber Security risks, in order to improve the security and resilience of critical infrastructure. Effective industry practices from multiple resources have been grouped into five functional areas: (1) Identity; (2) Protect; (3) Detect; (4) Respond; and (5) Recover.

The Cyber Security risk mitigation plan is based on these functional areas. The definitions and descriptions of the functional areas are from the NIST Cyber Security Framework 1.0, pages 8-9.

1. Identify

Identify refers to developing organizational understanding to manage Cyber Security risk to systems, assets, data, and capabilities. The activities in the Identify Function are foundational for effective use of the NIST Framework. Understanding the business context, the resources that support critical functions, and the related cyber security risks, enables an organization to focus and prioritize its efforts, consistent with its risk management strategy and business needs. Examples of control Categories within this Function include: Asset Management; Business Environment; Governance; Risk Assessment; and Risk Management Strategy.

2. Protect

Protect refers to developing and implementing the appropriate safeguards so that the company can provide safe and reliable delivery of critical infrastructure services. The Protect Function supports the ability to limit or contain the impact of a potential cyber security event. Examples of control Categories within this Function include: Access Control; Awareness and Training; Data Security; Information Protection Processes and Procedures; Maintenance; and Protective Technology.

[2] https://www.nist.gov/cyberframework.

3. Detect

Detect refers to developing and implementing the appropriate activities to identify the occurrence of a Cyber Security event. The Detect Function enables timely discovery of Cyber Security events. Examples of control Categories within this Function include: Anomalies and Events; Security Continuous Monitoring; and Detection Processes.

4. Respond

Respond refers to developing and implementing the appropriate activities to take action regarding a detected Cyber Security event. The Respond Function supports the ability to contain the impact of a potential Cyber Security event. Examples of control Categories within this Function include: Response Planning; Communications; Analysis; Mitigation; and Improvements.

5. Recover

Recover refers to developing and implementing the appropriate activities to maintain plans for resilience and to restore any capabilities or services that were impaired due to a cyber security event. The Recover Function supports timely recovery to normal operations to reduce the impact from a Cyber Security event. Examples of control Categories within this Function include: Recovery Planning; Improvements; and Communications.

2.1 Safety Model Assessment Proceeding

SDG&E presented how it manages Cyber Security risk in the Safety Model Assessment Proceeding (S-MAP). On May 1, 2015, SDG&E submitted its Application (A.) 15-05-002, which was accompanied by the supporting testimony of Scott King. Mr. King described the Information Security Program and the Cyber Security risk management process. The Information Security Program governs risk management activities via the application of best practices, acceptable use policies, security standards, and technology requirements for managing and maintaining technology systems.

The Cyber Security risk management process describes the methodology used to prioritize resources to address identified risks. Risks are identified using multiple sources of information and assessments of both practices and critical cyber security controls. The risk mitigation practices and controls described in the S-MAP testimony are mapped to the NIST Cyber Security Framework to provide a programmatic summary. Efforts to manage risk are prioritized based on the risk scoring, benefits of the control activity, and evolving threats to the safety and reliability of critical systems.

Managing Cyber Security risk is a key business practice at the Companies that continually evolves to keep pace with threats, technology innovations, and advances in cyber security best practices to efficiently and cost-effectively manage cyber-related risks. The NIST cyber security framework is used to group these activities and projects into the five functional areas described above.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in A.15-05-002/004 "SDG&E [/SoCalGas] is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[3] The Enterprise Risk Management (ERM) process and lexicon that the Companies have put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Companies are committed to increasing the use of quantification within its evaluation and prioritization of risks.[4] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers, and potential consequences of the Cyber Security risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, the Companies classify this risk as a cross-cutting risk that affects business and Information Technology (IT) systems as shown in 1. Cyber Security is a cross-cutting risk because an incident could potentially impact many areas throughout the Companies.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
CROSS-CUTTING	BUSINESS/IT SYSTEMS	TECHNOLOGY ASSETS AND INFORMATION

The threats related to this risk are dynamic. New adversarial techniques may evade current Cyber Security controls. Technology innovations and adoption continually increase the exposure of infrastructure and business services to a risk impact.

3.2 Potential Drivers[5]

When performing the risk assessment for Cyber Security risk the Companies identified potential indicators of risk, referred to as drivers. These include, but are not limited to:

- **Technology Failure** – The malfunction or failure of a technological device.

[3] A.15-05-002/004, filed May 1, 2015, at p. JMD-7.
[4] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[5] An indication that a risk could occur. It does not reflect actual or threatened conditions.

- **Human Threats** – These can be unintentional or deliberate. An unintentional threat is an error that occurs due to someone not doing something correctly. A deliberate threat includes potentially criminal activity that is likely motivated by profit, political agenda, or other illegal activity. Deliberate human threats are the most challenging threat to mitigate because tactics, methods, and capabilities evolve quickly to leverage unknown or unanticipated weaknesses.
- **Public Incident** – An incident, such as a long-term power outage, pollution, or chemical spill, motivating a threat agent to attempt to affect the risk.
- **Force of Nature** – An environmental event such as a flood, earthquake, or fire, that can cause a combination of asset, human, or process failures to circumvent controls designed to prevent the risk from occurring.

Human threat sources can be further grouped based on motivations and associated drivers. Human threat sources, motivations, and actions are described in Table from NIST SP 800-30.

Table 2: NIST SP 800-30 Threat Descriptions

Threat-Source	Motivation	Threat Actions
Hacker, cracker	Challenge Ego Rebellion	• Hacking • Social engineering • System intrusion, break-ins • Unauthorized system access
Computer criminal	Destruction of information Illegal information disclosure Monetary gain Unauthorized data alteration	• Computer crime (e.g., cyber stalking) • Fraudulent act (e.g., replay, impersonation, interception) • Information bribery • Spoofing • System intrusion
Terrorist	Blackmail Destruction Exploitation Revenge	• Bomb/Terrorism • Information warfare • System attack (e.g., distributed denial of service) • System penetration • System tampering
Industrial espionage (companies, foreign governments, other government interests)	Competitive advantage Economic espionage	• Economic exploitation • Information theft • Intrusion on personal privacy • Social engineering • System penetration • Unauthorized system access (access to classified, proprietary, and/or technology-related information)
Insiders (poorly trained, disgruntled, malicious, negligent, dishonest, or terminated employees)	Curiosity Ego Intelligence Monetary gain Revenge Unintentional errors and omissions (e.g., data entry error, programming error)	• Assault on an employee • Blackmail • Browsing of proprietary information • Computer abuse • Fraud and theft • Information bribery • Input of falsified, corrupted data • Interception • Malicious code (e.g., virus, logic bomb, Trojan horse) • Sale of personal information • System bugs • System intrusion • System sabotage • Unauthorized system access

The threats identified above are an expansion of human deliberate actions that may result in the realization of a cyber event. Worldwide access to the Internet and the pervasiveness of technology leveraging networking capabilities potentially expose information and operational technology and information assets to all human threat agents. The Companies monitor such potential threats and implement mitigation efforts, as described in Sections 5 and 6, to protect the employees, contractors, customers, the public, and the Companies.

3.3 Potential Consequences

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

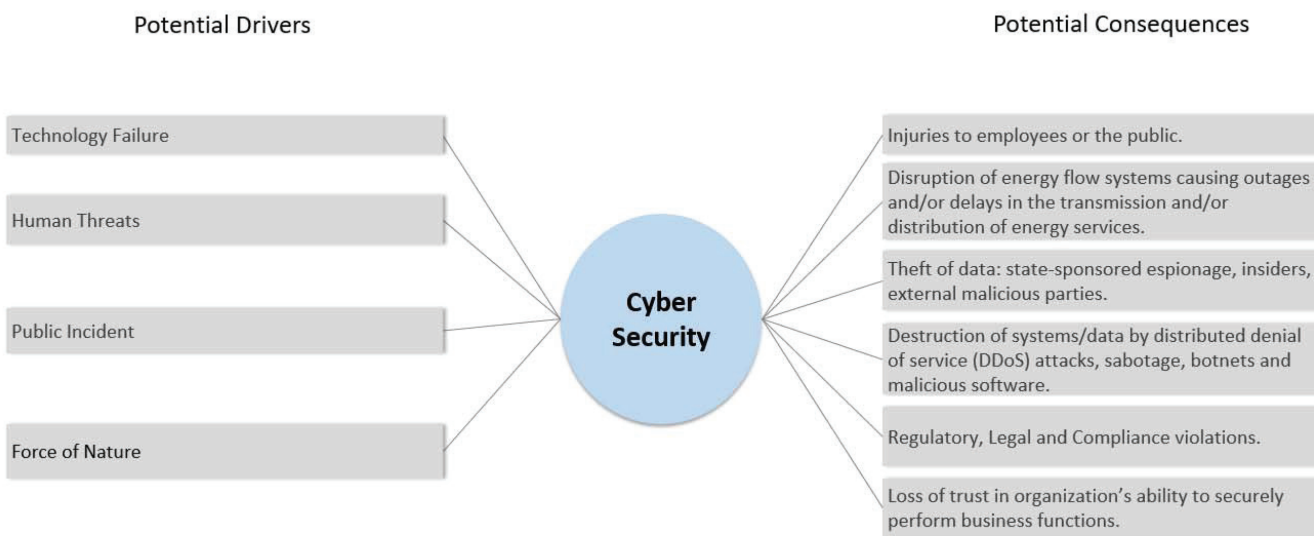
- Injuries to employees or the public.
  - Incorrect system information may result in unsafe operating conditions related to what the system operators believe to be happening versus the actual system state.
  - Loss of operational control of energy systems.
- Disruption of energy flow systems causing outages and/or delays in the transmission and/or distribution of energy services.
  - Direct impact to customer's lighting, heating, refrigeration, and other energy-related activities.
  - Social disruptions such as food distribution constraints, traffic light functions, gas distribution, water systems, telecommunications, and reliable support of other dependent industries.
- Theft of data: State-sponsored espionage, insiders, and external malicious parties.
  - Data may include system information, strategy and planning data, or other restricted or confidential information resulting in increased risk to assets, increased costs, and other business impacts.
  - Stolen customer information could be used to steal identities, perpetrate fraud or other criminal activities, or gain access to proprietary customer data.
  - Stolen data may also be used to plan and conduct exploitation of Cyber Security weaknesses or other risks.
- Destruction of systems/data by distributed denial of service (DDoS) attacks, sabotage, botnets, and malicious software.
  - The resulting impacts may include an inability to control energy delivery and other systems, failure of protective systems, loss of utility assets, customer disruption, or other system and financial impacts.
- Regulatory, Legal, and Compliance violations.
  - Breach of regulatory compliance (for example, an incident of non-compliance with NERC CIP (FERC) or a customer privacy breach (California Statutory)) resulting in adverse publicity, sanctions, and increased scrutiny of operations by the regulator.
- Loss of trust in organization's ability to securely perform business functions.
  - Business level impacts may include the inability to guard against Cyber Security incidents, technologically interact with partners, and retain employees.
  - Customer level impacts may make it difficult to collect necessary customer information and conduct other interactions, tainted by an unwillingness to share information.

These potential consequences were used in the scoring of Cyber Security that occurred during the Companies' 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. The Companies applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



4 Risk Score

The Companies' ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Cyber Security as one of the enterprise risks. During the development of the risk register, SMEs assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a public safety event can occur. For purposes of scoring this risk, SMEs used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The SMEs selected the following reasonable worst case scenario to develop a risk score for Cyber Security:

- An advanced, persistent threat infiltrates energy delivery management, monitoring, and safety systems to prepare for a coordinated attack that disrupts operator control systems; disables or destroys backup and redundant system protection and recovery assets; disrupts communication capabilities; and remotely launches attacks during a major local event.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen.

4.2 2015 Risk Assessment

Using this scenario, SMEs then evaluated the frequency of occurrence and potential impact of the risk using the Companies' 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[6] Using the levels defined in the REF, the SMEs applied empirical data to the extent it was available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the Cyber Security risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
4	6	5	5	4	44,548

4.3 Explanation of Health, Safety, and Environmental Impact Score

The Companies score Cyber Security a 4 (Major) in the Health, Safety, and Environmental impact area based on the potential to cause few serious injuries to the public or employees. This is because a cyber security incident within the control systems responsible for delivering energy into the service area could disrupt energy flow systems, causing widespread outages or infrastructure malfunctions, resulting in the potential for injuries. Also, an incident could impact local areas, resulting in neighborhoods or individuals experiencing impacts to health or safety-related equipment during periods of environmental stress (heat or cold), or to the use of necessary medical equipment.

[6] D.16-08-018, Ordering Paragraph 9.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, the Companies scored each of the other residual impact areas. The scenario, for example, such as the 2015 cyber security attack on the Ukrainian Power Grid (UPG), could have an impact on more than one of the risk areas. During that remote cyber security attack, power system components were maliciously operated and automation systems were disabled, resulting in disruption of power delivery to its customers. A third party gained illegal entry into UPG computers and SCADA systems. Multiple substations were remotely controlled and disconnected. Response and recovery activities were also hindered by changes in support systems, disabled devices, and attacks on the communications systems. The incident affected up to 225,000 customers in three different service territories for several hours. Service was recovered by operating in a manual mode.[7]

There are many, frequent stories in the media about information disclosure, vulnerabilities, threat agents, and compromises. Most of these stories, when applied to the Companies, would have a similar impact in one or more of the risk areas.[8]

The other risk impacts were scored using the worst case scenario, illustrated by these examples of cyber incidents:

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[7] Other examples of cyber incidents that would likely have impacts across all of the other risk impact areas include:

- The 2012 virus attack on Saudi Aramco did not directly result in an operational impact, however 30,000 systems were infected. The virus deleted data from computer hard drives. An incident of this type would severely impact business operations, have financial consequences, and likely result in regulatory, statutory, or compliance review and scrutiny.
- The Lansing Board of Water and Light ransomware attack that impacted significant numbers of corporate computers. In that situation, an employee opened an email leading to the incident. Utility service delivery was not impacted.

[8] For example:

- The United States Office of Personnel Management (OPM) had a data breach of information records for 21.5 million people, possibly including background check information and fingerprints. This type of information compromise would have both Regulatory, Legal, and Compliance impacts and Financial impacts.
- The recent Yahoo password breach affecting 500 million accounts provides an example of two issues that could impact utility customers. A compromise of our customer passwords would expose customer personal information with resulting identity theft risks. In this case, there would likely be Regulatory, Legal, and Compliance, as well as Financial, impacts. Further, the Yahoo passwords could be the same passwords customers have used for their utility accounts. In this case, customer information would also be exposed to unauthorized access.

- **Operational and Reliability:** A score of 6 (Severe) was given to this risk. A cyber security incident impacting transmission and/or distribution of energy would directly impact the reliable delivery of energy.
- **Regulatory, Legal, and Compliance**: Cyber Security was scored a 5 (Extensive) in the Regulatory, Legal, and Compliance impact area. This is reasonable because a severe impact to operations would likely result in an extended and in-depth review of the incident, as well as the existing mitigations and activities related to Cyber Security at the time of the event.
- **Financial:** The Financial impact of a cyber security incident was also scored as a 5 (Extensive). A variety of cyber incidents could potentially result in this level of financial impact due to the high visibility of this kind of incident in our industry. A customer information breach may potentially result in reparations, security investigation and improvement costs, and a loss of customer confidence. An energy outage could result in financial impacts, loss of confidence, and/or increased insurance costs. The possibility of an incident destroying assets or data, such as an Advanced Meter Infrastructure (AMI) solution, could also be severe.

4.5 Explanation of Frequency Score

SMEs used empirical data to the extent available and/or their expertise to determine the likelihood of a cyber security incident score as a 4 (Occasional), which is defined in the REF as the possibility of a Cyber Security-related event occurring once every 3-10 years. Those assigning this score considered reports in open media, security research, information-sharing entities, contracted information services, and threat intelligence sources.

5 Baseline Risk Mitigation Plan[9]

As stated above, Cyber Security risk is a major cyber security incident that causes disruptions to electric or gas operations (e.g., SCADA system) or results in damage or disruption to the Companies' operations, reputation, or disclosure of sensitive data. The 2015 baseline mitigations discussed below include the current evolution of the Companies' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time.

The Companies' baseline mitigation plan for this risk consists of five types controls aligned with the control functions in NIST Cyber Security Framework noted above: (1) Identify; (2) Protect; (3) Detect; (4) Respond; and (5) Recover. SMEs from the Information Security department collaborated to identify and document them. These controls focus on safety-related impacts[10] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018,[11] as well as controls and

[9] As of 2015, which is the base year for purposes of this Report.
[10] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[11] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."

mitigations that may address reliability.[12] Accordingly, the controls and mitigations described in Sections 5 and 6 primarily address safety-related impacts. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Cyber Security events, not just the scenario used for purposes of risk scoring.

The control functions provide a framework for the activities and projects used to maintain the cyber security posture. Some sample activities and 2015 projects are discussed for each of the functional areas. Additional activities are also performed and projects implemented, which are not completely enumerated here due to the confidential nature of the cyber security function and mitigation strategies. Also, when technological capabilities are implemented, they are used as long as they continue to effectively mitigate the associated risks, so there are not necessarily projects in every functional area every year. In some cases, additional activities and projects are necessary to specifically address some mandates.

The benefits of the current baseline mitigation approach are that it has been active and maturing for several years with the corresponding improvements in risk identification, tracking, and mitigation. It has been integrated into business processes, technology projects, and the organizational culture. Because more people in the organization are security aware, more potential issues are addressed sooner so that risks can be avoided. Also, security is addressed earlier in the acquisition and development lifecycles.

Cyber Security has had consistent capital funding for several years as well. These projects have established a core set of control capabilities that are leveraged by business projects and ongoing operations.

1. Identify

Program activities in the Identify Function include maintaining a security policy framework, asset management, risk assessments, threat intelligence, and risk management. For example, in conjunction with the IT Enterprise Architecture group, the Information Security control capabilities are documented. Risk assessments conducted by internal and external resources review the security posture of practices, technology, security controls, and other business activities. The assessments identify opportunities for improvements. These opportunities are prioritized via the risk management process. As projects are identified, funded, and completed, the security capabilities are updated in the capability repository.

[12] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

2. Protect

Protection-oriented activities are focused on avoiding or limiting potential cyber security events. Activities in this functional area include: managing asset access, cyber security awareness and training, protective technologies, and system maintenance. Ongoing cyber security awareness and training is important for engaging all employees so that they understand their roles and responsibilities regarding cyber security. Other activities in this area include vulnerability management, system implementation, security consulting and support, and operating support for protection systems. This support can include: two-factor authentication, the public key infrastructure, malware prevention, web content management, and supporting network protections, such as firewalls and intrusion detection and prevention.

In 2015, several projects were completed to support this functional area, including:

- An update and enhancement of security of endpoints, such as employee laptops. This project added advanced malware detection and other protections to avoid or reduce the impact of endpoint compromises.
- A rebuild of the public key infrastructure used to issue and manage certificates to authenticate devices, applications, and services. Cryptographic algorithms have a limited lifetime and must be updated periodically to maintain their effectiveness. This rebuild was partially driven by the need to replace an encryption algorithm, which was not considered resilient to current computer processors.
- The initiation of a data loss prevention capability to detect potentially unauthorized movement of information. The primary focus of this initial effort was the protection of customer information.

Non-GRC projects at SDG&E were also completed in the Protection area:

- Improvements on the communication infrastructure security; and
- Implementation of an isolated infrastructure to support NERC CIP security activities to minimize exposure to unrelated risks.

Note that because these projects were completed in 2015, they are reflected in the baseline risk mitigation plan, but will not continue for purposes of the proposed mitigation plan, discussed in Section 6. However, other projects for the Protect functional area are proposed and anticipated in the proposed plan.

3. Detect

The Detect Function enables timely discovery of Cyber Security events by monitoring security-related activities in systems and applications, anomaly detection, and security event detection and escalation. The 7x24 Security Operations Center monitors detection infrastructure systems to investigate security events. If the security events have the potential to impact the organization, they are escalated to the security incident response process.

4. Respond

The Respond Function supports the ability to contain the impact of a cyber security event. The response team coordinates cyber security incident response when a security event is escalated. They also provide analysis of the incident, during the incident, to determine the most effective response, as well as after the incident in terms of lessons learned. During the incident, communications with stakeholders are maintained. This functional area is the focus of ongoing training to maintain readiness through exercises to validate the response plans for high impact systems.

5. Recover

The Recover Function supports timely recovery to normal operations to reduce the impact from a cyber security event. This function is a core capability of the Information Technology business unit. The Information Security department's focus on Recovery functions is to maintain resilience against a Cyber Security event and, if necessary, to restore cyber security capabilities to a known state after an incident.

6 Proposed Risk Mitigation Plan

Planning the mitigation of Cyber Security risk is particularly challenging because of the wide range of potential risk drivers, including: rapid changes in technology, innovations in business capabilities, evolving threats in terms of sophistication, automation, and aggressiveness, and increasing system interdependencies. Cyber Security risk cannot be completely mitigated or avoided; however, the Companies can manage it by following well understood principles, recommending best practices, and striving to keep pace with changing threats.

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan. However, due to the evolving nature of the threats associated with this risk, if only the baseline mitigations were to be maintained, the risk would likely grow. Accordingly, in addition to the baseline controls, there will be several, new capital projects to improve or replace existing security capabilities to address changing threats or supported technologies. Also, there is a proposed increase in on-site staff at SoCalGas, the introduction of an entry level staffing program, and use of external services for some solutions instead of internal resources.

The additional employees, located primarily in the SoCalGas facilities, will provide better business and IT project and operational support. Also, an Information Security Associates program is proposed to add more entry level staff at both Companies in order to support the transition of the aging workforce, as well as lowering the overall average employee cost. These incremental changes are further described below.

1. Identify
    - Compliance Records Management – implement a system of recordkeeping dedicated to compliance records to better support regulatory auditing and governance of required safety-related Cyber Security risk mitigation activity.
    - Enterprise Threat Intelligence – automate distribution of threat intelligence to business and system owners to improve Cyber Security risk awareness and engagement.

2. Protect
    - Web Applications and Database Firewalls – improve protective capabilities for web applications and databases to reduce the likelihood and impact of an incident.
    - Host Based Protection – improve host-based protections for direct attacks and to help prevent attackers from pivoting to a host from a neighboring host.

3. Detect
    - Insider Threat Detection/Prevention – leverage emerging technologies to improve the detection of insider threat activities and the related risk impacts.
    - Perimeter Tap Infrastructure Redesign – improve the performance and visibility into network traffic to limit impacts of incidents.

4. Respond
    - Incident Response Secure Collaboration – implement a secure, out-of-band communication capability to coordinate and support incident response activity.
    - Security Orchestration – automate and support enhancements to the workflow related to responding to and analyzing escalated events to better manage and learn from cyber events.

5. Recover
    - Information Security technology backup and recovery – refresh backup and recovery for sensitive information security systems so as to return to a safe and secure risk posture.

7 Summary of Mitigations

Table 4a and 4b summarize the 2015 baseline risk mitigation plans, the risk driver(s) a control addresses, and the 2015 baseline costs for Cyber Security risk for SDG&E and SoCalGas, respectively. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

The Companies do not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in these tables were estimated using assumptions provided by SMEs and available accounting data.

Mitigation costs include capital costs for new and updated infrastructure, as well as operating and maintenance costs for labor resources and non-labor expenses. The costs represented here are the initial costs of the baseline mitigations before they are reallocated between SDG&E and SoCalGas. In general, capital costs are allocated to SoCalGas, and O&M costs are allocated to SDG&E. Non-GRC costs are those supporting mandated NERC CIP compliance. Only SDG&E has non-GRC costs, and none of these costs are shared with SoCalGas.

Table 4a: SDG&E Baseline Risk Mitigation Plan[13]
(Direct 2015 $000)[14]

ID	Control	Risk Drivers Addressed	Capital[15]	O&M	Control Total[16]	GRC Total[17]
1	Identify*	Addresses all risk drivers by defining the foundational asset and risk information necessary for mitigation	n/a	$1,420	$1,420	$780
2	Protect*	Address all risk drivers via controls, training, and activities focused on preventing or minimizing impacts	1,820	2,880	4,700	3,870
3	Detect*	Address all risk drivers by monitoring, detecting, and analyzing cyber events	0	1,020	1,020	880
4	Respond*	Address all risk drivers by containing and remediating cyber incidents	n/a	810	810	620
5	Recover*	Address all risk drivers by planning	n/a	70	70	20

13 Recorded costs were rounded to the nearest $10,000.
14 The figures provided in Table 4a, 4b, 5a, and 5b are direct charges and do not include company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
15 Pursuant to D.14-12-025 and D.16-08-018, the Companies provided the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
16 The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
17 The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[15]	O&M	Control Total[16]	GRC Total[17]
		and communicating the restoration of services after an incident				
	TOTAL COST		$1,820	$6,200	$8,020	$6,170

* Includes one or more mandated activities

Table 4b: SoCalGas Baseline Risk Mitigation Plan[18]
(Direct 2015 $000)

ID	Control	Risk Drivers Addressed	Capital[19]	O&M	Control Total[20]	GRC Total[21]
1	Identify	Addresses all risk drivers by defining the foundational asset and risk information necessary for mitigation	n/a	$50	$50	$50
2	Protect	Address all risk drivers via controls, training, and activities focused on preventing or minimizing impacts	6,370	400	6,770	6,770
3	Detect	Address all risk drivers by monitoring, detecting, and analyzing cyber events	n/a	n/a	n/a	n/a
4	Respond	Address all risk drivers by containing and remediating cyber incidents	n/a	10	10	10
5	Recover	Address all risk drivers by planning and communicating the restoration of services after an incident	n/a	n/a	n/a	n/a
	TOTAL		$6,370	$460	$6,830	$6,830

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18 Recorded costs were rounded to the nearest $10,000.
19 Pursuant to D.14-12-025 and D.16-08-018, the Companies provided the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
20 The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
21 The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[19]	O&M	Control Total[20]	GRC Total[21]
	COST					

* Includes one or more mandated activities

The baseline costs above in Tables 4a and 4b reflect the actual Information Security O&M and Capital costs based on accounting data.

The Companies have established a core set of control capabilities that are leveraged by business projects and ongoing operations. In 2015, there were no capital projects within the functional controls of Identify, Detect, Respond and Recover.

Table 5a and 5b summarize the proposed mitigation plans, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019 for SDG&E and SoCalGas, respectively. It is important to note that the Companies are identifying potential ranges of costs in this plan, and is not requesting funding approval. The Companies will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Tables 5a and 5b, the Companies are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 5a: SDG&E Proposed Risk Mitigation Plan[22]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[23]	2019 O&M	Mitigation Total[24]	GRC Total[25]
1	Identify*	Addresses all risk drivers by defining the foundational asset and risk information necessary for mitigation	n/a	$1,100 - 1,570	$1,100 - 1,570	$460 - 720
2	Protect*	Address all risk drivers via controls, training, and activities focused on preventing or minimizing impacts	3,000 - 9,000	4,000 - 6,020	7,000 - 15,020	6,170 - 14,130
3	Detect*	Address all risk drivers by monitoring, detecting, and analyzing cyber events	n/a	1,280 - 1,630	1,280 - 1,630	1,140 - 1,340
4	Respond*	Address all risk drivers by containing and	n/a	940 - 1,500	940 - 1,500	740 - 1,150

22 Ranges of costs were rounded to the nearest $10,000.
23 The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018, and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
24 The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
25 The GRC Total column shows costs typically represented in a GRC.

		remediating cyber incidents				
5	Recover*	Address all risk drivers by planning and communicating the restoration of services after an incident	n/a	250 - 450	250 - 450	200 - 340
	TOTAL COST		$3,000 - 9,000	$7,570 - 11,170	$10,570 - 20,170	$8,710 - 17,680

☐	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

Table 5b: SoCalGas Proposed Risk Mitigation Plan[26]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[27]	2019 O&M	Mitigation Total[28]	GRC Total[29]
1	Identify	Addresses all risk drivers by defining the foundational asset and risk information necessary for mitigation	$0 - 7,500	$110 - 560	$110 - 8,060	$110 - 8,060
2	Protect	Address all risk drivers via controls, training, and activities focused on preventing or minimizing impacts	28,700 - 41,300	400 - 1,060	29,100 - 42,360	29,100 - 42,360
3	Detect	Address all risk drivers by monitoring, detecting, and analyzing cyber	9,450 - 14,900	0 - 150	9,450 - 15,050	9,450 - 15,050

[26] Ranges of costs were rounded to the nearest $10,000.
[27] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018, and 2019 are the forecast years for SoCalGas' Test Year 2019 GRC Application.
[28] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[29] The GRC Total column shows costs typically represented in a GRC.

		events				
4	Respond	Address all risk drivers by containing and remediating cyber incidents	7,000 - 12,000	10 - 160	7,010 - 12,160	7,010 - 12,160
5	Recover	Address all risk drivers by planning and communicating the restoration of services after an incident	0 - 6,000	n/a	0 - 6,000	0 - 6,000
	TOTAL COST		$45,150 - 81,700	$520 - 1,930	$45,670 - 83,630	$45,670 - 83,630

☐	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

Capital cost estimates are based on the current Information Security project roadmap. Depending on other budget priorities, some projects may be implemented in later years. The low range is based on the roadmap timelines. The high range for the capital projects includes costs for projects from previous years being completed in that year, and projects that are identified and prioritized during the risk assessment process.

O&M costs have a labor and a non-labor component. The estimated labor costs are based on 2015 costs as the low range plus a minimal number of Information Security Associates (discussed in the benefits section below). The high range includes additional full-time staff to support the Companies' projects and operations, and other activities identified in risk assessments.

The non-labor component of the O&M costs is estimated by escalating costs associated with supporting the capital projects after their implementation. The high range also accommodates the costs of addressing capability improvements utilizing service-based offerings where there is a rate benefit and appropriate risk management.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent.[30] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[31]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts.

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[30] D.16-08-018 Ordering Paragraph 8.

[31] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.

4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[32] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Tables 5a and 5b of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

Company analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Cyber Security risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

The NIST developed a cyber security framework to serve as an implementation guide for corporate countermeasures. In this framework, core activities and outcomes are placed into five functions: identify, protect, detect, respond, and recover. The Company has measures that address requirements under these functions.

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[32] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

The migration activities (within the five functional control areas) were combined and assessed as one aggregated mitigation for the risk reduction analysis. Because cyber threats are in a constant evolutionary state, corporate countermeasures also evolve over time and, generally are lagging. Since countermeasures are designed to match known threats, all of them are categorized as baseline, so only one set of security measures was analyzed. The methodology used to estimate risk reduction was based on internal self-assessment results and the judgment of SMEs. This analysis addresses the mitigations at both utilities, collectively.

As self-assessments are performed over time, progress on each of the functions is noted. If the baseline portfolio were to not be funded, it can be assumed that risk would revert to an earlier state. This is the principle that is used in the estimation of risk reduction from this mitigation; namely that the benefit is the difference in performance between the current state and an earlier, known state.

Year 2015 assessment results are used to define the earlier, known state, and 2016 assessment results are used to define the current posture. Assessment results are given in units consistent with the 7X7 matrix of the risk evaluation framework. Because results are given for each of the five cyber security functions, and not for the full cyber security portfolio, it is necessary to consolidate them into a single value. Also, the functions were assigned weights that reflected the relative contribution of each to overall benefits, SMEs assigned determined these assignments as shown in Figure :

Figure 3: Control Functions - Contribution to Overall Benefits

Function	Contribution to overall benefits
Identify	15%
Protect	15%
Detect	20%
Respond	20%
Recover	30%

Applying these weights, SMEs estimated that the remaining risk is 35% of the original risk from the earlier, known state. This means 65% of the risk is estimated to have been mitigated. This is a conservative result because security measures existed before the year 2015.

8.3 Risk Spend Efficiency Results

Figures 4 and 5display the range[33] of RSEs for Cyber Security risk for SoCalGas and SDG&E.

[33] Based on the low and high cost ranges provided in Tables 5a and 5b of this chapter.

Figure 4: SoCalGas Risk Spend Efficiency

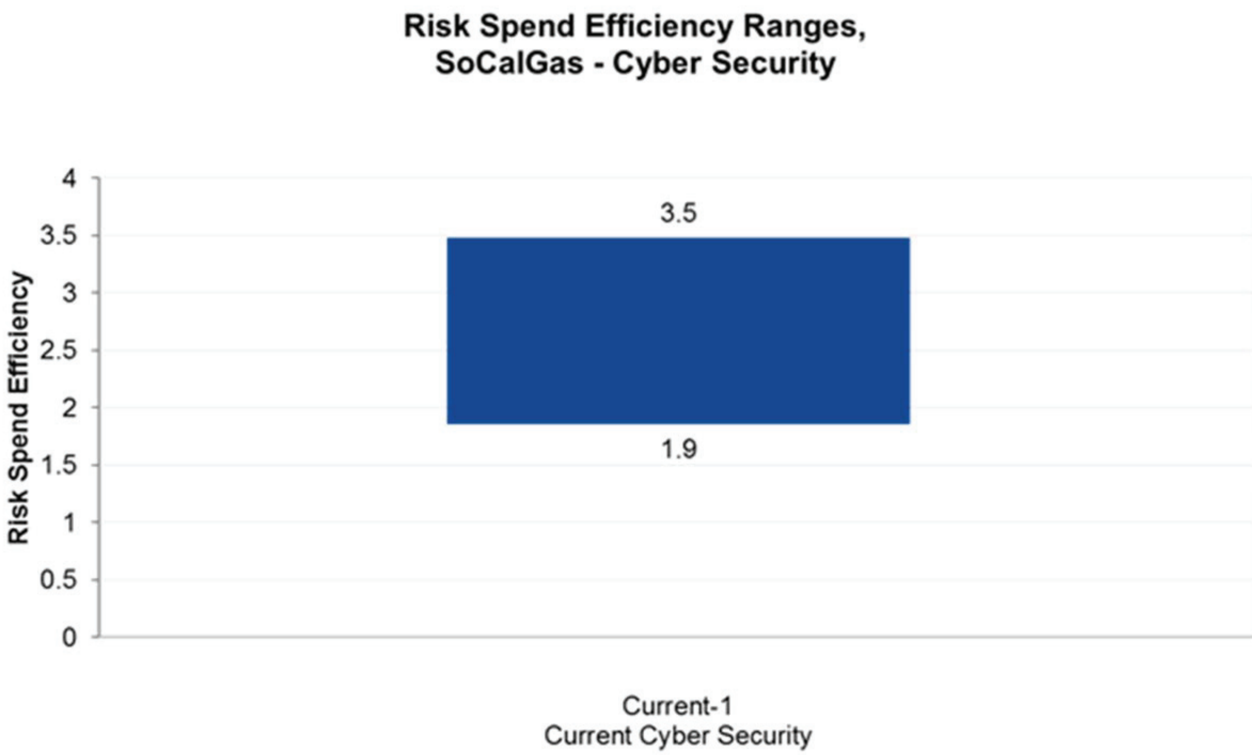
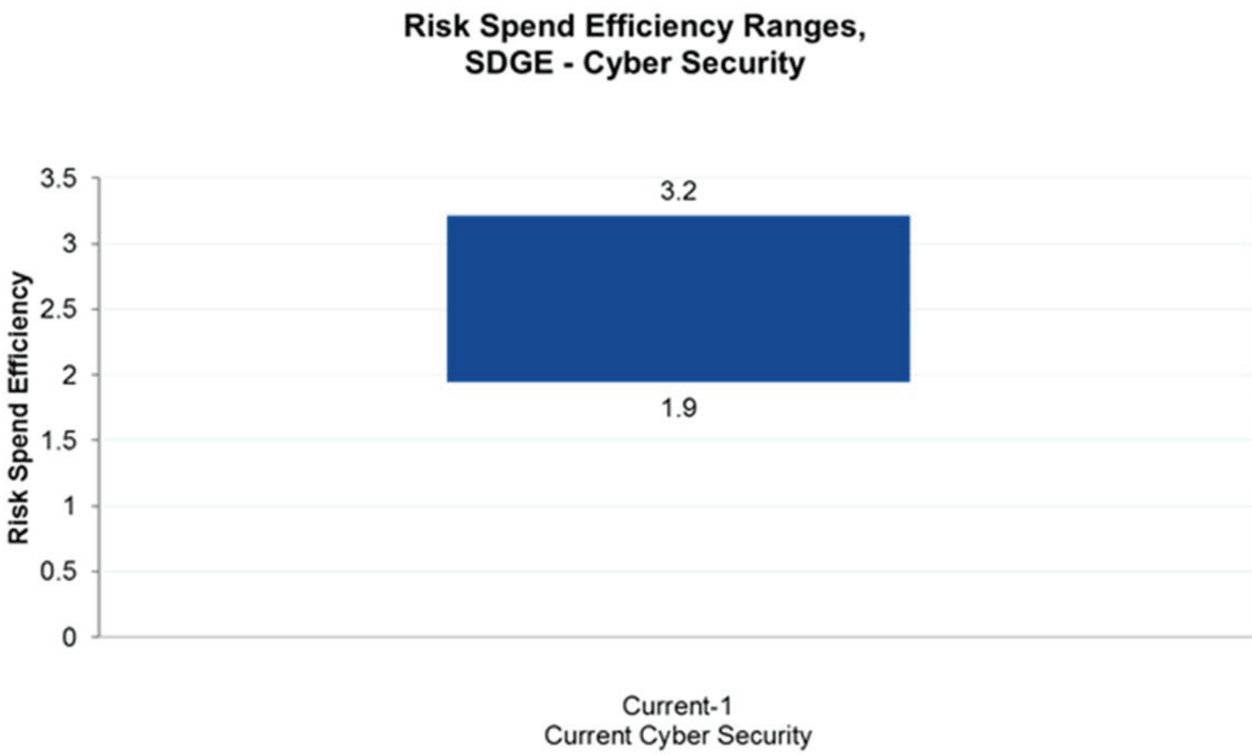


Figure 5: SDG&E Risk Spend Efficiency



9 Alternatives Analysis

The Companies considered alternatives to the proposed mitigations as it developed the proposed mitigation plan for the Cyber Security risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources.

9.1 Alternative 1 – Address All Known Issues

The first alternative considered was to more aggressively mitigate risk by quickly addressing all known issues. If the organization is less risk tolerant, then the Information Security program will address more of the medium and low risks more aggressively, reducing windows of vulnerability and addressing identified control capability risks sooner.

More aggressively addressing risk would increase capital spending, maintenance costs, and staffing in order to implement and operate more cyber security controls in a shorter period of time. Also, a more aggressive approach would lead to more business function-specific solutions instead of enterprise solutions, also increasing the cost of ownership. The amount of the cost increase depends on the degree of the accelerated activity. An increase in capital project costs also has a longer-term increase in labor and non-labor O&M costs in future years.

This alternative was dismissed in favor of the proposed plan due to resource, financial, and affordability constraints. The proposed plan balances resources and affordability by prioritizing projects and programs rather than addressing all known issues, while also reducing potential risk exposure to the extent it is feasible.

9.2 Alternative 2 – Delay Security Capability Implementation

The second alternative that was considered was to delay security capability implementation in response to a cyber threat, and business and Cyber Security technology changes. If the organization had a higher risk tolerance, then the Information Security program would slow down the implementation of security controls and focus on a smaller set of risks and business areas, increasing overall risk exposure.

Moderating the Cyber Security risk management would reduce capital spending and maintenance costs, as well as reduce increased staffing requirements. The amount of the decrease in cost would depend on the amount of moderation.

The Companies believe their risk management culture does not allow for this approach given the commitments to safety and cyber security. The current potential drivers of increasing capabilities of threat agents and higher risk exposure due to innovative technologies are increasing the Companies' risk. Only moderating cyber security activities and spending would not be beneficial to customers with respect to safe and reliable energy delivery and protecting sensitive customer information.

Risk Assessment and Mitigation Phase
Risk Mitigation Plan

Catastrophic Damage Involving a High-Pressure Gas Pipeline Failure
(Chapter SCG-4)

November 30, 2016

310329

Southern California Gas Company
A Sempra Energy utility

TABLE OF CONTENTS

Executive Summary

The Catastrophic Damage Involving a High-Pressure Gas Pipeline Failure (High-Pressure Pipeline Failure) risk relates to the potential public safety and property impacts that may result from the failure of high-pressure pipelines.

To assess this risk, Southern California Gas Company (SoCalGas) first identified a reasonable worst case scenario, and scored the scenario against four residual impact and residual frequency categories. Then, SoCalGas considered the 2015 baseline mitigations in place for High-Pressure Pipeline Failure. The 2015 controls are primarily based on Code of Federal Regulation (CFR) Part 192; General Order (GO) 112 state requirements; and Public Utility Code Sections 957 and 958, and include the following: (1) Maintenance (e.g., Patrolling, Leak Survey, etc.); (2) Qualifications of Pipeline Personnel (Training); (3) Requirements for Corrosion Control; (4) Operations (e.g., Odorization, etc.); (5) Pipeline Integrity (e.g., Threat Evaluation, etc.); and, (6) PSEP (e.g., Pressure testing and pipeline replacement, and valve automation and replacement).

These controls focus on safety-related impacts (e.g., Health, Safety, and Environment) per guidance provided by the Commission in Decision (D.) 16-08-018 as well as controls and mitigations that may address reliability. SoCalGas will continue its 2015 baseline controls. In addition, based on the foregoing assessment, SoCalGas proposes to expand its mitigations for the following categories:

1. Maintenance: SoCalGas proposes to expand class location activity to be able to identify areas of growth and strategically pressure test, replace, or derate pipeline segments.
2. Operations: SoCalGas proposes for example, to expand efforts to survey and maintain the Company's Right of Way (ROW) to increase span painting, pipeline maintenance, storm damage repair, removal of previously abandoned pipelines, vegetation removal, and ROW maintenance.
3. PSEP: Continuation and expansion of PSEP activities associated with work in less populated areas and pressure testing and replacement.

Next, SoCalGas developed the risk spend efficiency (sometimes referred to as RSE). The risk spend efficiency is a new tool that SoCalGas developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The RSE was determined using the proposed mitigations and resulted in prioritizing mitigation activities.

Finally, SoCalGas considered two alternatives to the proposed mitigations for the High-Pressure Pipeline Failure risk, and summarizes the reasons that the two alternatives were not selected as a proposed mitigation.

Risk: Catastrophic Damage Involving a High-Pressure Pipeline Failure

1 Purpose

The purpose of this chapter is to present the mitigation plan of the Southern California Gas Company (SoCalGas or Company) for the risk of catastrophic damage involving a high pressure asset (namely, pipelines and related components, referred to herein as "High-Pressure Pipeline Failure"). An asset is considered high pressure when it is operating at a pressure greater than 60 psig. These high pressure assets are operated by Transmission, Distribution and Storage.

The medium pressure assets operating at a pressure of 60 psig and less are included in the Risk Assessment Mitigation Phase (RAMP) chapter of Catastrophic Damage Involving Medium-Pressure Pipeline Failure. Similarly, events caused by third party damage are included in the RAMP chapter of Catastrophic Damage Involving Gas Infrastructure (Dig-Ins).

This risk is a product of SoCalGas' September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SoCalGas and San Diego Gas & Electric Company (SDG&E) (collectively, the Companies) take compliance and managing risks seriously, as can be seen by the amount of actions taken to mitigate each risk. This is the first time, however, that the Companies have presented a RAMP Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the Companies do not currently track expenditures in this way, so the baseline amounts are the best effort of the utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the Companies take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

[1] Commission Decision (D.) 14-12-025 at p. 31.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the Companies have made efforts to identify those costs.

2 Background

The SoCalGas transmission and distribution system operates in 12 different counties and spans from the California-Arizona border to the Pacific Ocean and from the California-Mexico border to Fresno County. SoCalGas is the largest gas distribution operator in the nation and the second largest transmission operator in High Consequence Area (HCA) miles, with approximately 1,100 miles out of 3,509 miles of pipelines defined as transmission by the United States Department of Transportation (DOT). In total, SoCalGas operates 6,741 miles of high-pressure pipelines in its service territory, which includes the 3,509 miles of transmission defined pipelines. The number of miles operated by operating unit is listed in Table 1:

Table 1: SoCalGas High Pressure Pipelines (>60 psig)

Operating Unit	Total High-Pressure Miles (>60psig)	Number of High Consequence Area Miles
Transmission	2,955	917
Distribution	3,741	178
Storage	45	5
Total	6,741	1,100

The U.S. Department of Transportation Pipeline and Hazardous Materials and Safety Administration (PHMSA) and ASME B31.8S, "*Managing System Integrity of Gas Pipelines*" categorizes nine types of threats that could lead to a high-pressure pipeline incident. They include:

1) External Corrosion
2) Internal Corrosion
3) Stress Corrosion Cracking
4) Manufacturing Defect
5) Construction & Fabrication
6) Outside Forces
7) Incorrect Operation

8) Equipment Threat
9) Third Party Damage[2]

These factors, also known as potential risk drivers, can work independently, interactively together, or in combination with fatigue.

When a gas pipeline has a loss of product, PHMSA categorizes it as a non-hazardous release of gas or a leak. Specifically, when the loss of gas cannot be resolved by lubing, tightening or adjusting, it is defined as a "leak." A leak may cause little-to-no risk from a safety standpoint, but it may have other impacts to the environment depending on the magnitude of the release. Risk to the public and employees can occur when leaks are in close proximity to an ignition source and/or where there is a potential for gas to migrate into a confined space. Safety of the leak is addressed by SoCalGas' leak indication prioritization and repair schedule procedures. In most cases, a pipe with a leak will continue to function as intended in the transport of gas, and therefore is not considered a failure using the definition defined by ASME B31.8S.

However, in some instances a pipeline may be weakened to the extent that the pipe can overload and will "break open" or burst apart. This is referred to as a pipeline rupture and considered a failure of the pipeline as it can no longer function as intended. This type of failure could be catastrophic in nature, releasing a high level of energy, and sometimes igniting, resulting in damage to the surrounding area, injury and potentially loss of life.

The leak verses rupture failure mode is generally dependent on the stress to the pipe, the pipe material properties and the geometry of the latent weak point on a pipeline. As a general rule, the rupture failure mode does not occur on a pipeline operating under 30% of Specified Minimum Yield Strength (SMYS), unless there is an egregious pipe anomaly acting as an initiation growth point and there is interacting threats involved.

Due to the catastrophic nature of a potential rupture failure mode, this risk category discusses the potential consequences of a rupture event occurring on the Company's high-pressure gas system.

The extent of damage of an incident can be modeled through the use of a potential impact radius (PIR) around a pipe. PHMSA has incorporated the PIR into its methods for determining a high consequence area (HCA) along the pipeline right-of-way.

The presence of HCA miles in a transmission system provides an indication of the potential consequences of an incident to the public. Applying mitigative measures as outlined in 192.935 such as increased inspections and assessments, additional maintenance, participation in a one-call system,

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[2] This threat has been removed from this risk plan and is being addressed under a standalone risk and mitigation plan. In the RAMP, this risk chapter is Catastrophic Damage Involving Gas Infrastructure (Dig-Ins).

community education and consideration of the installation of additional remote controlled valves can help reduce the likelihood or consequence of a rupture event in both high consequence and lesser populated areas.

2.1 Safety Model Assessment Proceeding

SoCalGas also presented how it models and assesses its risk on its transmission pipelines system, specifically with regard to its Transmission Integrity Management Program (TIMP), in the Safety Model Assessment Proceeding (S-MAP). On May 1, 2015, SoCalGas submitted its Application (A.) 15-05-004 and the supporting testimony of Mari Shironishi. Ms. Shironishi's testimony addressed the SoCalGas relative risk model that accounted for the nine threat categories (External Corrosion, Internal Corrosion, Stress Corrosion Cracking, Manufacturing, Construction, Equipment, Third Party Damage, Incorrect Operations and Weather Related and Outside Force) for the origination of the Transmission Integrity Management Program. As mentioned in Ms. Shironishi's testimony "since the fundamental inputs of the Relative Assessment do not change significantly for year to year, the primary driver for the subsequent integrity assessments is the requirements set by Subpart O, which requires a minimum reassessment interval of seven years."[3] These Subpart O requirements are the primary basis for the scheduling of the assessment and remediation cost presented within this RAMP chapter. SoCalGas continues to strive towards enhancing its TIMP risk model to the best of its ability to manage and mitigate risk.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in A.15-05-004, "SoCalGas is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[4] The Enterprise Risk Management (ERM) process and lexicon that SoCalGas has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks.[5] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, potential drivers and potential consequences of the High-Pressure Pipeline Incident risk.

[3] A.15-05-004, Testimony of Mari Shironishi, at p. MS-6.
[4] A.15-05-004, filed May 1, 2015, at p. JMD-7.
[5] Testimony of Diana Day submitted on November 14, 2014 in A.14-11-003.

3.1 Risk Classification

Consistent with the taxonomy presented by SoCalGas and SDG&E in the S-MAP, SoCalGas classifies this as an operational, gas risk. The risk classification is provided in Table 2.

Table 2: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	GAS	HIGH PRESSURE (>60 psig)

3.2 Potential Drivers[6]

When performing the risk assessment for High-Pressure Pipeline Failure, SoCalGas identified potential indicators of risk, referred to as potential drivers. These include, but are not limited to:

- **Corrosion (external corrosion, internal corrosion, and stress corrosion cracking)**

  This category includes internal, external and stress corrosion cracking. Corrosion is a degradation of a material due to a reaction to its environment.

- **Manufacturing Threat**

  This category includes the potential for a latent manufacturing anomaly in the body or the seam of a pipe that could affect the integrity of a pipe. These types of latent anomalies can often be deemed "stable" unless changes in pressure cycling or other interactive mechanisms cause anomaly growth to an injurious condition. According to PHMSA's "Significant Incident 20 year Trend," approximately 4.4% of all incidents are a result of material, weld, or equipment failure.[7]

- **Construction/Fabrication**

  This category includes the potential for construction errors to occur on installation as well as the potential risk from legacy construction practices such as the installation of miters, wrinkle bends and oxy-acetylene welds.

- **Outside Forces**

  This category includes both natural forces and those from external sources. Examples of natural forces includes: ground movement from earthquakes, floods, landslides, subsidence, and

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[6] An indication that a risk could occur. It does not reflect actual or threatened conditions.
[7] http://phmsa.dot.gov/pipeline/library/data-stats/pipelineincidenttrends.

lightning. Some of the outside forces are addressed in the Risk Assessment Mitigation Phase (RAMP) chapter of Climate Change Adaptation. Other external outside forces include vandalism, sabotage, vehicular damage, fire and other damages caused by external sources (excluding excavating equipment).

Within the Outside Force damage cause, vehicular damage is responsible for 75% of the incidents.[8]

- **Incorrect Operation**

  This category includes a variety of operational and procedural processes that could lead to human error or incorrect operation of a pipeline. Areas where incorrect operations can occur include, but are not limited to: inadequate inspection or monitoring, inadequate records, inadequate maintenance and construction practices.

- **Equipment**

  This category includes equipment related incidents. This includes: o-ring /gasket failure, seal, packing failure, and malfunction of control equipment).

Table 3 maps the potential drivers of High-Pressure Pipeline Failure to SoCalGas' risk taxonomy.

Table 3: Potential Operational Risk Drivers

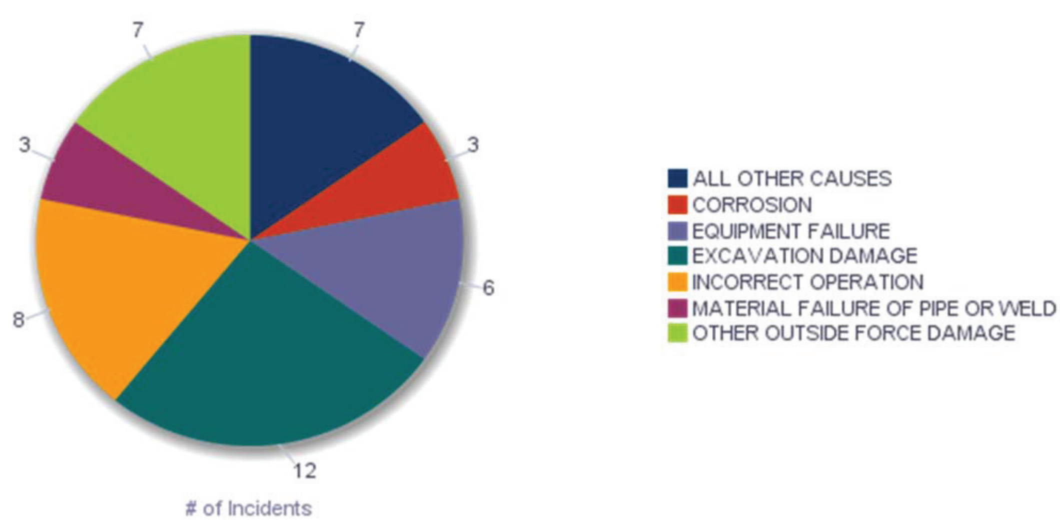
Potential Driver Category	Potential High-Pressure Pipeline Failure Driver(s)
Asset Failure	• Corrosion • Manufacturing Threat • Construction/Fabrication • Equipment
Asset-Related Information Technology Failure	Not applicable
Employee Incident	• Construction/Fabrication • Outside Forces

[8] https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?Portalpages&NQUser=PDM_WEB_USER&NQPassword=Public_Web_User1&PortalPath=%2Fshared%2FPDM%20Public%20Website%2F_portal%2FGT%20Performance%20Measures.

Potential Driver Category	Potential High-Pressure Pipeline Failure Driver(s)
	• Incorrect Operation
Contractor Incident	• Construction/Fabrication • Outside Forces • Incorrect Operation
Public Incident	• Outside Forces
Force of Nature	• Outside Forces

Figure 1 below, provided by PHSMA, demonstrates the leading causes of incidents related to high-pressure pipelines. This depicts the seriousness of this risk through the potential drivers and number of incidents, safety-related events.

Figure 1: Gas Transmission Serious Incident Cause 2005-2015[9]



[9] Figure from online metrics published by PHMSA on https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?Portalpages as 10/4/2016. Serious incidents include a fatality or injury requiring overnight, in-patient hospitalization.

Southern California Gas Company
A Sempra Energy utility

3.3 Potential Consequences

If one of the potential risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

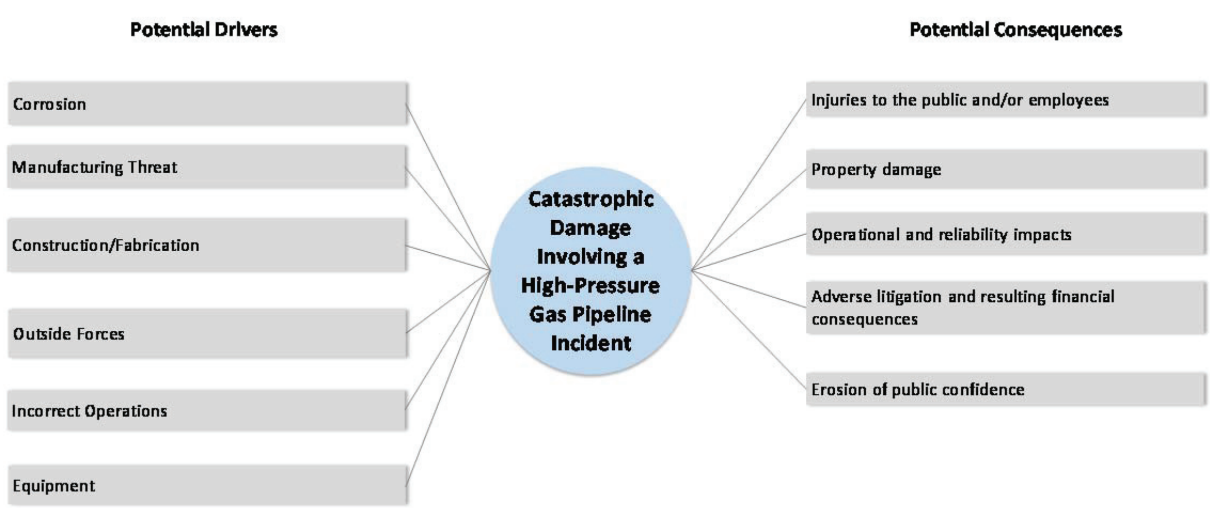
- Injuries to employees and/or the public.
- Property damage.
- Operational and reliability impacts.
- Adverse litigation and resulting financial consequences.
- Increased regulatory scrutiny.
- Erosion of public confidence.

These potential consequences were used in the scoring of High-Pressure Pipeline Failure that occurred during the SoCalGas' 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown in Figure 2, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates the potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SoCalGas applied this framework to identify and summarize the information provided above.

Figure 2: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of High-Pressure Pipeline Incident as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a high-pressure pipeline incident can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for High-Pressure Pipeline Failure:

- A natural gas high pressure pipeline failure in a populated residential area resulting in fatalities, injuries, and property damage. The incident resulted in reliability concerns in the surrounding gas network threatening curtailments and loss of core customers.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SoCalGas' 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[10] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 4 provides a summary of the High-Pressure Gas Failure risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

[10] D.16-08-018 Ordering Paragraph 9.

Table 4: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	5	5	6	3	36,950

4.3 Explanation of Health, Safety, and Environmental Impact Score

A score of 6 (severe) was given in 2015 in the impact area of Healthy, Safety, and Environmental. The basis for the score is that a fatality or serious injuries to employees and/or the public is a potential consequence for this risk due to the possibility of a failure of high-pressure pipelines located in populated areas. Furthermore, there is potential for a few fatalities to occur from a single incident.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, the following scores were assigned to the remaining residual risk categories.

- **Operational and Reliability**: A score of 5 (extensive) was given in the Operational and Reliability impact category. A risk score of 5 is defined in the 7X7 matrix as greater than 50,000 customers affected, impacts a single critical location or customers, or disruption of service for greater than 10 days. Based on the risk scenario, it is probable that there would be significant customer disruption which can include a whole street, several homes, or a whole city losing gas service depending if the damages involved high pressure gas lines.
- **Regulatory, Legal and Compliance**: A score of 5 (extensive) was given in this impact category. Similar risk events over the past 20 years have resulted in new regulations and compliance requirements such as the California Public Utility Code 958, the Notice of Proposed Rulemaking (NPRM), and modifications to GO 112. Additionally, litigation could result from the risk scenario.
- **Financial**: The Company could suffer various financial repercussions as a result of the other risk areas. Potential litigation and other financial consequences from the Commission and PHMSA are prime examples of the costs associated with the high-pressure pipeline system failing. Though the exact cost can vary depending on the type of incident, if a failure were to occur, these could have the potential financial impact loss of $1 billion to $3 billion consistent with a score of 6 (severe) defined in SoCalGas' 7X7 matrix.

4.5 Explanation of Frequency Score

A frequency score of 3 (infrequent), indicating the likelihood of this event being once every 10-30 years, was chosen taking into account industry-wide data combined with the current state of the Company's system and operations. The lack of an incident at the Company must be tempered by the fact that, according to PHMSA, the number of fatalities that have occurred due to high-pressure failures in California are 10 persons.[11]

5 Baseline Risk Mitigation Plan[12]

As stated above, High-Pressure Pipeline Failure entails a pipeline failure event resulting in fatality/injuries to the public or damage to property and/or environmental damage. The 2015 baseline mitigations discussed below include the current evolution of the Companies' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time.

These controls focus on safety-related impacts[13] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[14] as well as controls and mitigations that may address reliability.[15] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various events related to High-Pressure Pipeline Failure, not just the scenario used for purposes of risk scoring.

The 2015 controls are primarily based on the Code of Federal Regulation (CFR) Part 192, General Order (GO) 112-E state requirements and Public Utility Code (PUC) §957 and §958. The CFR Part 192 prescribes minimum safety requirements for pipeline facilities and the transportation of gas and GO 112-E complements and enhances the requirements set forth on a federal level on a state level. In addition, PUC §957 and §958 required gas corporations to prepare and submit to the Commission a proposed comprehensive valve plan and plan to pressure test or replace transmission pipelines that lack sufficient record of a pressure test. The Company complied with these statutes through the filing of the Pipeline Safety Enhancement Plan (PSEP) in 2011. PSEP is continuing and the next stages of PSEP work will be incorporated into the Test Year 2019 GRC proceeding. SoCalGas engages in compliance activities in order to mitigate this risk and to comply with applicable laws.

The primary areas highlighted in the risk registry are:

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[11] https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?Portalpages.
[12] As of 2015, which is the base year for purposes of this Report.
[13] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[14] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[15] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

1. Maintenance: Patrolling, Leak Survey, Pressure Limiting and Regulator Station Inspections and Maintenance, Valve Maintenance
2. Qualifications of Pipeline Personnel (Training)
3. Requirements for Corrosion Control: Corrosion Control, Monitoring and Remedial Measures
4. Operations: Odorization, Emergency Preparedness, Continual Surveillance
5. Pipeline Integrity: Threat Evaluation, Risk Analysis, Pipeline Assessments and P&M
6. PSEP: Pressure Testing and Replacement, and Valve Automation and Replacement

1. Maintenance

The minimum safety requirements prescribed by CFR 192 Subpart M – Maintenance include performing pipeline patrol, bridge and span inspections and meter set assemblies, valve and regulator inspection and maintenance on regular basis throughout the year. These activities are intended to address threats as identified by PHMSA specifically outside forces (vandalism, fault lines, liquefaction, etc.), equipment failure (pipeline facilities and components) and corrosion. These preventive measures provide an opportunity to address issues that otherwise could lead to an incident or failure. The following details the required intervals for completing the preventative measures per CFR 192 Subpart M:

- Bridge and Span inspections are required at least once every two calendar years, but with intervals not exceeding 27 months.
- Pressure limiting station, relief device, signaling device, and pressure regulating station and its equipment must be inspected and tested at intervals not exceeding 15 months, but at least once each calendar year.
- Valve must be checked and serviced at intervals not exceeding 15 months, but at least once each calendar year.
- The frequency of patrols is determined by the size of the line, the operating pressures, the class location, terrain, weather, and other relevant factors and range from one to four times per calendar year.

2. Training

The minimum safety training and qualification requirements of field personnel that perform Cathodic Protection, Construction and other activity on the pipeline are prescribed by CFR 192 Subpart N – Qualification of Pipeline Personnel. The prescribed training is intended to address Incorrect Operations as identified by PHMSA, which includes incorrect operating procedures or failure to follow a procedure that could lead to a serious incident or failure. The training and qualifications are intended to increase the safety of the personnel and public by focusing on understanding and proficiency of the concepts through testing.

3. Requirements for Corrosion Control

The minimum safety requirements prescribed by CFR 192 Subpart I – Requirements for Corrosion Control Operations include monitoring of cathodic protection areas, remediation of CP areas that are out of tolerance and preventative installations to avoid areas out of tolerance. These activities are intended to address threats as identified by PHMSA specifically external and internal corrosion. These preventive measures provide an opportunity to address issues that otherwise could lead to a serious incident or a failure. The following details the required intervals for completing these preventative measures as prescribed in Subpart I:

- Each pipeline that is under cathodic protection must be tested at least once each calendar year, but with intervals not exceeding 15 months, to determine whether the cathodic protection meets the requirements of §192.463.
- Each cathodic protection rectifier or other impressed current power source must be inspected six times each calendar year, but with intervals not exceeding 2 ½ months, to insure that it is operating.

4. Operations

The minimum safety requirements prescribed by CFR 192 Subpart L – Operations include emergency preparedness and odorization. These activities are intended to address threats as identified by PHMSA. Emergency preparedness and odorization are intended to address all threats. These preventive measures provide an opportunity to address issues that otherwise could lead to a failure. The following details the required intervals for completing these preventative measures as prescribed in Subpart L:

- To assure the proper concentration of odorant in accordance with this section, each operator must conduct periodic sampling of combustible gases using an instrument capable of determining the percentage of gas in air at which the odor becomes readily detectable.

5. Pipeline Integrity

The minimum safety requirements for assessment of transmission pipelines within high consequence areas are prescribed by CFR 192 Subpart O – Gas TIMP and include threat identification, risk analysis, assessment, remediation, preventative, and mitigative measures. These activities are intended to address all threats as identified by PHMSA as applicable to each pipelines. This program provides an opportunity to address issues that otherwise could lead to a serious incident or failure.

- An operator must establish a reassessment interval for each covered segment in accordance with the requirements of this section. The maximum reassessment interval by an allowable reassessment method is seven years.

6. PSEP

Commission Decision (D.) 11-06-017 found that "natural gas transmission pipelines in service in California must be brought into compliance with modern standards for safety" and ordered all California natural gas transmission pipeline operators "to prepare and file a comprehensive Implementation Plan to replace or pressure test all natural gas transmission pipelines in California that has not been tested or for which reliable records are not available."[16] The Commission required that the plans "also address retrofitting pipeline to allow for in-line inspection tools and, where appropriate, automated or remote controlled shut off valves."[17] Many of the requirements of D.11-06-017 were later codified into California Public Utilities Code Sections 957 and 958.

On August 26, 2011, the Company filed their PSEP. The PSEP encompasses the following four objectives:

- Enhance public safety
- Comply with the Commission's directives
- Minimize customer impacts
- Maximize cost effectiveness

The PSEP identifies pipeline sections without sufficient record of a pressure test and, through the Decision Tree process, recommends either pressure testing or replacement. PSEP also includes a Valve Enhancement Program to enhance system safety by installing and upgrading valve infrastructure to support the automatic and remote isolation and depressurization of the transmission pipeline system in 30 minutes or less in the event of a pipeline rupture.

In June 2014, the Commission issued D.14-06-007 which approved SoCalGas' and SDG&E's proposed PSEP and set forth a process for reviewing and approving PSEP Phase 1 implementation costs after-the-fact through Reasonableness Reviews. In D.16-08-003, the Commission authorized the tracking of PSEP Phase 2 costs and directed PSEP to transition to the General Rate Case beginning in the 2019 Test Year.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan to, in most cases, maintain the current residual risk level. In addition, SoCalGas is proposing to expand mitigations to further address the risk of High-Pressure Pipeline Failure. The proposed activities are for mitigations that are primarily based on the CFR Part 192, GO 112-F state requirements and PUC §957

[16] D.11-06-017, mimeo., at 18-19.
[17] D.11-06-017, mimeo., at 21.

and §958. The additional mitigation not specifically prescribed in CFR 192 and GO 112-F are intended to enhance the prescribed minimum requirements in areas identified as contributing to potential risk drivers.

It should be noted that the proposed activities do not account for the Notice of Proposed Rule Making (NPRM) issued by PHMSA on Pipeline Safety: Safety of Gas Transmission and Gathering Pipelines which may expand the integrity requirements beyond HCAs, require the verification of Maximum Allowable Operating Pressure (MAOP), and records requirements among other items. The expanded requirements of General Order 112-F have been included, which include a change in leak survey from annual to semi-annual.

The baseline mitigations below are maintaining their current levels in the proposed plan. These mitigations are needed to keep the risk from increasing.

1. Qualifications of Pipeline Personnel (Training)
2. Requirements for Corrosion Control: Corrosion Control, Monitoring and Remedial Measures
3. Pipeline Integrity: Threat Evaluation, Risk Analysis, Pipeline Assessments and P&M

SoCalGas proposes to expand the following baseline mitigations, as further described below.

4. Maintenance: Patrolling, Leak Survey, Pressure Limiting and Regulator Station Inspections and Maintenance, Valve Maintenance
5. Operations: Odorization, Emergency Preparedness, Continual Surveillance
6. PSEP: Continuation of PSEP activities will be addressed in the Test Year 2019 GRC in accordance with D.16-03-003

1. <u>Maintenance</u>

As part of pipeline patrol, construction activity and growth is monitored to identify the need for class location studies. In certain instances, these class location studies indicate sufficient growth in the area to require a class location change, which could lead to the transmission pipeline being replaced, pressure tested, or the pipeline's pressure being de-rated.[18] In order to address class location changes driven by population growth and construction activity in SoCalGas' service territory, SoCalGas is proposing to expand this activity to be able to identify areas of growth and strategically pressure test, replace, or derate pipeline segments. Taking action to pressure test, replace, or derate the pipeline mitigates catastrophic damage involving a high pressure asset by validating the pipeline's integrity (pressure test), replacing a pipeline with a new modern pipeline (replace), or increase the pipeline's safety margin by lowering the operating pressure (derate).

[18] See 49 CFR 192.611.

2. Operations

As part of SoCalGas' efforts to continually survey and maintain Company's Right of Way (ROW), SoCalGas proposes to increase span painting, pipeline maintenance, storm damage repair, removal of previously abandoned pipelines, vegetation removal, and right of way maintenance. Incremental efforts to survey and maintain SoCalGas' ROWs reduces risks associated with high pressure pipelines and enhances employee, contractor, and public safety by repairing pipeline and related infrastructure, improving pipeline and line marker visibility, and increasing pipeline accessibility.

In addition to the maintenance of the ROW itself, maintenance of access roads allows SoCalGas personnel to access ROWs, enables pipelines to be accessed in a timely manner, minimizes third party pipeline damages, prevents of wild fire damages, and improves the overall general safety of employees and the public.

Finally, upcoming changes to GO 112 through implementation of GO 112-F will require instrumented leak survey of all Transmission pipelines. Currently, instrument leak survey is only required where pipelines are operating in a Class 3 or Class 4 locations, which means, currently, 900 miles of Transmission pipeline are required to be leak surveyed. GO 112-F requires an additional 1,800 miles of Transmission pipeline to be instrument leak surveyed in Class 1 and 2 locations. GO 112-F does, however, allow difficult to access pipelines operating in a Class 1 and Class 2 locations to be patrolled by aircraft. Accordingly, this activity is being expanded to comply with revisions to GO-112-F.

3. PSEP

PSEP is transitioning into the GRC process as directed by D.16-08-003. The mitigation activities in the proposed plan for PSEP are primarily associated with work in less populated areas, and pressure testing and replacement included in Phase 2A. D.16-08-003 also authorized SoCalGas to file a Forecast Application to request approval for some Phase 2A work to commence prior to GRC approval. The increased activities reflect the anticipated regulatory approval timeframes for the GRC and Forecast Application, which will result in construction commencing in 2019.

7 Summary of Mitigations

Table 5 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for High-Pressure Pipeline Failure. While control or mitigation activities may address both potential risk drivers and potential consequences, potential risk drivers link to the likelihood of a risk event. Thus, potential risk drivers are specifically highlighted in the summary tables.

SoCalGas does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 5 were estimated using assumptions provided by Subject Matter Experts (SMEs) and available accounting data.

Table 5: Baseline Risk Mitigation Plan[19]
(Direct 2015 $000)[20]

ID	Mitigation	Potential Risk Drivers Addressed	Capital[21]	O&M	Control Total[22]	GRC Total[23]
1	CFR 192 Subpart M – Maintenance*	• Outside Forces • Equipment • Corrosion	$12,890	$ 7,670	$20,560	$20,560
2	CFR 192 Subpart N – Qualifications of Pipeline Personnel*	• Incorrect Operations	n/a	400	400	400
3	CFR 192 Subpart I – Requirements for Corrosion Control*	• Corrosion	500	330	830	830
4	CFR 192 Subpart L – Operations*	• Corrosion • Manufacturing • Construction • Equipment • Incorrect Operations	8,010	3,700	11,710	11,710
5	CFR Part 192 Subpart O – Gas Transmission Pipeline Integrity Management*	• Corrosion • Manufacturing • Construction • Equipment • Incorrect	42,990	31,960	74,950	74,950

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[19] Recorded costs were rounded to the nearest $10,000.
[20] The figures provided in Tables 5 and 6 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[21] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[22] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[23] The GRC Total column shows costs typically presented in a GRC.

ID	Mitigation	Potential Risk Drivers Addressed	Capital[21]	O&M	Control Total[22]	GRC Total[23]
		Operations				
6	PUC 957 & 958 – PSEP: High Pressure Testing and Replacement, Valve Automation and Replacement*	• Manufacturing • Construction • Outside Forces	389,720	60,950	450,670	0
	TOTAL COST		$454,110	$105,010	$559,120	$108,450

* Includes one or more mandated activities

Table 6 summarizes SoCalGas's proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SoCalGas is identifying potential ranges of costs in this plan, and is not requesting funding approval. SoCalGas will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 6 the Companies are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 6: Proposed Risk Mitigation Plan[24]
(Direct 2015 $000)

ID	Mitigation	Potential Risk Drivers Addressed	2017-2019 Capital[25]	2019 O&M	Mitigation Total[26]	GRC Total[27]
1	CFR 192 Subpart M – Maintenance*	• Outside Forces • Equipment • Corrosion	$38,930 - 43,020	$7,690 - 8,500	$46,620 - 51,520	$46,620 - 51,520
2	CFR 192 Subpart N – Qualifications of Pipeline Personnel*	• Incorrect Operations	n/a	400 - 440	400 - 440	400 - 440
3	CFR 192 Subpart I – Requirements for Corrosion Control *	• Corrosion	2,920 - 3,780	520 - 1,140	3,440 - 4,920	3,440 - 4,920
4	CFR 192 Subpart L – Operations*	• Corrosion • Manufacturing • Construction • Equipment • Incorrect Operations	14,280 - 15,780	18,120 - 20,030	32,400 - 35,810	32,400 - 35,810
5	CFR Part 192 Subpart O – Gas Transmission Pipeline Integrity Management*	• Corrosion • Manufacturing • Construction • Equipment • Incorrect Operations	124,920 - 187,120	44,930 - 49,650	169,850 - 236,770	169,850 - 236,770
6	PUC 957 & 958 – PSEP:	• Manufacturing • Construction	365,250 - 608,750	13,500 - 110,000	378,750 - 718,750	133,750 - 321,750

24 Ranges of costs were rounded to the nearest $10,000.
25 The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SoCalGas' Test Year 2019 GRC Application.
26 The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
27 The GRC Total column shows costs typically represented in a GRC.

	High Pressure Testing and Replacement, Valve Automation and Replacement*	• Outside Forces				
	TOTAL COST		$546,300 - 858,450	$85,160 - 189,760	$631,460 - 1,048,210	$386,460 - 651,210

☐	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

While all the mitigations and costs presented in Tables 5 and 6 mitigate the High-Pressure Pipeline Failure risk, some of the activities also mitigate other risks presented in this RAMP Report, including: Catastrophic Damage Involving Third Party Dig-Ins (Dig-Ins) and Employee, Contractor, Customer and Public Safety. Because these activities mitigate High-Pressure Pipeline Failure as well as these aforementioned risks, both the costs and risk reduction benefits are included in all applicable RAMP chapters.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the Companies are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent." For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of

RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 4 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[28] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

[28] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

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8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another.

Figure shows the RSE calculation.

Figure 3: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 6 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SoCalGas analysts used the general approach discussed in Section 8.1 above, in order to assess the RSE for the High Pressure Pipeline Incident risk. The RAMP Approach chapter in this Report, provides a more detailed example of the calculation used by the Company.

To calculate the RSE, SoCalGas began with the six mitigations in its proposed plan:

1. Qualifications of Pipeline Personnel (Training)
2. Requirements for Corrosion Control
3. Pipeline Integrity (TIMP)
4. Maintenance
5. Operations
6. PSEP

SoCalGas then analyzed and arranged these mitigations into common groupings that address similar potential drivers or consequences, for purposes of analysis:

(a) Transmission integrity (current controls)
(b) PSEP (current controls)
(c) Technical training (current controls)
(d) Regulatory compliance activities (current controls)

For the High-Pressure Pipeline Failure risk in particular, there were limited new or expanded activities in the proposed plan. Accordingly, only the four groups listed above, with no incremental activities, were analyzed.

For each of the four mitigation groupings used for the RSE, SoCalGas determined the preferred methodology for quantifying the RSE. The primary assumption for the RSE for the High-Pressure Pipeline Fail ure risk was that performance would deteriorate in absence of the mitigation. Data from the PHMSA and asset data, where applicable, was used to model the deterioration boundaries. The appropriate data was selected based on the judgment of SMEs.

- **Transmission Integrity**

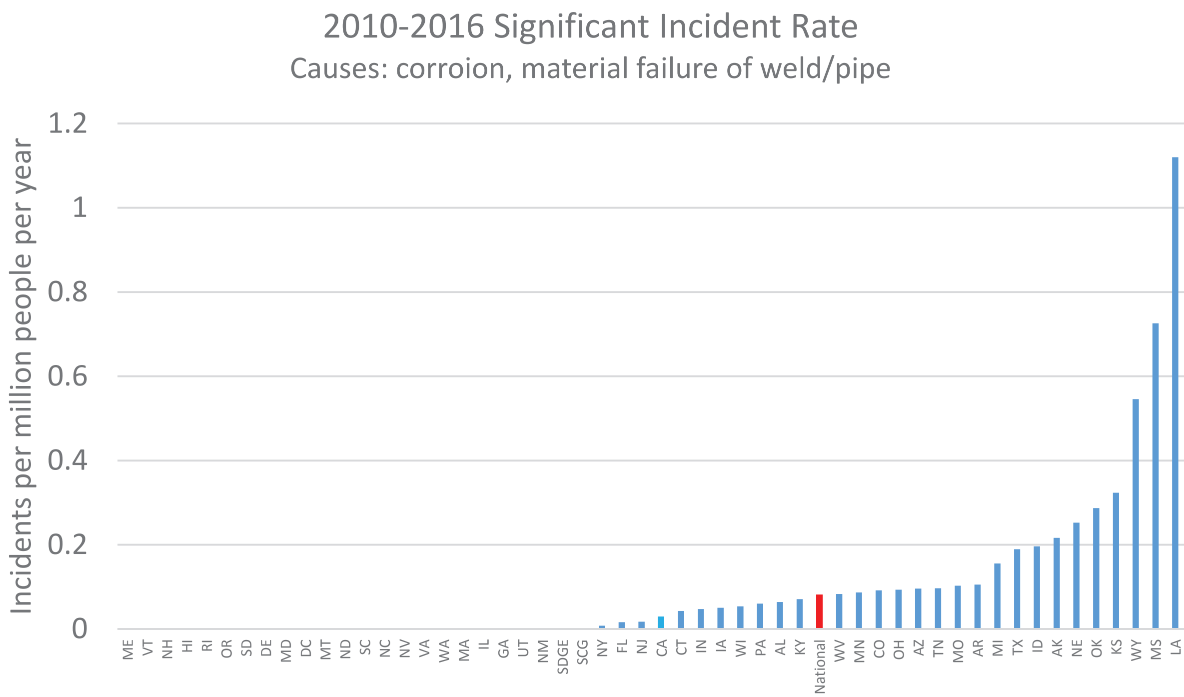
The modeling approach for transmission integrity programs is to find the level of possible performance deterioration if these programs did not exist, which would represent the baseline, inherent risk level. It is assumed that should these programs were not to be funded, then performance would deteriorate to at best the pipeline failure incident rate of the worst state in the nation. The term “at best” is used because even the worst-performing states are assumed to have some similar programs in place.

The potential drivers associated with a high-pressure pipeline failure are corrosion and material failure of weld or pipe. This was compared to the incident rate due to all causes to attain the residual risk multiplier, which is the ratio of future to current performance.

Not all targeted assets will be remediated within the time period of interest. To account for this, the residual risk multiplier will be adjusted proportionally to the proportion of remediated assets to all high pressure assets.

The chart shown below contains the pipeline failure incident rates of all 50 states, in addition to SoCalGas and the national average. SoCalGas is among the entries with zero incidents per million people per year, and the worst-performing state is Louisiana at 1.120 incidents per million people per year. Using SoCalGas’ service population of 21.6 million people, the incident rates can be converted to an incident expectation, given by the following calculation:

$$
\begin{aligned}
&Expected\ Incident\ Rate = \Delta(Incident\ Rate) * Service\ Population \\
&= (1.120 - 0)\ incidents\ per\ million\ people\ per\ year * 21.6\ million\ people \\
&= 24.2\ incidents\ per\ year
\end{aligned}
$$



The average number of incidents per year from all causes for the same time period is 1.1[29] and the proportion of targeted miles being addressed is 43%. Putting it all together, the residual risk multiplier is given by the following calculation:

$$\mathit{Residual\ Risk\ Multiplier} = \frac{\mathit{Incident\ Rate\ from\ select\ Causes}}{\mathit{Incident\ Rate\ from\ all\ Causes}} * \mathit{Proportion\ of\ Remediated\ Assets}$$

$$\mathit{Residual\ Risk\ Multiplier} = \frac{24.2\ \mathit{incidents\ per\ year}}{1.1\ \mathit{incidents\ per\ year}} * 43\%$$

$$\mathit{Residual\ Risk\ Multiplier} = 9.7$$

Therefore, if the mitigation is not funded, the projected risk is 9.7 times the current residual risk.

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[29] Expected Incidents per year for All Causes for SCG = Current Incidents per year per million people * Service population

= 0.051 incidents per year per million people * 21.6 million people

= 1.1 incidents per year

310329

- **PSEP**

The RSE modeling approach for these programs was the same as that used for transmission integrity programs with a couple of slight differences. The first difference was that a different set of potential incident drivers was used to establish the deteriorated performance level. Potential driver categories chosen as applicable to these programs were: corrosion, material failure of weld or pipe, equipment failure, and other[30]. The second difference was that the national average was used rather than the worst state performance, to account for the fact that the benefit of this mitigation has high chance of being duplicative with the other mitigations in place (e.g., compliance activities, TIMP). For this category of projects, the residual risk multiplier is (4.2 / 1.1) X (27.3%) = 1.1. Therefore, if the mitigation is not funded, the projected risk is 1.1 times the current residual risk.

- **Technical Training**

The modeling approach for these programs was the same as that used for transmission integrity programs with two exceptions. The first exception was that a different set of potential incident drivers was used to establish the worst state performance level. Potential drivers chosen as applicable to this category were: incorrect operations. The second exception was that there is no secondary adjustment for the percentage of targeted assets, but there was an adjustment for the fact that it takes some time for the effects of technical training to wear off.

For this category of projects, the residual risk multiplier is (3.0 / 1.1) X (33.3%) = 0.9. Therefore, if the mitigation is not funded, the projected risk is 0.9 times the current residual risk.

- **Regulatory Compliance Activities**

The modeling approach for these programs was the same as that used for transmission integrity programs with two exceptions. The first exception was that a different set of potential incident drivers was used to establish the worst state performance level. Potential drivers chosen as applicable to this category were: all causes with incorrect operations and natural and other forces excluded. The second exception was that there was no secondary adjustment for the percentage of targeted assets.

For this category of projects, the residual risk multiplier is (48.6 / 1.1) X (100%) = 45.1. Therefore, if the mitigation is not funded, the projected risk is 45.1 times the current residual risk.

[30] The "other" potential drivers are derived from the PHMSA data base. They were grouped into an "other" category because these entries do not have any obvious relationship to another.

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8.3 *Risk Spend Efficiency Results*

Based on the foregoing analysis, SoCalGas calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

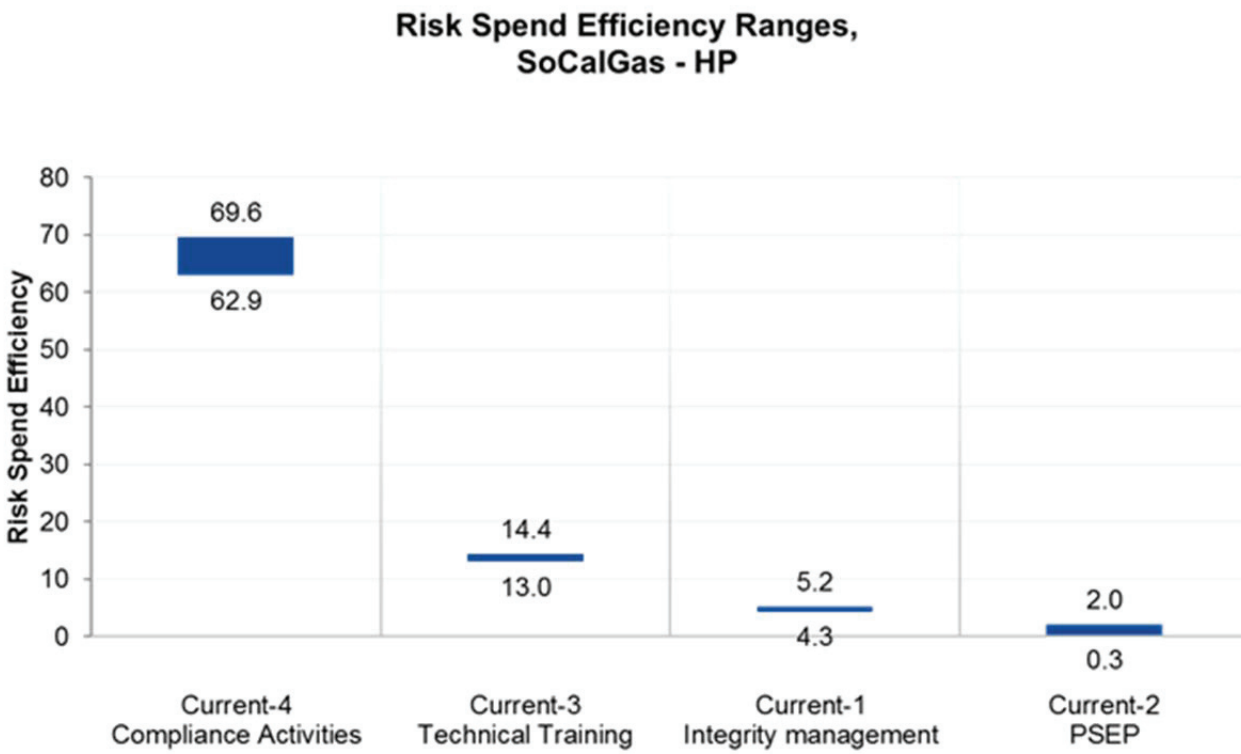
1. Regulatory compliance activities (current controls)
2. Technical training (current controls)
3. Transmission integrity (current controls)
4. PSEP (current controls)

Figure displays the range[31] of RSEs for each of the SoCalGas High Pressure Pipeline Incident risk mitigation groupings, arrayed in descending order.[32] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

[31] Based on the low and high cost ranges provided in Table 6 of this chapter.

[32] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 4: Risk Spend Efficiency



9 Alternatives Analysis

SoCalGas considered alternatives to the proposed mitigations as it developed the proposed mitigation plan for the High-Pressure Pipeline Failure risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources.

9.1 Alternative 1 – Acceleration of TIMP

SoCalGas considered expanding TIMP-related work as an alternative into non-HCA. However, this alternative was not selected due to the pending NPRM and in recognition that conflicts may arise with scheduling and resources. SoCalGas will continue to expand TIMP-related work into non-HCA as dictated by assessment results and overall system performance as part of Preventative and Mitigative measures.

9.2 Alternative 2 – Acceleration of PSEP

In addition, SoCalGas considered increasing the pace of PSEP-related work. Again, this would enhance safety more expeditiously, but would also require additional capital to accommodate the accelerated pace. Similar to the TIMP alternative, the proposed PSEP pace is preferred because it balances affordability, risk reduction and financial constraints with available resources.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Workplace Violence
(Chapter SDG&E-9/SCG-5)

November 30, 2016

TABLE OF CONTENTS

Executive Summary

The purpose of this chapter is to present the mitigation plan of the San Diego Gas & Electric Company (SDG&E) and Southern California Gas Company (SoCalGas) (collectively, the Companies) for the risk of Workplace Violence. The Workplace Violence risk involves a violent incident related to the workplace, resulting in emotional or physical harm to an employee(s) or third parties. The Companies' 2015 baseline mitigation plan for this risk consists of four controls:

1. Physical Security Systems
2. Contract Security
3. Planning, Awareness, and Incident Management
4. Training

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the California Public Utilities Commission (Commission or CPUC) in Decision 16-08-018, as well as controls and mitigations that may address reliability. The Companies' proposed mitigation plan comprises both baseline and new mitigation activities. The Companies are proposing to continue supporting their physical security systems and contract security personnel.

Based on the foregoing assessment, the Companies proposed future mitigations. Generally, the baseline projects described above have been completed and placed into service. For Workplace Violence, the Companies proposed to continue the four control categories, identified above, but included enhancements within each category. The enhancements include:

1. Physical Security Systems and Contract Security
    - Install or upgrade access control and detection capabilities
    - Add security guards to new locations and comply with new laws enacted since the baseline evaluation that increase labor costs
2. Planning, Awareness, and Incident Management
    - Upgrade or replace the incident/case management system
    - Add social media monitoring tool
    - Add personnel in the risk management and corporate security areas

The risk spend efficiency (RSE) is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The RSEs for Workplace Violence are evaluated at the risk portfolio level, with the activities grouped into one, aggregated mitigation.

Risk: Workplace Violence

1 Purpose

The Companies consider workplace violence to be a violent incident related to the workplace, resulting in emotional or physical harm to an employee(s) or third parties. Emotional harm or distress includes, but is not limited to, mental distress, mental suffering, or mental anguish. Physical harm refers to any physical injury to the body, including an injury that caused, either temporarily or permanently, partial or total physical disability, incapacity or disfigurement.

This risk is a product of the Companies' September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Companies. The Companies take compliance and managing risks seriously, as can be seen by the numerous actions taken to mitigate each risk. This is the first time, however, that the Companies have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the Companies do not currently track expenditures in this way, so the baseline amounts are the best effort of the Companies to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the Commission and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety-related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the Companies take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the Companies have made efforts to identify those costs.
This risk assessment focuses on the drivers or factors that could potentially cause an incident and result in potential consequences. Drivers and events that are unknown to the Companies are outside the scope of this risk. Further, this chapter focuses on events that could potentially occur at the Companies' facilities. However, any actions that could result in emotional or physical harm to employees or third

[1] D.14-12-025 at p. 31.

parties related to the workplace for which the Companies are reasonably aware, regardless of the facility type, are within the scope of this risk.

2 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Applications (A.) 15-05-002/004, "SDG&E[/SoCalGas] is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[2] The Enterprise Risk Management (ERM) process and lexicon that the Companies have put in place were built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Companies are committed to increasing the use of quantification within its evaluation and prioritization of risks.[3] This includes identifying leading indicators of risk. Sections 2 – 8 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers, and potential consequences of the Workplace Violence risk.

2.1. Risk Classification

Consistent with the taxonomy presented by the Companies in A.15-05-002/004, the Companies classify this as a cross-cutting risk that affects people and is a function of employee or former employee conduct. Workplace Violence is a cross-cutting risk because an incident could occur in any department of the company. The risk classification is provided in

Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
CROSS-CUTTING	PEOPLE	EMPLOYEE CONDUCT

[2] A.15-05-002/004, filed May 1, 2015, at p. JMD-7.
[3] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.

2.2. *Potential Drivers*[4]

When performing the risk assessment for Workplace Violence, the Companies identified potential indicators of risk, referred to as drivers, that could potentially lead to a Workplace Violence incident. These include, but are not limited to, the following drivers as defined below:

- **Human Error** – an error that occurs due to someone not doing something correctly.
- **Process Failure** – an inadequacy in programs/procedures that are intended to help avoid the risk from occurring and control the consequence of the risk if it occurs.
- **System Failure** – an inadequacy in security systems that are intended to help avoid the risk from occurring.

In addition to the above potential drivers, the Companies have identified potential circumstances that could contribute to Workplace Violence. These include, but are not limited to: extremist ideologies, personal issues or conflict, and mental health issues.

These potential drivers and circumstances are not intended to be a comprehensive list, as the types of workplace violence incidents vary greatly. The potential drivers and circumstances noted in this plan correspond with those in studies, such as the New York City Police Department's "Active Shooter: Recommendations and Analysis for Risk Mitigation" and the Federal Bureau of Investigation's "A Study of Active Shooter Incidents in the United States Between 2000 and 2013." These studies provide analysis of active shooter incidents showing a wide range of motivations, including domestic quarrels, professional differences, and mental health issues.

2.3. *Potential Consequences*

If one of the drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

- Emotional abuse, injury, or fatality;
- Operational disruptions;
- Citations, adverse litigation, and related financial impacts; and/or
- Costs associated with policy/procedure changes.

These potential consequences were used in the scoring of the Workplace Violence risk that occurred during the Companies' 2015 risk registry process. See Section 3 for more detail.

2.4. *Risk Bow Tie*

The risk "bow tie," shown in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. The Companies applied this framework to identify and summarize the information provided above.

[4] An indication that a risk could occur. It does not reflect actual or threatened conditions.

Figure 1: Risk Bow Tie

3 Risk Score

The Companies' ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Workplace Violence as one of the enterprise risks. During the development of the risk registry, subject matter experts (SMEs) assigned a score to this risk, based on empirical data to the extent it was available and/or using their expertise, following the process outlined in this section.

3.1. Risk Scenario – Reasonable Worst Case

There are many possible ways in which a Workplace Violence risk event can occur. For purposes of scoring this risk, SMEs used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The SMEs selected the following reasonable worst case scenario to develop a risk score for Workplace Violence:

- An active shooter at a well-populated SDG&E facility takes action, which results in injuries and fatalities.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen.

3.2. 2015 Risk Assessment

Using this scenario, SMEs then evaluated the frequency of occurrence and potential impact of the risk using the Companies' 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[5] Using the levels defined in the REF, the SMEs applied empirical data to the extent it was available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 2 provides a summary of the Workplace Violence risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 2: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	1	2	3	3	23,107

3.3. Explanation of Health, Safety, and Environmental Impact Score

Based on the risk scenario of an active shooter at a well-populated company facility, such an incident could result in a few life-threatening injuries and/or fatalities. A Federal Bureau of Investigation's report, "A Study of Active Shooter Incidents in the United States Between 2000 and 2013," states that 160 active shooter incidents occurred, with 486 deaths and 557 injured people, over the 13-year span of the study. The report also explains that the number of individuals killed or injured during an active shooter incident has increased as well.

Notably, in December 2011, Southern California Edison Company (SCE) experienced a workplace shooting at its office complex in Irwindale by an alleged SCE employee, resulting in multiple injuries and fatalities.[6] Another shooting incident in 2009, involving two current and one former SoCalGas employees, left three people dead.[7]

Accordingly, SDG&E scored Workplace Violence a 6 (Severe) in the Health, Safety, and Environmental impact area, as there could likely be several fatalities and/or life threatening injuries based on the risk

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[5] D.16-08-018 Ordering Paragraph 9.
[6] http://articles.latimes.com/2011/dec/17/local/la-me-shooting-follow-20111218.
[7] http://www.washingtontimes.com/news/2009/mar/19/suspect-in-killing-of-socal-gas-workers-found-shot/.

scenario. A 7 (Catastrophic) did not seem appropriate, as this score would reflect a large-scale event with a high number of deaths and/or irreversible impacts to the environment.

3.4. Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, the Companies gave the following scores to the remaining impact categories:

- **Operational and Reliability**: Workplace Violence was scored a 1 (Insignificant) as it is likely that the Companies' primary operations of gas and electricity transmission and distribution would continue, and that there would be minimal disruption to service, if a Workplace Violence incident were to occur. This rating focused on the overall operational capability of the Companies and service impact to customers; it did not rate the level of impact to an individual business unit.
- **Regulatory, Legal, and Compliance**: Workplace Violence was scored a 2 (Minor) as the potential for regulatory penalties with respect to an active shooter incident is anticipated to be minimal (if any). The potential legal issues associated with this risk are most likely to be civil in nature; the potential impacts of these legal issues are addressed in the Financial impact area.
- **Financial**: Workplace Violence was scored a 3 (Moderate) as there could be potential financial impacts to the company from potential litigation (e.g., a wrongful death lawsuit) and possible associated costs for security remediation and upgrades, training programs, and potential policy/procedures changes. Although it is difficult to predict the amount of litigation a company may face after an active shooter incident, based on the risk scenario, the Companies estimated that potential costs could be between $1 million and $10 million.

3.5. Explanation of Frequency Score

The SMEs considered an active shooter incident to occur infrequently (a score of 3), which is defined as having the potential to occur every 10-30 years in the company's service territory. As a comparison, it was assumed that facilities with a history of active shooting incidents, such as schools or government facilities, may merit a score of 4 (Occasional), which is defined as occurring every 3-10 years. There have been few active shooter incidents specific to the utility industry; however, the Companies did not consider it to be appropriate to elevate the rating higher than a 3.

4 Baseline Risk Mitigation Plan[8]

As stated above, Workplace Violence risk involves a violent incident related to the workplace, resulting in emotional or physical harm to an employee(s) or third parties. The 2015 baseline mitigations discussed below include the current evolution of the Companies' management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time. The Companies' mitigation plan for this risk includes the following controls:

[8] As of 2015, which is the base year for purposes of this Report.

- Physical Security Systems and Contract Security
- Planning, Awareness, and Incident Management
    - Workplace Violence Mitigation Team
    - Training
    - Investigations
    - Employee awareness
    - New-hire screening processes
    - Employee Assistance Program(s)
    - Incident/Case Management System
    - Risk Management Program

SMEs from Corporate Security, which is a function of the Companies' parent company Sempra Energy, and each company's Human Resources (HR) department collaborated to identify and document them. These controls focus on safety-related impacts[9] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018,[10] as well as controls and mitigations that may address reliability.[11] Accordingly, the controls and mitigations described in Sections 4 and 5 primarily address safety-related impacts. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Workplace Violence incidents, not just the scenario used for purposes of risk scoring.

The United States Department of Labor outlines the components of an effective workplace violence program,[12] including:

- Work Environment – creating a professional, healthy, and caring work environment
- Security – maintaining a secure and physically safe workplace
- Education – communicating awareness regarding workplace violence
- Performance / Conduct Indicators – identifying conduct that may present warning signs
- Employee Support Services – assisting employees in dealing with personal/professional issues

The Companies' workplace violence mitigation plans address each of these components as described below.

1. <u>Physical Security Systems and Contract Security</u>

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[9] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[10] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal of RAMP is to "make California safer by identifying the mitigations that can optimize safety."
[11] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.
[12] https://www.dol.gov/oasam/hrc/policies/dol-workplace-violence-program.htm.

The purpose of physical security is to maintain the safety of employees, contractors, and the public, as well as the Companies' facilities, through the use of systems, personnel, policies, and procedures. Two physical security mitigation activities in the current risk mitigation plan align with this purpose: physical security systems and contract security (e.g., security guards).

Security enhancements to infrastructure and security guards posted at company facilities each improve access control, intrusion detection, and interdiction capabilities, to deter, detect, delay, or help prevent undesirable events at company facilities. Depending on the facility, several physical security system upgrades have been completed, including, but not limited to, improvements with access control, intrusion detection systems, and interdiction capabilities.

In addition to security systems, the Companies employ contract security (security guards) to secure and physically protect assets and people. These security guards are located at critical facilities and work locations. Company policies and procedures outline physical security procedures, including access control, officer post orders and incident reporting.

2. <u>Planning, Awareness, and Incident Management</u>

The Planning, Awareness, and Incident Management mitigation includes projects and programs that largely provide services to try to manage this risk before an event can occur. These mitigations consist of the Workplace Violence Mitigation Team, training, investigations, employee awareness, new hire screening processes, employee assistance and wellness programs, and Corporate Security's risk management program. Each is discussed below.

Workplace Violence Mitigation Team (WVMT)

The Workplace Violence Mitigation Team (WVMT), formed in 2011, is a joint team of Managers, Directors, or Vice President level representatives within Corporate Security, HR, and Legal. The team is specifically trained to assess and respond to the threat posed by an individual that may be prone to violence. The WVMT is responsible for developing and executing an effective Workplace Violence Prevention program that includes, but is not limited to:

- Training supervisors and employees to detect early warning signs of possible workplace violence;
- Investigating and mitigating potential workplace violence incidents;
- Responding appropriately to threat-related emergencies;
- Identifying and enlisting the assistance of qualified professionals in workplace violence assessment, security, and incident management; and
- Documenting all activities related to workplace violence prevention and control.

The WVMT uses various threat management tools provided by outside professional resources or developed and adapted by the WVMT. These tools are intended to guide the WVMT in their data collection and decision making throughout the management of a case. The tools may be used in conjunction with appropriate degrees of professional threat management consultation.

The WVMT meets as needed when an individual displays signs that he/she may be prone to violence or engage in violent action on company property. Upon notification of an alleged threat, an initial investigation helps determine if additional action is warranted.

A recent third-party review of Sempra Energy security and investigative programs stated: "The Sempra approach to Workplace Violence Mitigation Teams is considered to be of a high caliber. We have identified this as an area where Sempra has adopted 'leading practices' in the area of workplace violence prevention."

Training

The Companies offer a variety of training opportunities to employees to increase awareness regarding the identification and response to criminal activity, including workplace violence. Examples include, but are not limited to: Active Shooter Training, Security Awareness Training, Workplace Violence Training, and Hostile Intruder Training. A few are described in more detail below.

Active Shooter Training has been provided to thousands of employees and focuses on the actions employees should take during an active shooter scenario. The training was developed by Corporate Security, and is based upon the Department of Homeland Security (DHS) training titled "Run, Hide, Fight." Through interactive discussion, this training provides basic awareness of recognizing an active shooter situation and how to respond accordingly. Topics include:

- Active Shooter Definition
- Active Shooter Incidents
- Active Shooter Characteristics and Triggers
- Run, Hide, Fight
- Last Resort Survival Measures
- Police Arrival
- Preparation

This training goes beyond a simple explanation of the issue, and provides employees with actions to take during an active shooter incident, including considerations for evacuation, appropriate hiding locations and instructions, and, when necessary, how to take action when confronted with an active shooter. The training also offers reporting procedures and proper conduct when police arrive.

Corporate Security also provides *Security Awareness Training* to employees, which focuses on identifying threats and suspicious activity, response to threats, and proper reporting protocols. *Workplace Violence training* is provided every other year by two board-certified forensic psychologists who consult to numerous federal, state, and local law enforcement agencies. This training instructs on the use of Workplace Assessment of Violence Risk (WAVR-21), a screening tool used by workplace violence mitigation teams.[13]

As discussed in the following section, Corporate Security recommends this training continue to be offered through regular instructor-led sessions or through online viewing of materials provided on the Corporate Security website.

Investigations

Corporate Security agents investigate hundreds of incident reports each year, including, but not limited to, disruptive incidents, burglary, theft, employee misconduct, and suspicious activity. Corporate Security works closely with Legal, HR, affected business units, and, when necessary, law enforcement, to thoroughly investigate allegations of workplace violence. This process assists with gathering or validating information needed for decision makers to act accordingly.

Employee Awareness

The Companies use a variety of methods to increase employee awareness, including, but not limited to: emergency and incident planning, training, education, drills, and communication. Workplace violence, safety, and security awareness training is provided on a regular basis to employees. Evacuation plans have been developed, updated, trained, and drilled. Security alerts and bulletins are provided as needed through email and posted on digital message boards, or on the company website. In addition, an emergency notification system, often referred to as a reverse 911 system, is in place to rapidly distribute emergency information to employees. This system will call, text, and email employees so that emergency messages are distributed efficiently and effectively. These efforts can provide employees with a heightened security awareness and effective communication platforms to assist with mitigation of security incidents, including workplace violence.

New Hire Screening Processes

There may be several reasons for performing new hire screening for job applicants. Some job duties are conducted in potentially hazardous environments. In these circumstances, the Companies take steps to try to avoid hiring that could result in safety or security incidents. The importance of the electric and natural gas transmission and distribution systems, including their interdependency with life/safety, emergency response, and national security, also provides a basis for heightened security and identity-verification processes. The Companies perform new hire screening in accordance with federal, state, and local laws.

[13] http://www.wavr21.com/

Employee Assistance and Wellness Programs

Some workplace violence incidents are a result of domestic, financial, health, substance abuse, or other types of issues, which may have the potential to be resolved with employee assistance programs. As described on the company website, since their inception in 1990, the Energy For Life Wellness Programs have been committed to enhancing the physical and mental well-being of all company employees through programs, resources, information, and support services that promote safe and healthy lifestyles.

These company-provided wellness programs are offered to all employees through methods such as on-site and online services, work groups, health fairs, fitness programs, and educational brochures. In addition, the Employee Assistance Program (EAP) is a confidential counseling and referral service to help employees' family members deal with life's daily challenges. These services may assist employees with personal and/or work-related problems that may impact their job performance, health, mental, and emotional well-being. As stated above, the Department of Labor outlines the importance of early intervention in the prevention of workplace violence, including employee assistance and wellness programs.

Employees have access to the 24/7 support services if they feel threatened by another employee. Every matter reported will be investigated by the company and, if requested, a response given to the individual reporting the issue. If necessary, the matter may be referred to staff or outside counsel for professional evaluation and recommendations on how to respond. This mitigation is recognized by the Department of Labor as a critical component in the prevention of workplace violence and should continue to be provided and updated as necessary.

Incident/Case Management System

Corporate Security maintains an incident/case management system to track incidents and investigations, such as, burglary, theft, vandalism, and workplace violence. The system provides data necessary for analysis of security programs, and assists with strategic planning to improve security and safety of company facilities, employees, and the public.

Risk Management Program

Corporate Security has established an intelligence program to collect, analyze, and disseminate intelligence that may assist with decision making regarding energy operations and security procedures. An intelligence program helps anticipate, identify, and assess threats that could harm the company, its employees, guests, or assets, and provides actionable strategic and tactical intelligence to mitigate risk. The program develops and maintains regular contact with local, national, and international law enforcement and intelligence community partners on a regular basis. The program also creates a risk management process to prioritize and mitigate threats, vulnerabilities, and consequences. Threat assessments and security plans specific to company infrastructure support regulatory requirements.

5 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 4 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. In addition, the Companies are proposing during the 2017-2019 timeframe to expand or add the mitigations addressed below.

1. Physical Security Systems and Contract Security

The Companies are proposing to continue supporting their physical security systems and contract security personnel. The purpose of these activities is to reduce the likelihood of a Workplace Violence event by increasing protective measures at company facilities that have employees.

Generally, the baseline projects described above have been completed and placed into service. The Companies are proposing to complete similar security projects to increase protection, such as installing or updating access control and detection capabilities at facilities that have employees. Similarly, the presence of security guards increases protection with the aim of reducing the likelihood of an intentional event.

There are two expanded activities, as compared to the baseline, with respect to security guards. First, the Companies propose to add security guards to new locations. Second, SDG&E must comply with Senate Bill (SB) 3, which will become effective January 1, 2017. The resulting effects are increases in costs above the GRC standard escalation. In other words, the cost associated with doing business (i.e., employing security guards) has increased. This is sometimes referred to as non-standard escalation.

2. Planning, Awareness, and Incident Management

This mitigation consists of expanded and new activities: upgrade or replacement of the incident/case management system; addition of social media monitoring tool; and additional personnel in the risk management and corporate security areas.

Incident/Case Management System

The current incident/case management system manages security incidents by capturing information from investigations and providing historical querying capability. This system is approximately ten years old. With the increase of requests for information and data calls from state and federal regulatory entities, it is recommended that this system be upgraded or replaced. The current system does not allow for querying of data at the appropriate level of detail. Simple changes that may provide some additional functionality to assist with querying will be expensive and may only provide some of the necessary upgrades. It is possible alternate systems already used by Sempra may provide suitable incident/case management services to meet this increased need. Costs of upgrading the existing system are currently being compared to other options.

Social Media Monitoring

Many utilities, other private sector companies, and public agencies are using social media monitoring for emergency notifications, incident updates, threat identification, customer communications, and to identify the misuse of branding. In a security setting, these tools can provide real-time updates to incidents, which may affect the safety or security of employees. These tools also can provide insight into emerging or imminent threats to company employees or infrastructure.

Risk Management

Based on new federal and state laws, the Companies are required to provide additional workplace violence risk management. The Companies are required to identify and prioritize threats, vulnerabilities, and consequences due to federal and state mandates and requests for information. In addition, this information will assist with security planning and mitigation development. Currently, Corporate Security has one risk/intelligence analyst. Given the increase in workload due to increased regulations, another resource is needed.

Corporate Security Agent

Over the last couple of years, the demand for Corporate Security services has increased as well as regulatory requirements, including the RAMP process, are requiring more detailed security planning and reporting. Currently, SDG&E's Corporate Security has two agents covering the security for the entire service area, 4,300 employees, 3.6 million customers, and all facilities. SoCalGas' Corporate Security has four agents covering the security for the entire service area, 8,400 employees, 21 million customers, and approximately 130 facilities.

6 Summary of Mitigations

Tables 3a and 3b summarize the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for Workplace Violence. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

The Companies do not account for and track costs by activity, but rather by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

While all the controls shown on Table 3a and 4b mitigate Workplace Violence, some of the controls also mitigate other risks presented in this RAMP Report. Specifically, for SDG&E, Physical Security Systems and Contract Security, managed by Corporate Security, also help mitigate the RAMP risk of Public Safety Events - Electric. Accordingly, because the benefits associated with these activities can be attributed to both this risk and Public Safety Events - Electric, the costs are presented in both chapters.

For SoCalGas, Physical Security Systems, Contract Security, Investigations, the Incident Management System, the Risk Management Program, and Security Agent managed by Corporate Security also help mitigate the RAMP risk of Physical Security of Critical Infrastructure. Accordingly, because there are benefits associated with these activities attributed to both this risk and Physical Security of Critical Infrastructure, the costs are also presented in both chapters.

Table 3a: SDG&E Baseline Risk Mitigation Plan[14]
(Direct 2015 $000)[15]

ID	Control	Risk Drivers Addressed	Capital[16]	O&M	Control Total[17]	GRC Total[18]
1	Physical Security Systems Contract Security	• Human Error • Process Failure • System Failure	 $3,450 840	 $400 3,930	 $3,850 4,770	 $3,850 4,770
2	Planning, Awareness, and Incident Management	• Human Error • Process Failure • System Failure	250	290	540	540
	TOTAL COST		$4,540	$4,620	$9,160	$9,160

* Includes one or more mandated activities

[14] Recorded costs were rounded to the nearest $10,000.
[15] The figures provided in Tables 3a, 3b, 4a and 4b are direct charges and do not include company loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[16] Pursuant to D.14-12-025 and D.16-08-018, the Companies provided the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[17] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[18] The GRC Total column shows costs typically presented in a GRC.

Table 3b: SoCalGas Baseline Risk Mitigation Plan[19]
(Direct 2015 $000)

ID	Control	Risk Drivers Addressed	Capital[20]	O&M	Control Total[21]	GRC Total[22]
1	Physical Security Systems Contract Security	• Human Error • Process Failure • System Failure	$90 40	$210 1,670	$300 1,710	$300 1,710
2	Planning, Awareness, and Incident Management	• Human Error • Process Failure • System Failure	10	420	430	430
	TOTAL COST		$140	$2,300	$2,440	$2,440

* Includes one or more mandated activities

Tables 4a and 4b summarize the Companies' proposed mitigation plan (which comprises both baseline and new mitigation activities) and associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that the Companies are identifying potential ranges of costs in this plan, and are not requesting funding approval. The Companies will request approval of funding in their next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Tables 4a and 4b, the Companies are using a 2019 forecast provided in ranges based on 2015 dollars.

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[19] Recorded costs were rounded to the nearest $10,000.
[20] Pursuant to D.14-12-025 and D.16-08-018, the Companies provided the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[21] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[22] The GRC Total column shows costs typically presented in a GRC.

Table 4a: SDG&E Proposed Risk Mitigation Plan[23]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[24]	2019 O&M	Mitigation Total[25]	GRC Total[26]
1	Physical Security	• Human Error • Process Failure • System Failure				
	Systems		$12,040 - 14,720	$370 - 400	$12,410 - 15,120	$12,410 - 15,120
	Contract Security		2,660 - 2,950	6,400 - 7,170	9,060 - 10,120	9,060 - 10,120
2	Planning, Awareness, and Incident Management	• Human Error • Process Failure • System Failure	530 - 580	530 - 720	1,060 - 1,300	1,060 - 1,300
	TOTAL COST		$15,230 - 18,250	$7,300 - 8,290	$22,530 - 26,540	$22,530 - 26,540

(white box)	Status quo is maintained
(light blue box)	Expanded or new activity
*	Includes one or more mandated activities

[23] Ranges of costs were rounded to the nearest $10,000.
[24] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018, and 2019 are the forecast years for the Companies' Test Year 2019 GRC Applications.
[25] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[26] The GRC Total column shows costs typically represented in a GRC.

SDGE A Sempra Energy utility SoCalGas A Sempra Energy utility

Table 4b: SoCalGas Proposed Risk Mitigation Plan[27]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[28]	2019 O&M	Mitigation Total[29]	GRC Total[30]
1	Physical Security	• Human Error • Process Failure • System Failure				
	Systems		$1,660 - 2,420	$150 - 230	$1,810 - 2,650	$1,810 - 2,650
	Contract Security		410 - 460	3,450 - 3,700	3,860 - 4,160	3,860 - 4,160
2	Planning, Awareness, and Incident Management	• Human Error • Process Failure • System Failure	30 - 33	670 - 890	700 - 920	700 - 920
	TOTAL COST		$2,100 - 2,910	$4,270 - 4,820	$6,370 - 7,730	$6,370 - 7,730

☐ (white)	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

1. Physical Security and Contract Security
The capital cost estimates for physical security systems were zero-based, derived from projections used to seek internal approval. The O&M costs were estimated as a percentage of the capital costs using subject matter expertise and experience with historical projects.

The physical security systems are largely capital projects. While the projects will change (e.g., expansion to additional locations), the projected annual spend is anticipated to be in line with historical spending. This estimate is only for physical security systems of manned locations that

[27] Ranges of costs were rounded to the nearest $10,000.
[28] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018, and 2019 are the forecast years for the Companies' Test Year 2019 GRC Applications.
[29] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[30] The GRC Total column shows costs typically represented in a GRC.

may have a risk of Workplace Violence. Unmanned locations, such as substations, were not included in this calculation.

The costs for security guards are based on a five-year average labor cost, plus the cost of complying with SB 3, plus the cost of additional guarded locations. The five-year average was used as there was no discernable trend from 2011-2015.

2. Planning, Awareness and Incident Management Mitigation
The cost estimates for many of the activities (e.g., training, awareness, screening, employee assistance) in this group were based on applicable, historical costs. For some activities that were anticipated to increase, the Companies used the 2015 base year amounts and added the costs related to incremental activities. The range provides flexibility as the Companies finalize the scope of the mitigation activities.

For the proposed incident/case management system mitigation, costs of upgrading the existing system are currently being compared to other options available on the market. The range for this activity in the proposed plan took into account the variability of pricing when upgrading this system.

Corporate Security has received several presentations, demonstrations, and trial periods of social media monitoring tools ranging from $25,000 to $100,000. Some of the more beneficial tools may cost around $65,000 per year. Accordingly, the range for this activity reflects the price variations of such tools.

Additional personnel are included in the proposed plan: one for Corporate Security's risk management function and one Corporate Security agent. A range was provided based on an average salary as the actual costs will depend upon the individuals' experience.

7 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[31] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[32]

[31] D.16-08-018 Ordering Paragraph 8.
[32] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 6). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

7.1. General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

7.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 2 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what

the potential risk score would be) if that control was removed.[33] For incremental mitigations, the analysis assesses the anti–cipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

7.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 6. They multiplied the risk reduction developed in subsection 0 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another.

Figure shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Tables 4a and 4b of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

7.2. Risk Spend Efficiency Applied to This Risk

SDG&E and SoCalGas analysts used the general approach discussed in Section 7.1, above, in order to assess the RSE for the Workplace Violence risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

This analysis used a metric (or proxy) – the national victimization rate for all crimes – to assess risk reduction. The Federal Bureau of Justice Statistics (BJS), within the Department of Justice, compiles victimization information through annual, comprehensive surveys. There are crimes with human victims and victimless crimes. The Federal surveys are meant to capture information on the former type. Survey information represents national statistics and does not contain data that can be used to separate workplace events from other events.

The Utilities compile crime information of both types as well. The categories of crime information collected by the Federal government and the Company are:

- Federal: robbery, rape/sexual assault, simple assault, and aggravated assault.
- Corporate: robbery, indecent exposure, workplace violence, and assault.

[33] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

There is not an exact match between the crime information collected by both entities, but the data collected is similar enough to make reasonable comparisons.

An assumption of this analysis is that a victimization rate comparison reflects how safe or how unsafe a workplace environment is, and that this difference in crime exposure can be used as a proxy to evaluate the risk scenario. This proxy seems reasonable because it enables the comparison of the Utilities' workplace experience over time to the national experience; representing "at work" and "not at work" possibilities. It should be noted the Utilities' victimization rates include all threatening communication, not physical assaults only, as the BJS uses. Where applicable, the more conservative estimate was used for calculation.

The risk reduction for current controls (analyzed as one group) was calculated by determining the percent decrease from the highest victimization rate between 2010-2014 (either internal Company data or BJS data) to the 2014 internal Company victimization rate. The risk reductions from incremental mitigations (analyzed as one group) were determined by estimating the percent decrease of the residual risk (2014 internal Company rate) resulting from these proposed activities. Subject matter experts estimated this decrease to be 10%. For comparison purposes, victimization rates were calculated "per thousand people," with BJS rates representing the U.S. population and internal Company rates representing the number of respective Company employees.

SDG&E's highest victimization rate over this period occurred in 2010 and was 31.2 victimizations per thousand people (employees) per year. The national average over this period is 18.6 victimizations per thousand people per year. The higher of these two figures is used for improvement calculations and results in a baseline victimization rate decrease of 22.4 or 72%. The incremental mitigations are estimated to provide a 10% decrease of the residual risk (SDG&E 2014 victimization rate).

SoCalGas' highest victimization rate over this period occurred in 2012 and was 53.8 victimizations per thousand people (employees) per year. The national average over this period is 18.6 victimizations per thousand people per year. The higher of these two figures is used for improvement calculations and results in a baseline victimization rate decrease of 12.1 or 23%. The incremental mitigations are estimated to provide 10% decrease of the residual risk (SoCalGas 2014 victimization rate).

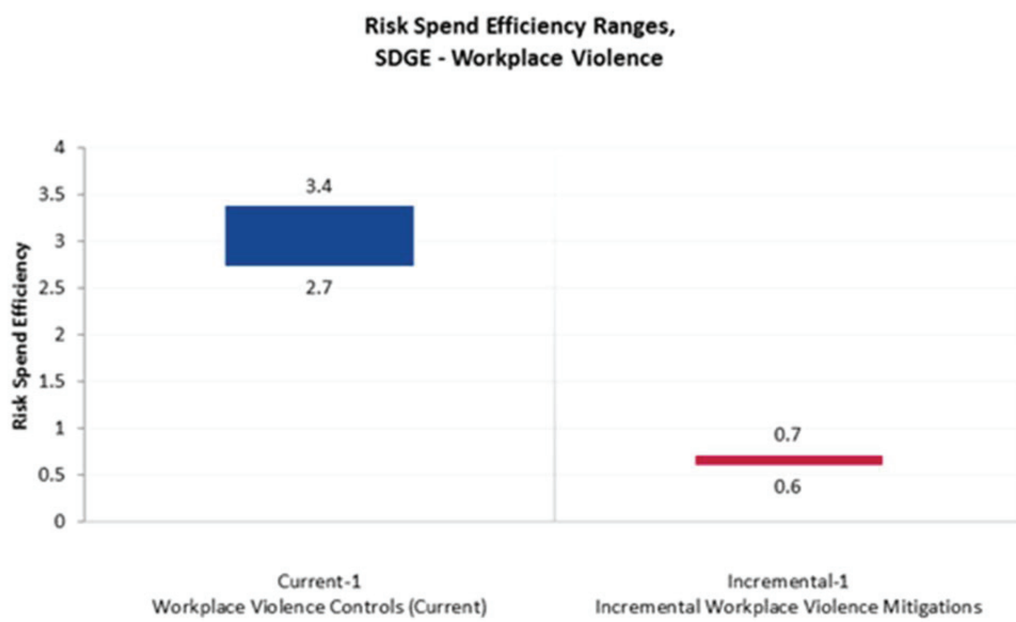
7.3. Risk Spend Efficiency Results

Based on the foregoing analysis, the utilities calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Workplace Violence Controls
2. Incremental Workplace Violence Mitigations

Figures 3 and 4 display the range[34] of RSEs for each of the utilities' Workplace Violence risk mitigation groupings, arrayed in descending order.[35] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

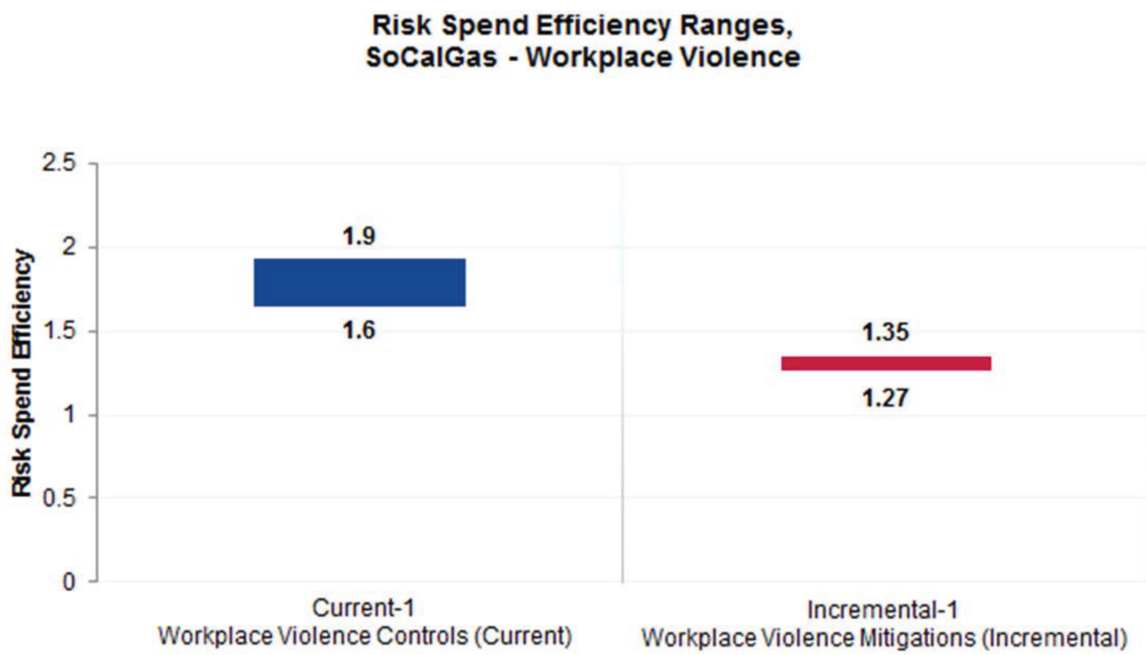
Figure 3: SDG&E Risk Spend Efficiency



[34] Based on the low and high cost ranges provided in Tables 4a and 4b of this chapter.

[35] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 4: SoCalGas Risk Spend Efficiency



8 Alternatives Analysis

The Companies considered alternatives to the proposed mitigations as it developed the incremental mitigation plan for the Workplace Violence risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources. The following represents alternatives for training and for physical security. The viability of each alternative was determined through discussions with stakeholders.

8.1. Alternative 1 – Training Changes

A potential alternative for training is to outsource training or develop computer-based training. Although this alternative may have an increased cost in the short term (i.e., to hire the outside agency or develop the training), it would generally reduce costs in the future. Current training uses Corporate Security agents as instructors. Ideally, it is best to use Corporate Security agents as they provide greater insight into company employees, history, locations, and operations. Accordingly, this alternative was dismissed. However, as demand increases for security-related training, it may be necessary to further explore alternatives.

8.2. Alternative 2 – Physical Security Tradeoffs

Physical security systems (cameras, fences, etc.) and guards may be used as alternatives to each other in some locations for some threats. This would mean that some company locations would only have security guards while others would only have security systems. The potential benefit to this alternative is a reduction of costs; however, it would also increase the risk exposure. Accordingly, this alternative was dismissed in favor of the proposed plan. Implementing physical security systems and guards together often provides increased risk reduction and provides a back-up to one another.

Risk Assessment Mitigation Phase

Risk Mitigation Plan

Physical Security of Critical Gas Infrastructure

(Chapter SCG-6)

November 30, 2016

SoCalGas
A Sempra Energy utility

TABLE OF CONTENTS

Executive Summary

The Physical Security of Critical Infrastructure (Physical Security) risk relates to the damage to critical gas infrastructure that can result from intentional acts.

To assess this risk, SoCalGas first identified a reasonable worst case scenario, and scored the scenario against five residual impact categories (e.g., Health, Safety, Environmental; Operational & Reliability, etc., discussed in Section 4). Then, SoCalGas considered as a baseline, the SoCalGas mitigation in place for in 2015 for Physical Security and estimated the costs (costs are discussed in Section 7). SoCalGas identified the following controls as of 2015:

1. Physical Security Systems and Contract Security: including physical security systems and contract security (e.g., security guards);
2. Operational Resiliency; and,
3. Planning, Awareness, and Incident Management: including, for example, Critical Asset Security Team, investigations, risk management program, training, etc.

These controls focus on safety-related impacts (e.g., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability.

Based on the foregoing assessment, SoCalGas proposed future mitigations. For Physical Security, SoCalGas proposed to continue the three control categories, identified above, but included the following enhancements or additional mitigations within these two control categories:

1. Physical Security Systems and Contract Security
    - Install or upgrade access control and detection capabilities
    - Add security guards to new locations and comply with new laws enacted since the baseline evaluation that increase labor costs
2. Planning, Awareness, and Incident Management: additional personnel in risk management and corporate security areas.

Next, SoCalGas developed the risk spend efficiency. The risk spend efficiency is a new tool that SoCalGas developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The RSE was determined using the proposed mitigations and resulted prioritizing mitigation activities.

Finally, SoCalGas considered two alternatives to the proposed mitigations, and summarizes the reasons that the two alternatives were not selected as a proposed mitigation.

Risk: Physical Security of Critical Infrastructure

1 Purpose

The purpose of this chapter is to present the mitigation plan of Southern California Gas Company (SoCalGas or Company) for the risk of damage to "critical" gas infrastructure. This risk involves damage caused by intentional acts, including but not limited to theft, robbery, burglary, vandalism, disgruntled individuals or groups, terrorism, trespassing, etc., which results in a gas leak, fire, explosion, and/or outages.

This risk is a product of SoCalGas' September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. While 2015 is used as a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SoCalGas and San Diego Gas & Electric Company (SDG&E) (collectively, the Utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

[1] D. 14-12-025 at p. 31.

2 Background

The risk assessment provided herein focuses on *critical* gas infrastructure[2] in accordance with Transportation Security Administration (TSA) guidelines.[3] The TSA guidelines are applicable to natural gas and hazardous liquid transmission pipelines, natural gas distribution pipelines, and to liquefied natural gas facility operators.

For this chapter, SoCalGas only addresses intentional acts that may impact "critical" gas infrastructure. Accordingly, any gas infrastructure that does not meet the TSA's criteria of "critical" is not included and this chapter does not address incidents that are considered to be unintentional such as a vehicular accident rupturing a gas pipeline.

In compliance with these guidelines, SoCalGas has instituted security enhancements or upgrades to infrastructure which have improved access control, intrusion detection, and interdiction capabilities to deter, detect, delay, or mitigate physical risk events at SoCalGas facilities. Depending on the facility, SoCalGas completed several security upgrades, including but not limited to improvements to access, detection, and interdiction.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-004, "SoCalGas is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand, analyze and categorize risks." The Enterprise Risk Management (ERM) process and lexicon that SoCalGas has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks. This includes identifying leading indicators of risk. Sections 3 – 9 of this chapter describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Physical Security of Critical Infrastructure.

[2] Critical gas infrastructure information is confidential and protected from disclosure. *See e.g.,* 18 CFR §388.113(c); FERC Orders 630, 643, 649, 662, 683, and 702 (defining CEII); 6 U.S.C. §§131(3), 133(a)(1)(E); 6 CFR §§ 29.2(b), 29.8 (defining CII and restricting its disclosure); Gov't Code § 6254(e) & (ab) (Plant production data, and similar information relating to utility systems development and "Critical infrastructure information" may be exempt from disclosure under the Public Records Act); FAST Act (Critical Electric Infrastructure Security) Amended December 4, 2015.

[3] TSA, "Pipeline Security Guidelines," April 2011.

3.1 Risk Classification

Consistent with the taxonomy presented by SoCalGas and SDG&E in A.15-05-004, SoCalGas classifies this risk as a gas, operational risk as shown in Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	GAS	VARIOUS

3.2 Potential Drivers[4]

When performing the risk assessment for Physical Security of Critical Infrastructure, SoCalGas identified potential indicators of risk, referred to as drivers. These include, but are not limited to:

1. **Intentional Damage** – a purposeful act via theft, vandalism, disgruntled employees, terrorism, trespassing that leads to service interruptions or disruption of operations to a critical gas transportation/delivery facility.
2. **Human Error** – an error that occurs due to someone not doing something correctly which leads to the realization of the risk.
3. **Process Failure** – a failure of programs/procedures that are intended to prevent the risk from occurring and control the consequence of the risk if it occurs.
4. **System Failure** – a failure of security systems that are intended to prevent the risk from occurring.

Table 2 maps the specific drivers of the Physical Security of Critical Infrastructure risk to SoCalGas' risk taxonomy.

Table 2: Operational Risk Drivers

Driver Category	Physical Security of Critical Infrastructure Driver(s)
Asset Failure	• System Failure
Asset-Related IT Failure	• System Failure
Employee Incident	• Intentional Damage • Human Error • Process Failure
Contractor Incident	• Intentional Damage • Human Error

[4] An indication that a risk could occur. It does not reflect actual or threatened conditions.

	• Process Failure
Public Incident	• Intentional Damage
Force of Nature	Not applicable

In addition to the above drivers, other potential circumstances may contribute to the risk of Physical Security, including intentional attacks as a result of: extremist ideologies, criminal acts, personal issues or conflict, mental health issues. The list of drivers and potential circumstances are not intended to be a comprehensive list as Physical Security incidents may vary from one incident to another.

3.3 Potential Consequences

If one of the drivers listed above were to occur resulting in a Physical Security-related event, the potential consequences may include:

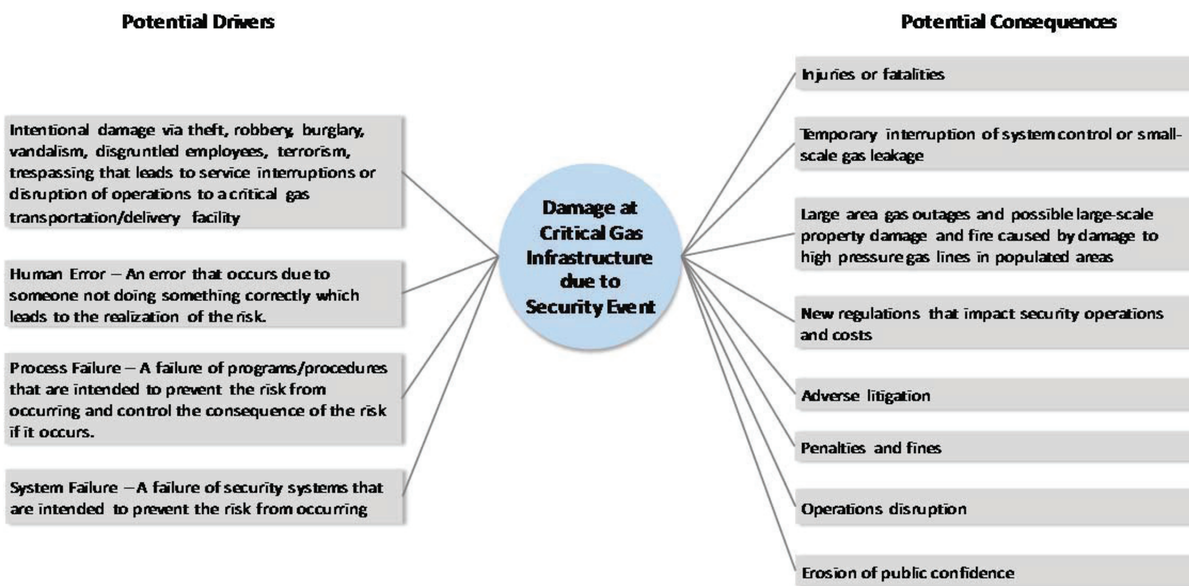
- Injuries or fatalities;
- Temporary interruption of system control or small-scale gas leakage;
- Large area gas outages and possible large-scale property damage and fire caused by damage to high pressure gas lines in populated areas;
- New regulations that impact security operations and costs;
- Adverse litigation and resulting financial consequences;
- Erosion of public confidence; and
- Operations disruption.

These potential consequences were used in the scoring of Physical Security that occurred during SoCalGas' risk registry process. Section 4 contains the risk scoring discussion.

3.4 Risk Bow Tie

The risk "bow tie," shown below, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that may lead to a risk event and the right side shows the potential consequences of a risk event. SoCalGas applied this framework to identify and summarize the information provided in Sections 3.2 and 3.3, above.

Figure 1: Risk Bow Tie



4 Risk Score

The SoCalGas and SDG&E ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Physical Security as a potential enterprise risks. During the development of the risk register, subject matter experts (SMEs) assigned a score to this risk, based on empirical data, to the extent it is available and/or using their expertise, and followed the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

Critical infrastructure damage could occur in varied ways. For purposes of scoring this risk, SMEs applied a reasonable worst case scenario to assess the impact and frequency. The scenario represented a hypothetical situation that could happen, within a reasonable timeframe, and could lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The SMEs used the reasonable worst case scenario to develop a risk score and the scenario selected to assess the Physical Security risk is:

- A terrorist group uses explosives to rupture major transmission lines, which results in a fire. Employees and members of the public may sustain injuries. This also may result in severe disruption to the gas supply with potentially widespread curtailments of both core and noncore customers.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SoCalGas' 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP. Using the levels defined in the REF, the SMEs applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the Physical Security risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, SoCalGas included this risk in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 3: Risk Score

Residual Impact				Frequency	Total
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
5	6	4	4	3	23,107

4.3 Explanation of Health, Safety, and Environmental Impact Score

Considering the reasonable worst case scenario, SoCalGas assumed that terrorists willing to carry out this type of attack may also harm employees onsite or nearby. In addition, in this scenario, SoCalGas assumed the explosive devices could harm workers or neighbors within the area if they were situated near the explosion or fire. This rating also considers the potential disruption to public safety operations and health and human services that may rely on natural gas operations. Accordingly, SoCalGas scored Physical Security a 5 (extensive) in the Health, Safety, and Environmental impact area.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SoCalGas scored the other residual impact areas as follows:

- **Operational and Reliability:** SoCalGas rated Physical Security a 6 (severe) in the Operational and Reliability impact area. The criticality of gas facilities can vary the impact of the incident and outage type. Accordingly, in applying the reasonable worst case scenario, SoCalGas assumed that a significant loss will occur in which all major pipelines at a single facility are significantly damaged or impacted by a terrorist event and the reliability of gas service to the region will be compromised, resulting in curtailments of both core and non-core customers.

- **Regulatory, Legal and Compliance:** SoCalGas scored the Regulatory, Legal, and Compliance impact a 4 (major). SoCalGas assigned this score because enhanced regulations may be implemented as a result of the reasonable worst case scenario, similar to the enactment of NERC CIP 14 after Pacific Gas and Electric Company (PG&E)'s Metcalf incident.

- **Financial:** SoCalGas rated Physical Security a 4 (major) in the Financial impact area. The potential costs associated with this type of scenario could range between $10 million and $100 million, which would account for, as a minimum, the following:

    - Temporary, emergency repairs
    - Permitting
    - Material procurement
    - Permanent repairs
    - Pipeline contractors(s)
    - Environmental
    - Inspection
    - Customer Restores
    - Media/Customer Communications
    - Potential litigation
    - Security

4.5 Explanation of Frequency Score

The frequency of terrorist incident penetrating a critical gas facility was considered to be 3 (infrequent), which is defined in accordance with SoCalGas' 7X7 matrix as having the potential to occur every 10-30 years. While attacks against critical gas infrastructure have occurred within the United States, Canada, and Mexico within the last 10 years, the attacks did not cause significant operational disruption and few of the attacks were well planned or successful. However, because there continues to be attacks overseas, terrorist groups could use similar techniques to perform attacks domestically.

5 Baseline Risk Mitigation Plan[5]

As stated above, the Physical Security risk involves damage to critical gas infrastructure resulting from intentional acts. The 2015 baseline mitigations discussed below includes the current evolution of the utilities' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include activities to comply with laws that were in effect at that time. SoCalGas' baseline mitigation plan for this risk consists of three controls:

[5] As of 2015, which is the baseline year for purposes of this Report.

(1) Physical Security Systems and Contract Security;

(2) Operational Resiliency; and,

(3) Planning, Awareness, and Incident Management, which includes,

a. Critical Asset Security Team
b. Investigations
c. Risk Management Program
d. Security Awareness Training
e. Law Enforcement Liaison and Trade Groups
f. Utilities Liaison
g. Site Security Reviews
h. Business Resumption Plan
i. Gas Security Plans

SMEs from Corporate Security within Gas Engineering collaborated to identify and document the baseline controls. These controls focus on safety-related impacts[6] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[7] as well as controls and mitigations that may address reliability.[8] Accordingly, the controls and mitigations described in this section and in Section 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed risk mitigation plans are intended to address various events related to Physical Security and is not limited to the scenario used for the Risk Score.

1. Physical Security Systems and Contract Security

The purpose of physical security is to maintain the safety of employees, contractors, the public, and SoCalGas facilities through the use of systems, personnel and policies and procedures. This includes the maintenance and improvement of safety through the implementation of proactive threat identification and mitigation measures; and more effective access control, detection, and interdiction capabilities. Aligned with this, SoCalGas' physical security mitigation in this chapter includes two activities: physical security systems and contract security (e.g. security guards).

Physical security systems provide protection enhancements to infrastructure to improve access control, intrusion detection, and interdiction capabilities to deter, detect, delay, or prevent undesirable events at Company facilities. The type and extent of security upgrades varies by facility, but several have been completed, including, fences, gates and cameras.

In addition to security systems, SoCalGas employs *contract security* (security guards) to secure and physically protect assets and people. These security guards are located at critical facilities and work

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[6] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[7] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[8] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

locations. Company policies and procedures outline physical security procedures, including access control, officer post orders and incident reporting.

2. Operational Resiliency

Operational resiliency relates to the utility's ability to maintain operations or quickly resume operations should one of these facilities be compromised. Operational resiliency at critical sites should allow SoCalGas to maintain safety and reliability even if, e.g., a hypothetical intentional act, such as terrorism, were to occur. SoCalGas addresses operational resiliency by proposing and constructing new or enhanced infrastructure projects and programs.

3. Planning, Awareness, and Incident Management

The Planning, Awareness, and Incident Management mitigation includes projects and programs that largely provide services in an attempt to proactively manage this risk before an event can occur. These mitigations consist of activities such as the Critical Asset Security Team (CAST), training, investigations, Corporate Security's risk management program, Industry Outreach and Planning. SoCalGas provides some examples below.

One example of a Planning, Awareness, and Incident Management mitigation is the CAST. CAST is composed of personnel from multiple business units, including Corporate Security, Engineering, Operations, Legal and Environmental assists with enhancing security at all of SoCalGas' facilities. This cross-functional team was created to assess current security countermeasures across the SoCalGas infrastructure and to make incremental and long-term security recommendations. This team manages the implementation of many of the physical security systems.

Another example is security awareness training. SoCalGas offers a number of training opportunities to employees to increase awareness regarding the identification and response to criminal activity. Security awareness training focuses on identifying threats and suspicious activity, responding to threats, and proper reporting protocols. Training is also provided to external public safety representatives to increase awareness of SoCalGas facilities, infrastructure, and operations. SoCalGas also engages with other external entities including participation in trade groups, security committees, or other working groups with utilities. This outreach assists with the sharing of information regarding security incidents, response, and prevention. It is also an important tool to assist with benchmarking certain topics related to Physical Security.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations discussed in Section 5 will continue to be performed in the Proposed Risk Mitigation Plan, in most cases, to maintain the current residual risk level. In addition, the Company is proposing to expand or add the mitigations addressed in this Section.

1. Physical Security Systems and Contract Security

Generally, the baseline controls for Physical Security Systems and Contract Security, described above, will continue. SoCalGas also is proposing similar security projects to enhance protection, such as installing cameras and gates at additional locations. Similarly, the presence of security guards increases protection with the aim of reducing the likelihood of an intentional event.

Regarding security guards, SoCalGas must comply with Senate Bill (SB) 3, which will become effective January 1, 2017. The resulting effects are increases in costs above the standard escalation. In other words, the cost associated with doing business (i.e., employing security guards) has increased, sometimes referred to as non-standard escalation.

2. Operational Resiliency

SoCalGas' operational resiliency activities will include a variety of proposed infrastructure enhancements.

3. Planning, Awareness, and Incident Management

This mitigation consists of expanded and new activities, such as additional personnel in the risk management and corporate security areas. Over the last couple of years, the demand for Corporate Security services has increased as well as regulatory requirements, including the RAMP process, are requiring more detailed security planning and reporting. Given the increase in workload due to increased regulations, additional resources are needed.

7 Summary of Mitigations

Table 4**Error! Reference source not found.** summarizes the 2015 baseline risk mitigation plan, the risk driver(s) addressed by a certain control activity, and the 2015 baseline costs for Physical Security. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SoCalGas does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

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Table 4: Baseline Risk Mitigation Plan[9]
(Direct 2015 $000)[10]

ID	Control	Risk Drivers Addressed	Capital[11]	O&M	Control Total[12]	GRC Total[13]
1	Physical Security Systems Contract Security	• Intentional Damage • Human Error • Process Failure • System Failure	$4,480 40	n/a 1,670	$4,480 1,710	$4,480 1,710
2	Operational Resiliency	• Intentional Damage • Human Error • Process Failure • System Failure	430	n/a	430	430
3	Planning, Awareness, and Incident Management	• Intentional Damage • Human Error • Process Failure • System Failure	n/a	510	510	510
	TOTAL COST		$4,950	$2,180	$7,130	$7,130

* Includes one or more mandated activities

While all the mitigations and costs presented in Tables 4 and 5 mitigate Physical Security, some of the controls also mitigate other risks presented in this RAMP Report. Specifically, Physical Security Systems, Contract Security, Investigations, the Incident Management System, the Risk Management Program, and Security agent managed by Corporate Security also help mitigate the RAMP risk of Workplace Violence. Accordingly, because there are benefits associated with these activities attributed

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[9] Recorded costs were rounded to the nearest $10,000.

[10] The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.

[11] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the “baseline” costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.

[12] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).

[13] The GRC Total column shows costs typically presented in a GRC.

to both this risk and Physical Security of Critical Infrastructure, the costs are also presented in both chapters.

Error! Reference source not found. summarizes SoCalGas' proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SoCalGas is identifying potential ranges of costs in this plan, and is not requesting funding approval. SoCalGas will request approval of funding, in its next GRC. There may be non-CPUC jurisdictional mitigation activities addressed in RAMP; any costs associated with these activities will not be carried over to the GRC.

Table 5: Proposed Risk Mitigation Plan[14]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017 -2019 Capital[15]	2019 O&M	Mitigation Total[16]	GRC Total[17]
1	Physical Security Systems Contract Security	• Intentional Damage • Human Error • Process Failure • System Failure	$10,950 - 13,390 410 - 460	$15 - 20 3,460 - 3,700	$10,970 - 13,410 3,870 - 4,160	$10,970 - 13,410 3,870 - 4,160
2	Operational Resiliency	• Intentional Damage • Human Error • Process Failure • System Failure	12,300 - 17,700	n/a	12,300 - 17,700	12,300 - 17,700
3	Planning, Awareness, and Incident Management	• Intentional Damage • Human Error • Process Failure • System Failure	n/a	660 - 840	660 - 840	660 - 840
	TOTAL COST		$23,660 - 31,550	$4,140 - 4,560	$27,800 - 36,110	$27,800 - 36,110

☐	Status quo is maintained
☐	Expanded or new activity
*	Includes one or more mandated activities

[14] Ranges of costs were rounded to the neared $10,000.
[15] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SoCalGas' Test Year 2019 GRC Application.
[16] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[17] The GRC Total column shows costs typically represented in a GRC.

For Physical Security, the capital forecast was completed using estimated costs for planned security projects. The range provides flexibility as the final scope has not been determined at this time. This estimate is only for physical security systems of critical locations within scope of this risk.

1. Physical Security Systems and Contract Security

   The physical security systems are largely capital projects. While the projects will change (e.g., expansion to additional locations), the projected annual spend is expected to be in line with historical spending. The costs for security guards are based on a five-year average labor cost, along with the cost of complying with SB 3, plus the cost of additional guarded locations. The cost of CAST was estimated using a base-year forecast methodology, as the activity and related costs are not anticipated to change significantly from 2015 levels.

2. Operational Resiliency

   Costs associated with this mitigation were developed by SMEs utilizing their knowledge and experience of what similar projects would cost.

3. Planning, Awareness, and Incident Management

   Many of the mitigations within this grouping used a five-year average (2011-2015) to assist with forecasting of future costs. Some activities that were anticipated to increase used the 2015 base year amounts and added the costs related to incremental activities.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent.[18] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[19]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

[18] D.16-08-018 Ordering Paragraph 8.
[19] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[20] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

[20] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

8.1.2 Calculating Risk Spend Efficiency (RSE)

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another.

Figure shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 5 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SoCalGas analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Gas Physical Security risk. The RAMP Approach Chapter in this Report provides a more detailed example of the calculation used by the Company.

For the purpose of the risk reduction methodology, the risk assessment team combined mitigations into two categories: Physical Security and Operational Resiliency. Physical Security includes physical security systems, guards, and each of the mitigations listed in Planning, Awareness, and Incident Management. The second, Operational Resiliency, consists of various resiliency operations, including AC-injection, withdrawal, and metering debottleneck. Next, SoCalGas further categorized these groups into current or incremental activities. The “Current” category indicates that SoCalGas is currently performing and will continue to perform this activity; “Incremental” refers to a new or significantly expanded activity.

The analysis for Operational Resiliency was based on the assessment of SoCalGas SMEs of potential projects and estimated risk reduction to the overall system. The risk assessment methodology was taken from several Federal-level risk assessment methodologies and included ratings criteria and justifications.

- **Physical Security (current controls)**

The analysis compared the system-wide susceptibility to a physical security attack with and without the baseline mitigations. The frequency adjustment was derived from SoCalGas subject matter experts’ physical security risk assessment data. The risk reduction was calculated as the percentage change in the risk assessment score between the current, “with,” mitigation assessment score and “without” mitigation assessment score. For the life of the project, the team assumed that long term items, such as fencing, have a life expectancy of 30 years. Shorter term items, such as electronics, have a life of 5 years. The assessment team used a weighted average of ~17 years.

- **Physical Security (incremental mitigations)**

The frequency adjustment was also derived from the SoCalGas subject matter experts' risk assessment spreadsheets. For this mitigation, the analysis compared the current risk assessment score with the risk assessment score after the incremental physical security measures are put in place.

- **Operational Resiliency (incremental mitigations)**

The benefits of this risk were calculated according to the following methodology: Two facilities out of 10 critical facilities will be remedied through the application of the resiliency operations. These operations are estimated to be 40% effective and the effectiveness was weighted for all of the facilities. With the facility weighting, the overall system risk was calculated to be reduced by 5%.

8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SoCalGas calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

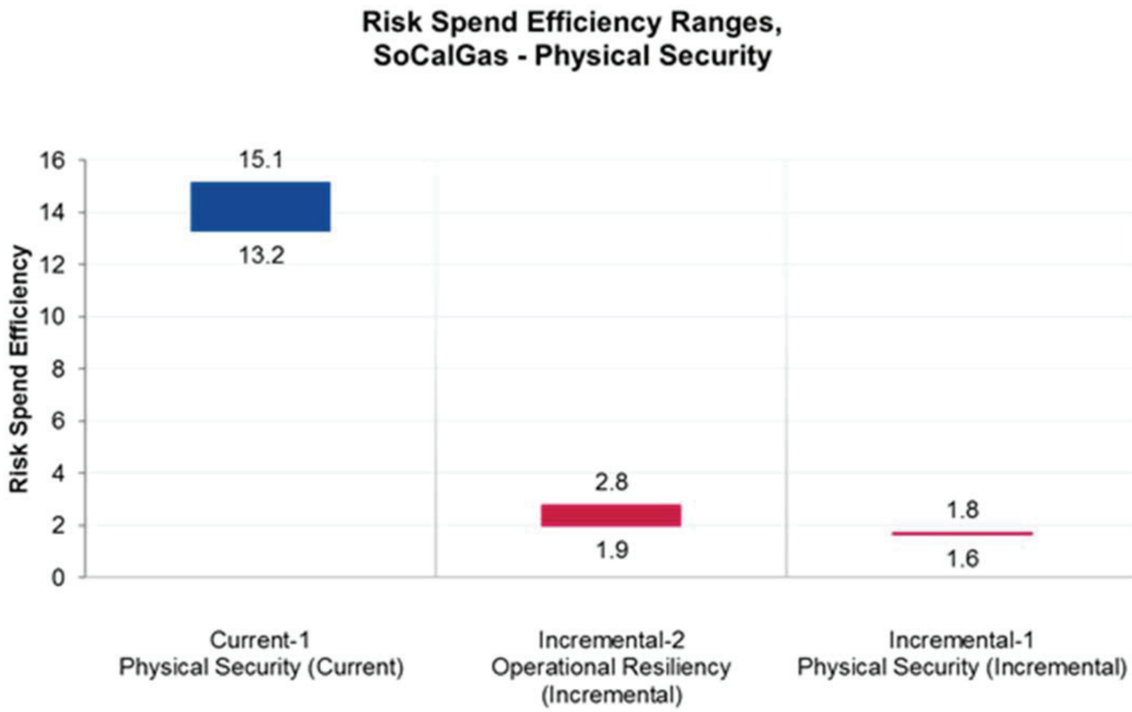
1. Physical Security (current controls)
2. Operational Resiliency (incremental mitigations)
3. Physical Security (incremental mitigations)

Figure displays the range[21] of RSEs for each of the SoCalGas Physical Security risk mitigation groupings, arrayed in descending order.[22] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

[21] Based on the low and high cost ranges provided in Table 5 of this chapter.

[22] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 3: Risk Spend Efficiency



9 Alternatives Analysis

Alternatives are continually considered as programs are updated. The following represents alternatives for training and for physical security systems that were considered as SoCalGas developed its proposed plan for Physical Security.

9.1 Alternative 1 – Training Changes

SoCalGas considered outsourcing training or developing computer based training as an alternative. Although this alternative may have an increased cost in the short term to hire the outside agency or develop the computer based program, it would generally reduce costs in the future. Current training uses Corporate Security agents as instructors. It was determined that it is best to use Corporate Security agents as they provide greater insight into Company employees, history, locations, and operations. Accordingly, this alternative was dismissed. However, as demand increases for security related training, it may be necessary to review and/or further explore alternatives.

9.2 Alternative 2 – Physical Security Tradeoffs

Physical security systems (cameras, fences, etc.) and guards may be used as alternatives to each other depending on the facility and the threat. This would mean that some SoCalGas locations would only have security guards while others would only have security systems. The alternatives are considered for each individual facility and may be based upon threat level, vulnerably, visibility, location, costs, operations, etc. The potential benefit to this alternative is a reduction of costs; however, it would also increase the risk exposure. Accordingly, this alternative was dismissed in favor of the proposed plan – that is, implementing physical security systems and guards because they often provide increased risk reduction and can be a back-up to one another.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Workforce Planning
(Chapter SCG-7)

November 30, 2016

SoCalGas
A Sempra Energy utility

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Executive Summary

The purpose of this chapter is to present the mitigation plan of Southern California Gas Company (SoCalGas) for the risk of Workforce Planning. The Workforce Planning risk covers the risk of not having an appropriate workforce with the right skills to meet business needs due to the acceleration of workforce attrition and changing business needs. SoCalGas' 2015 baseline mitigation plan for this risk consists of five controls:

1. Workforce Planning
2. Knowledge Transfer
3. Training
4. Training – Technical Non-Human Resources (HR)
5. Succession Planning

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the California Public Utilities Commission (Commission or CPUC) in Decision (D.) 16-08-018 as well as controls and mitigations that may address reliability. SoCalGas' proposed mitigation plan comprises both baseline and new mitigation activities.

Based on the foregoing assessment, SoCalGas proposed future mitigations. For Workforce Planning, SoCalGas proposed to continue the five control categories, identified above, but included enhancements within each category. The enhancements include:

1. Workforce Planning
   - Development and maintenance of the workforce planning model
   - Identification of labor force gaps; development of staffing/workforce plans for business units; conducting skills gap analysis; and implementation of workforce planning software
   - Expansion of organizational capabilities assessment to include competency work and job analysis
2. Knowledge Transfer
   - Increase in full time equivalents (FTEs) to conduct the additional activities and all employee participation costs for time spent on knowledge management activities (e.g., workshops, Communities of Practice, technology development, etc.) to create knowledge transfer plans for critical, safety-related roles
3. Training
   - The expansion of Essentials of Supervision, Leadership Training Camp development costs, implementation of the Leadership Challenge, and all employee participation costs to help SoCalGas address skills gaps in leadership and technical skills to promote the safe execution of work
4. Training – Technical Non-HR
   - Revamping and redesigning current technical training
   - Development of a Management Technical Training program to be offered to all new front line supervisors

5. Succession Planning
    - Additional FTE to help with the succession planning process for critical roles below the director level to help proactively provide training in advance and mitigate knowledge gaps that could lead to safety incidents

The risk spend efficiency was developed for Workforce Planning. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. For Workforce Planning, the risk spend efficiency was completed at the risk portfolio level, with the activities grouped into one, aggregated mitigation. The methodology for calculating the risk spend efficiency was generally based on job proficiency data.

Risk: Workforce Planning

1 Purpose

The purpose of this chapter is to present the mitigation plan of SoCalGas for the risk of Workforce Planning. The Workforce Planning risk covers the risk of not having an appropriate workforce with the right skills to meet business needs due to the acceleration of workforce attrition (as projected by hiring trends and 5-year retirement eligibility rates) and changing business needs. While this risk could have several impacts (e.g., safety. environmental, etc.), the risk mitigation plan set forth herein focuses on safety-related mitigations only.

At the same time, the utility industry is undergoing a significant transformation. A main business objective for SoCalGas is adopting new technologies in order to deliver the safest and most reliable services to its customers. This evolving technological environment is creating a demand for new, additional skillsets. The goal is to have experience in new/emerging technologies, while still maintaining necessary legacy knowledge. SoCalGas' workforce planning mitigation strategies enable the thoughtful transition of retirement eligible employees and, where appropriate, the procurement of skills in new/emerging technologies. One example of orderly transition is the recent voluntary retirement program (VREP). Management offered a voluntary separation package to a select group of retirement eligible employees in areas believed to have skill surpluses to make room for thoughtful technology skill acquisition. SoCalGas has periodically offered similar VREP programs in the past and a small percentage of employees with critical knowledge are expected to accept the recent VREP offering.

This risk is a product of the SoCalGas and San Diego Gas & Electric Company (SDG&E) (collectively, the Companies) September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used as the base year for mitigation planning, risk management has been occurring, successfully, for many years within the Companies. The Companies take compliance and managing risks seriously, as can be seen by the numerous actions taken to mitigate each risk. This is the first time, however, that the Companies have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the Companies do not currently track expenditures in this way, so the baseline amounts are the best effort of the company to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the Commission and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety-related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the

[1] D.14-12-025 at p. 31.

Companies take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the Companies have made efforts to identify those costs.

At SoCalGas, safety is a top priority and begins with the tone at the top – key to the success of reducing the risk of Workforce Planning is top management demonstrating commitment to safety and leading by example.[2] This safety-focused tone at the top aspires to reduce the realization of this risk occurring to the extent possible. As stated in American Petroleum Institute's (API) Recommended Practice 1173 and similarly stated by the Commission, "The industry – wide goal of zero incidents requires comprehensive, systemic effort."[3] While SoCalGas shares this ultimate goal of a "vision zero" or incident-free workplace, given that this a dynamic risk and is centered on human factors by which employees and contractors can make mistakes, SoCalGas' focus in this chapter is on what can be realistically achieved.

Moreover, the large size of SoCalGas' workforce makes achieving an incident-free workplace a challenge. To address this challenge, SoCalGas continues to develop a thoughtful risk assessment to effectively manage over 8,000 employees, considering an increasing turnover rate, a high rate of internal movement, and increasing retirement and separation rate. The risk assessment of Workforce Planning attempts to identify leading indicators (e.g., drivers) and consequences before and when issues occur in conjunction with on-going monitoring and analysis. The scope of this risk focuses on an overall governance framework and related initiatives.

2 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-004, "SoCalGas is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[4] The Enterprise Risk Management (ERM) process and lexicon that SoCalGas has put in place were built on the internationally-accepted IS0 31000 risk management standard. In the

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[2] The importance of top management's role in a successful pipeline safety management system is outlined in Pipeline Safety Management System Requirements in the API Recommended Practice 1173, First Edition, June 2014, Draft Version 11.2.
[3] Pipeline Safety Management System Requirements in the API Recommended Practice 1173, First Edition, June 2014, Draft Version 11.2 and Safety Policy of the California Public Utilities Commission, July 10, 2014.
[4] A.15-05-004, filed May 1, 2015, at p. JMD-7.

application and evolution of this process, the Companies are committed to increasing the use of quantification within its evaluation and prioritization of risks.[5] This includes identifying leading indicators of risk. Sections 2 – 8 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Workforce Planning risk.

2.1 Risk Classification

Consistent with the taxonomy presented by the Companies in A.15-05-004, SoCalGas classifies this risk as a cross-cutting risk that affects people and is a function of organizational health. This risk is considered cross-cutting because it touches every department company-wide. The risk classification is provided in Table 1 below.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
CROSS-CUTTING	PEOPLE	ORGANIZATIONAL HEALTH

2.2 Potential Drivers[6]

When performing the risk assessment for Workforce Planning, SoCalGas identified potential drivers, such as those drivers outlined in the Employee, Contractor, Customer, and Public Safety risk, which could lead to a safety incident. Potential incidents that can result pursuant to the Workforce Planning risk can primarily be attributed to a human factor, such as a gap in experience or knowledge to meet business needs.

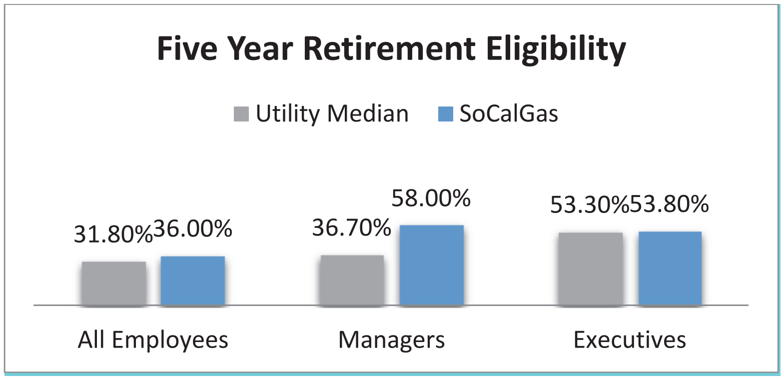
Potential drivers for the Workforce Planning risk include, but are not limited to:

- **Improved economic environment incentivizes employees to find new jobs or retire.**
  Improved economic conditions and the resulting impacts are outside the control of SoCalGas. Nonetheless, SoCalGas can plan for increases in retirements through various tools discussed herein, such as succession planning and knowledge management.

- **Aging workforce correlates with higher attrition rates and accelerated job movement due to vacancies.**
  At SoCalGas, a growing number of employees are eligible to retire across the company between 2015 and 2025. In fact, SoCalGas currently surpasses the utility industry median for retirement

[5] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[6] An indication that a risk could occur. It does not reflect actual or threatened conditions.

eligibility for all employees, especially managers.[7] As illustrated by the results of a utility benchmarking survey, 36% of employees and 58% of managers will be eligible for retirement in the next five years.



- **An increase of millennial employees more likely to change jobs and companies.**[8]
  As workforce attrition increases, so does hiring at SoCalGas. Internal data analysis shows an increasing trend to hire millennials (born after 1980). As the graph below shows, the hiring rate has increased by over 1.5 times between 2010 and 2014, with millennials comprising well over half of employees hired into SoCalGas.

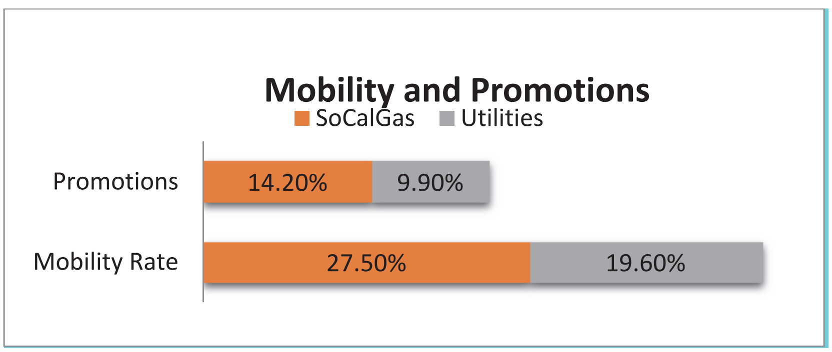
Based on the Bureau of Labor statistics, employees 20-24 years of age tend to move around more within and across organizations.[9] The graph below shows between 2004-2014, the average job tenure was only 1.3 years compared to 4.9-5.3 years for employees 35-44 years of age.

[7] Results for retirement eligibility and hiring rate were obtained from the 2015 PwC Saratoga Benchmarking study.
[8] https://www2.deloitte.com/content/dam/Deloitte/at/Documents/human-capital/millennial-innovation-survey-2016.pdf.
[9] Information and Bureau of Labor statistics chart obtained from: http://www.eremedia.com/tlnt/dont-look-now-but-your-millennials-are-looking-for-their-next-gig/.

Average Job Tenure In Years For Select Age Groups	1983	1987	1991	1996	2000	2004	2008	2012	2014
TOTAL									
20 to 24 years	1.5	1.3	1.3	1.2	1.1	1.3	1.3	1.3	1.3
25 to 34 years	3	2.9	2.9	2.8	2.6	2.9	2.7	3.2	3
35 to 44 years	5.2	5.5	5.4	5.3	4.8	4.9	4.9	5.3	5.2
MEN									
20 to 24 years	1.5	1.3	1.4	1.2	1.2	1.3	1.4	1.4	1.4
25 to 34 years	3.2	3.1	3.1	3	2.7	3	2.8	3.2	3.1
35 to 44 years	7.3	7	6.5	6.1	5.3	5.2	5.2	5.4	5.4
WOMEN									
20 to 24 years	1.5	1.3	1.3	1.2	1	1.3	1.3	1.3	1.3
25 to 34 years	2.8	2.6	2.7	2.7	2.5	2.8	2.6	3.1	2.9
35 to 44 years	4.1	4.4	4.5	4.8	4.3	4.5	4.7	5.2	5.1

Source: Bureau of Labor Statistics

Increased attrition has led to promotion and mobility rates (14% and 28% respectively) that trend almost 50% higher compared to other utilities nationwide. See illustrative graph below.[10]



- **Increase in technological changes can challenge employees without the right technical skills.**

  New workforce skills or more training for existing workers is needed as SoCalGas continues to promote and adopt the use of technology to help satisfy increasingly complex regulatory and compliance considerations (e.g., environmental, engineering).

[10] Results for mobility and promotion rates were obtained from the 2015 PwC Saratoga Benchmarking study.

- **Increased demand for specialized skills may cause competition in the industry and lead to vacancies.**

  At SoCalGas, as attrition among utilities continues, along with various on-going business initiatives, the market for employees with utility-specific skillsets can become more competitive.

The specific risk drivers identified above are based on external reports, utility industry benchmarks and SoCalGas internal data on retirement eligibility, promotions and mobility rates, hiring rates and the changing entry point position,[11] and workforce requirements. All of these factors create an environment for increased workforce attrition, which in turn creates labor workforce, skills and knowledge gaps. Thus, as these varying drivers gain momentum, an increasingly active mitigation/control framework (i.e., workforce planning, knowledge management, training, and succession planning initiatives) is needed.

2.3 Potential Consequences

If one of the drivers listed above were to occur, leading to a lack of experience or knowledge gap that results in an employee or contractor error, this could cause a safety-related incident. The potential consequences, in a reasonable worst case scenario, could include:

- Injuries to employees, contractors, customers, and/or the public due to lack of experience;
- Property damage;
- Inefficiencies/increased costs due to lower tenure and limited experience; and/or
- Financial impacts due to environmental, regulatory, civil, and/or criminal violations.

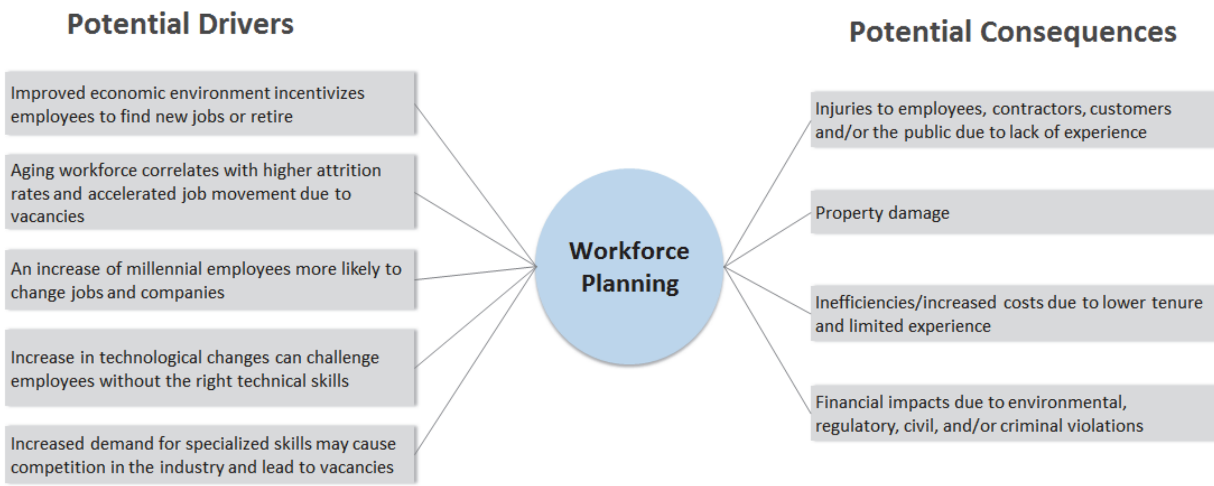
These potential consequences were used in the scoring of the Workforce Planning risk that occurred during the Companies' 2015 risk registry process. See Section 3 for more detail.

2.4 Risk Bow Tie

The risk "bow tie," shown in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SoCalGas applied this framework to identify and summarize the information provided above.

[11] With the Meter Reader and Advanced Meter Installer positions concluding in 2017, SoCalGas will have new entry point positions into the organization. Since these positions require more skills and experience, they are referred to as entry point positions, rather than entry level positions.

Figure 1: Risk Bow Tie



The Workforce Planning risk event provided in the center of the bow tie is the shortage of a qualified workforce.

3 Risk Score

The Companies' ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Workforce Planning as one of the enterprise risks. During the development of the risk registry, subject matter experts (SMEs) assigned a score to this risk, based on empirical data to the extent it was available and/or using their expertise, following the process outlined in this section.

3.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a Workforce Planning risk event can occur. For purposes of scoring this risk, SMEs used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could be expected to happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The SMEs selected the following reasonable worst case scenario to develop a risk score for Workforce Planning:

- An employee performs work that she/he has had minimal experience performing and causes a service disruption, which results in injuries to one or more individuals – whether an employee, contractor, customer or member of the public. A regulatory investigation is opened and/or adverse litigation is initiated.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen.

3.2 2015 Risk Assessment

Using this scenario, SMEs then evaluated the frequency of occurrence and potential impact of the risk using the Companies' 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[12] Using the levels defined in the REF, the SMEs applied empirical data to the extent it was available and/or using their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk. Table 2 provides a summary of the Workforce Planning risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

The scores reflect the possibility of employees lacking the appropriate skills to do jobs that may have a safety or compliance impact. If appropriate safety protocol is not followed (because of lack of proper training and/or knowledge), there can be major consequences.

The scores were also influenced by the need to continue and/or develop leadership skills, understanding that the lack of leadership can affect employee engagement and adherence to safety protocols. The scores are shown in Table 2 below.

Table 2: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
4	4	4	4	5	5,774

3.3 Explanation of Health, Safety, and Environmental Score

SoCalGas scored Workforce Planning a 4 (Major) in the Health, Safety, and Environmental impact area.

Lack of technical knowledge and skills among employees at all levels could lead to one or more serious injuries and illnesses to the public or employees. For leaders with direct reports, without the job knowledge or ability to maintain a fully engaged workforce, mistakes can occur, ultimately leading to incidents. This is especially true for employees within critical jobs related to safety, who need to be fully equipped with the knowledge and skills to perform their work. Without proper knowledge management strategies in place, employees might not possess the knowledge and skills needed to safely perform their job functions.

[12] D.16-08-018, Ordering Paragraph 9.

3.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SoCalGas gave the following scores to the remaining impact categories:

- **Operational & Reliability**: SoCalGas scored Workforce Planning a 4 (Major). SoCalGas believes it is feasible that customers may experience operational impacts due to inexperienced, untrained employees performing critical tasks. Further, the lack of fully skilled and knowledgeable employees in critical jobs and all supervisory roles could result in an increase in the length of time for completing jobs.
- **Regulatory, Legal, and Compliance:** SoCalGas scored Workforce Planning a 4 (Major), which involves violations that result in financial consequences. If a Workforce Planning event were to occur, it is feasible that SoCalGas may endure penalties. This is also consistent with the score given in the Financial impact area.
- **Financial**: SoCalGas scored Workforce Planning a 4 (Major). A negative outcome in the Regulatory, Legal, and Compliance impact area could have a financial consequence.

In addition to the consequences mentioned above, the lack of fully skilled and knowledgeable employees in critical jobs and all supervisory roles could result in dissatisfied customers and unengaged workers, which can then lead to high turnover.

3.5 Explanation of Frequency Score

The frequency score of 5 (frequent) was based on SoCalGas' current knowledge of the business and historical experience. As mentioned above, SoCalGas could experience a turnover rate of over 36% of its employees in a five-year period, including more than 50% of managers and executives. In addition to the retirement-related turnover, SoCalGas expects additional turnover due to a higher number internal moves and exits related to an increase in millennial hiring. The potential for a skills gap in critical job functions may increase the risk of a safety-related incident if SoCalGas conducts the baseline activities without enhancements further described in Section 5 below. Without an adequate workforce with the right skills, SoCalGas is at risk to experience health, safety, and environmental consequences, including, but not limited to, permanent or serious injuries and illnesses. Therefore, a frequency of an event occurring every 1-3 years is reasonable. SoCalGas needs to update the company's practices to strategically plan for a changing workforce.

4 Baseline Risk Mitigation Plan[13]

As stated above, the Workforce Planning risk covers the risk of not having an appropriate workforce with the right skills to meet business needs due to the acceleration of workforce attrition and changing business needs. The 2015 baseline mitigations discussed below include the current evolution of SoCalGas' management of this risk. The baseline mitigations have been developed over many years to

[13] As of 2015, which is the base year for purposes of this Report.

address this risk. They include the amount to comply with laws that were in effect at that time. SoCalGas' mitigation plan for this risk includes the following controls:

- Workforce Planning
- Knowledge Transfer
- Training
- Training – Technical Non-HR
- Succession Planning

SMEs from the Corporate Security and Human Resources departments collaborated to identify and document them. These controls focus on safety-related impacts[14] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018,[15] as well as controls and mitigations that may address reliability.[16] Accordingly, the controls and mitigations described in Sections 4 and 5 primarily address safety-related impacts. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Workforce Planning incidents, not just the scenario used for purposes of risk scoring.

SoCalGas' Workforce Planning mitigation plan addresses each of these components as described below.

1. <u>Workforce Planning</u>

Conducting Workforce Planning provides SoCalGas with the ability to identify, then focus on critical roles within the organization and distinguish the skills needed to adequately perform those jobs. Critical roles are considered to be those roles that have significant safety and operational consequences (e.g., roles in departments such as System Projection, Gas Operations, Customer Services, etc.). Workforce Planning also helps with employee development so that employees have the right skills for current and future jobs within SoCalGas. Workforce Planning aligns with all business units and incorporates the succession planning efforts for a more holistic approach and to better anticipate current and future workforce needs. Not conducting comprehensive Workforce Planning, such as skills assessment, critical role identification, or operational headcount planning, can result in not having enough people and/or the right skills to prevent a safety-related incident.

2. <u>Knowledge Transfer</u>

SoCalGas implements knowledge management strategies to provide employees with the structure, support, and resources necessary to transfer unique knowledge related to critical jobs. Knowledge transfer plans are designed particularly for employees who transition out of critical roles.

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[14] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[15] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal of RAMP is to "make California safer by identifying the mitigations that can optimize safety."
[16] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

3. Training

Leadership training, such as Essentials of Supervision, Leadership Training Camp, and the Leadership Challenge, is necessary to communicate the safety tone at the top and echo the principles stated in API's Recommended Practice. Due to increased retirements and movement throughout the company, equipping management with the necessary leadership skills, such as communicating SoCalGas' vision, engaging employees in the work that they do, and instilling our safety culture, is essential to the successful implementation of safety-related practices and risk management.

4. Training – Technical Non-HR

Since Workforce Planning is a cross-cutting risk that impacts safety across the entire company, it is important to focus attention on technical training conducted by various business units, in addition to training sponsored by HR. Technical training is covered by other RAMP risks, including Employee, Contractor, Customer, and Public Safety, Catastrophic Damage Involving High-Pressure Pipeline Failure, Catastrophic Damage Involving Medium-Pressure Pipeline Failure, and Catastrophic Damage Involving Gas Infrastructure (Dig-Ins), and includes skills training for employees to perform their jobs safely.

5. Succession Planning

As discussed above, in the next five years, over 50% of managers will be retirement eligible. This does not include all the employees who will transition to other roles, which will further exacerbate knowledge loss. Therefore, formal annual succession planning is critical over the next five years. There are efforts already in place to support accelerated development for newer employees and executives.

5 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 4 will continue to be performed in the proposed plan. SoCalGas believes that continuing the baseline mitigations alone, however, will not enable maintenance of the current residual risk level due to the trends described above regarding acceleration of inexperienced employees and leaders as a result of increased attrition. Accordingly, SoCalGas is proposing during the 2017-2019 timeframe to expand or add the mitigations addressed below.

The benefits of the identified mitigations would help identify shortages in the workforce and skill deficits in critical and leadership roles. This would enable SoCalGas to focus on and create necessary interventions to help address these gaps and to prevent the risk score from further increasing. As identified in the Section 1 above, the data suggest SoCalGas will be experiencing increased attrition both from highly tenured and newer employees, as well as high mobility within the organization, creating the potential for knowledge and skills gaps and potential labor shortages. The levels attributed to this risk are due to potential knowledge, skill, and labor gaps, that may lead to safety and operational issues.

Thus, conducting the 2015 baseline activities alone will not be enough to maintain the current level of risk, due to the changing levels of workforce proficiency.

1. Workforce Planning

Proposed activities include: (1) the development and maintenance of the workforce planning model, (2) identification of labor force gaps, development of staffing/workforce plans for business units, and skills gap analysis – including software implementation for analytics, scenario planning, critical role identification, and (3) expansion of organizational capabilities assessment to include competency work and job analysis. This includes labor and non-labor resources as well as costs associated with time for participating in the proposed activities (employee participation time in trainings, planners' time conducting workforce planning, etc.). For new activities that were added to programs (e.g., job analysis and competency modeling work, workforce planning work, software implementation), the projections were based on the cost of incremental labor and the cost for the software. These workforce planning activities will help SoCalGas appropriately plan for and staff critical, safety-related roles. Critical role identification will be an integral part of this mitigation, which will also facilitate knowledge management and succession planning mitigations below.

2. Knowledge Transfer

Activities included as part of the knowledge transfer program include continuation and expansion of knowledge management function and support, knowledge workshops and the formation of additional specialized groups within certain technical areas who have a common goal and engage on an ongoing basis (i.e., Communities of Practice[17]), technology development and implementation, and knowledge transfer plans. The projected resources were based on 2015 costs in addition to estimated vendor costs (both consulting and technology solutions) and labor costs for incremental work. The incremental labor costs are attributed to an increase in FTEs to conduct the additional activities and all employee participation costs for time spent on knowledge management activities. Because of the high number of retirement-eligible employees, the need to accelerate skills, knowledge, and development is key to the success of SoCalGas' focus on safety, especially in specialized/critical roles, such as safety-related roles like cathodic protection or gas compression maintenance roles. These knowledge transfer activities (e.g., workshops, Communities of Practice, technology development, etc.) will help SoCalGas appropriately create knowledge transfer plans for critical, safety-related roles. The expansion of these activities will be based on safety-related roles that will be identified through the proposed workforce planning activities.

[17] Communities of Practice (CoP) is a common term in knowledge management. For more information, see http://web.stanford.edu/~eckert/PDF/eckert2006.pdf.

3. Training

Maintaining core leadership training and expanding the use of technology encompass the activities proposed for Training. The activities include the expansion of Essentials of Supervision, Leadership Training Camp development costs, implementation of the Leadership Challenge, and all employee participation costs. The costs for Leadership Training Camp and the Leadership Challenge were forecasted considering 2015 costs. The costs for Essentials of Supervision were based on the estimated numbers of hours it would take to expand and revise the training as well as employee participation time. Employee participation costs were based on 2015 estimated labors hours. Moreover, a new effort to revamp/redesign current technical training using new and emerging technologies was proposed and costs for this included incremental FTEs and software to create the technology-based training solutions. Because SoCalGas is a highly regulated entity, this increases development time to train employees and enhance their productivity. These training activities will help SoCalGas appropriately address skills gaps in leadership and technical skills to promote the safe execution of work. Training for supervisors will be revised and expanded based on company safety data to help reduce employee safety incidents. Training for managers and above focuses on how to engage with employees about safety and how to instill safety culture in employees.

4. Training – Technical Non-HR

Activities within the scope of technical training include revamping and redesigning current technical training. These activities are covered by other RAMP risks including Employee, Contractor, Customer & Public Safety, Catastrophic Damage Involving High-Pressure Pipeline Failure, Catastrophic Damage Involving Medium-Pressure Pipeline Failure, and Catastrophic Damage Involving Gas Infrastructure (Dig-Ins). These activities are included in the Workforce Planning risk to address the cross-cutting nature of this risk and illustrate the impact Workforce Planning has on safety across the entire organization. In addition to the activities proposed by the various RAMP risks for technical training, the Workforce Planning risk also proposes the development of a Management Technical Training program to be offered to all new front line supervisors since currently there is no formal technical training available to front line supervisors. These activities would help develop the technical skills and increase job specific procedural knowledge for employees and supervisors, thereby decreasing the rate of safety-related incidents. Front line supervisors oversee processes that may be hazardous to employees and/or the public; therefore, this proposed training will help minimize potential safety incidents.

5. Succession Planning

Succession planning forecasted activities and costs include the time value for all employees who are part of the succession planning process as well as incorporating discussions about critical roles/employees and knowledge mapping and transfer plans. The forecast for succession planning was based on a trend, since there was approximately a 3% increase in costs per year, establishing a clear upward trend. There are also Succession Planning related labor costs for an additional FTE to help with the succession planning process for critical roles. While there are efforts already in place to support accelerated development for newer employees and executives, the same amount of effort is not focused on mid-level employees. It is essential that SoCalGas not only focuses on accelerating advancement and development for the new employees and executives, but also mid-level employees as they will likely take over key roles for retiring employees. For example, a mid-level manager or technical expert who possesses critical knowledge currently would not participate in the succession planning process which creates a risk of knowledge loss if the employee vacates the role. Thus, planning for successors of those in critical roles will help to proactively provide training in advance and mitigate knowledge gaps that could lead to safety incidents, as SoCalGas currently does not currently conduct succession planning for any role below the director level.

6 Summary of Mitigations

Table 3 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) control addresses, and the 2015 baseline costs for Workforce Planning. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SoCalGas does not account for and track costs by activity, but rather at an organizational level, based on cost centers. For the purposes of the RAMP, SoCalGas determined the costs provided in Table 4 of the mitigation activities for this risk by considering the cost centers for all labor and non-labor dollars, including cost centers and hourly rates of those employees aiding in gathering workforce planning data, attending knowledge management-related meetings, participating in leadership and technical training, and conducting succession planning. Moreover, cost centers associated with the development of the various activities, as well as external vendor costs, were included as part of the resources noted in Table 3. SoCalGas determined the costs for 2015 and reviewed five years of historical information for years 2011-2015 to analyze patterns and trends. The O&M figures provided in Table 3 were based on costs incurred during base year 2015.

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Table 3: SoCalGas Baseline Risk Mitigation Plan[18] (Direct 2015 $000)[19]

ID	Control	Risk Drivers Addressed	Capital[20]	O&M	Control Total[21]	GRC Total[22]
1	Workforce planning tools and templates	• Improved economic environment • Aging workforce • An influx of employees who are more prone to change jobs and companies • Fundamental shifts in the business requiring new workforce skills	n/a	$2,240	$2,240	$2,240
2	Knowledge transfer tools and processes	• Aging workforce	n/a	470	470	470
3	Training i.e., employee development solutions[23]	• Employees entering leadership/ supervisory roles with little experience	n/a	1,900	1,900	1,900

[18] Recorded costs were rounded to the nearest $10,000.
[19] The figures provided in Tables 3 and 4 are direct charges and do not include company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[20] Pursuant to D.14-12-025 and D.16-08-018, SoCalGas provided the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[21] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[22] The GRC Total column shows costs typically presented in a GRC.
[23] This item was added in the 2016 registry as a separate item to address overall employee development solutions designed to close skills gaps. In 2015, employee development solutions were included in Targeted Workforce Planning.

ID	Control	Risk Drivers Addressed	Capital[20]	O&M	Control Total[21]	GRC Total[22]
4	Training – Technical non-HR*[24]	• Employees entering leadership/ supervisory roles with little experience • Fundamental shifts in the business requiring new workforce skills	1,060	23,170	24,230	24,230
5	Formal succession planning	• Aging workforce • An influx of employees who are more prone to change jobs and companies	n/a	150	150	150
	TOTAL COST[25]		n/a	$4,760	$4,760	$4,760

* Includes one or more mandated activities

While all the controls and baseline costs presented in Table 3 mitigate Workforce Planning risk based on the current state of the workforce, some of the controls also mitigate other risks presented in this RAMP Report. Since Workforce Planning is a cross-cutting risk, it impacts several other RAMP risks. Specifically, non-HR technical training is a compilation of costs outlined in the various RAMP risks including Employee, Contractor, Customer, and Public Safety, Catastrophic Damage Involving High-Pressure Pipeline Failure, Catastrophic Damage Involving Medium-Pressure Pipeline Failure, and Catastrophic Damage Involving Gas Infrastructure (Dig-Ins).

Table 4 summarizes SoCalGas' proposed mitigation plan (which comprises both baseline and new mitigation activities) and associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SoCalGas identified potential ranges of costs in this plan, and are not requesting funding approval. The Companies will request approval of funding, in their next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC.

[24] This item is covered in other RAMP risks and is being called out here to demonstrate the cross-cutting nature of the Workforce Planning risk.
[25] The total cost does not include the average cost of technical non-HR training in the amount of $23,170 for O&M and $1,060 for capital.

The activities outlined in Table 4 include continuation of the 2015 baseline activities and SoCalGas' proposed activities for the 2017-2019 timeframe which expand or add to the baseline mitigations. The unique aspect of this risk is that continuing to do the 2015 baseline activities alone will not be enough to sustain the current residual risk score of 5,774, due to the changing environment and workforce characteristics. Therefore, many of proposed activities will help sustain the current risk level and prevent it from increasing. The incremental resources being proposed include software implementation and FTEs to help manage the additional workforce planning, knowledge management, training, and succession planning activities to help maintain the same levels as the baseline.

The proposed plan would identify workforce pressures and organizations that need additional attention in order to align training, knowledge management, and succession planning efforts so that the right people are in the right jobs with the right skills to mitigate safety risks. The proposed costs started with the baseline 2015 activities, plus costs associated with the additional activities being proposed. The 2019 costs were determined by estimating the labor and non-labor cost for each mitigation strategy based on costs and activities conducted between 2011-2015 and adding incremental activities. The range was developed to provide flexibility with regard to the exact scope and plan for the new incremental activities.

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Table 4: SoCalGas Proposed Risk Mitigation Plan[26]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[27]	2019 O&M	Mitigation Total[28]	GRC Total[29]
1	Workforce Planning	• Improved economic environment • Aging workforce • An influx of employees who are more prone to change jobs and companies • Fundamental shifts in the business	n/a	$2,48 - 3,230	$2,480 - 3,230	$2,480 - 3,230
2	Knowledge Transfer	• Aging workforce • An influx of employees who are more prone to change jobs and companies	n/a	940 - 1,210	940 - 1,210	940 - 1,210
3	Training	• Employees entering leadership/ supervisory roles with little experience	n/a	2,590 - 3,220	2,590 - 3,220	2,590 - 3,220
4	Training – Technical non-HR*	• Employees entering leadership/ supervisory roles with little experience • Fundamental shifts in the business	2,850 - 3,480	26,230 - 34,510	29,080 - 37,990	29,080 - 37,990
5	Succession Planning	• Aging workforce • An influx of employees who are more prone to change jobs and companies	n/a	230 - 280	230 - 280	230 - 280
	TOTAL COST[30]		n/a	$6,240 - 7,940	$6,240 - 7,940	$6,240 - 7,940

(white box)	Status quo is maintained
(shaded box)	Expanded or new activity
*	Includes one or more mandated activities

[26] Ranges of costs were rounded to the nearest $10,000.
[27] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018, and 2019 are the forecast years for the Companies' Test Year 2019 GRC Applications.
[28] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[29] The GRC Total column shows costs typically represented in a GRC.
[30] The total cost does not include the O&M and capital cost of technical training outside of HR in the range of $29,080 - $37,990.

Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[31] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[32]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 6). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

6.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

6.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts.

[31] D.16-08-018 Ordering Paragraph 8.
[32] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.

4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 2 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[33] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

6.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 6. They multiplied the risk reduction developed in subsection 6.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each proposed mitigation to another within the same risk. Figure 2 shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 4 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

6.2 Risk Spend Efficiency Applied to This Risk

SoCalGas analysts used the general approach discussed in Section 7.1, above, in order to assess the RSE for the Workforce Planning risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

The risk reduction associated with the aforementioned projects was estimated using research, proprietary data and information from SoCalGas, along with input from subject-matter experts. The current controls were analyzed as one group. Incremental mitigations were analyzed as one group, also.

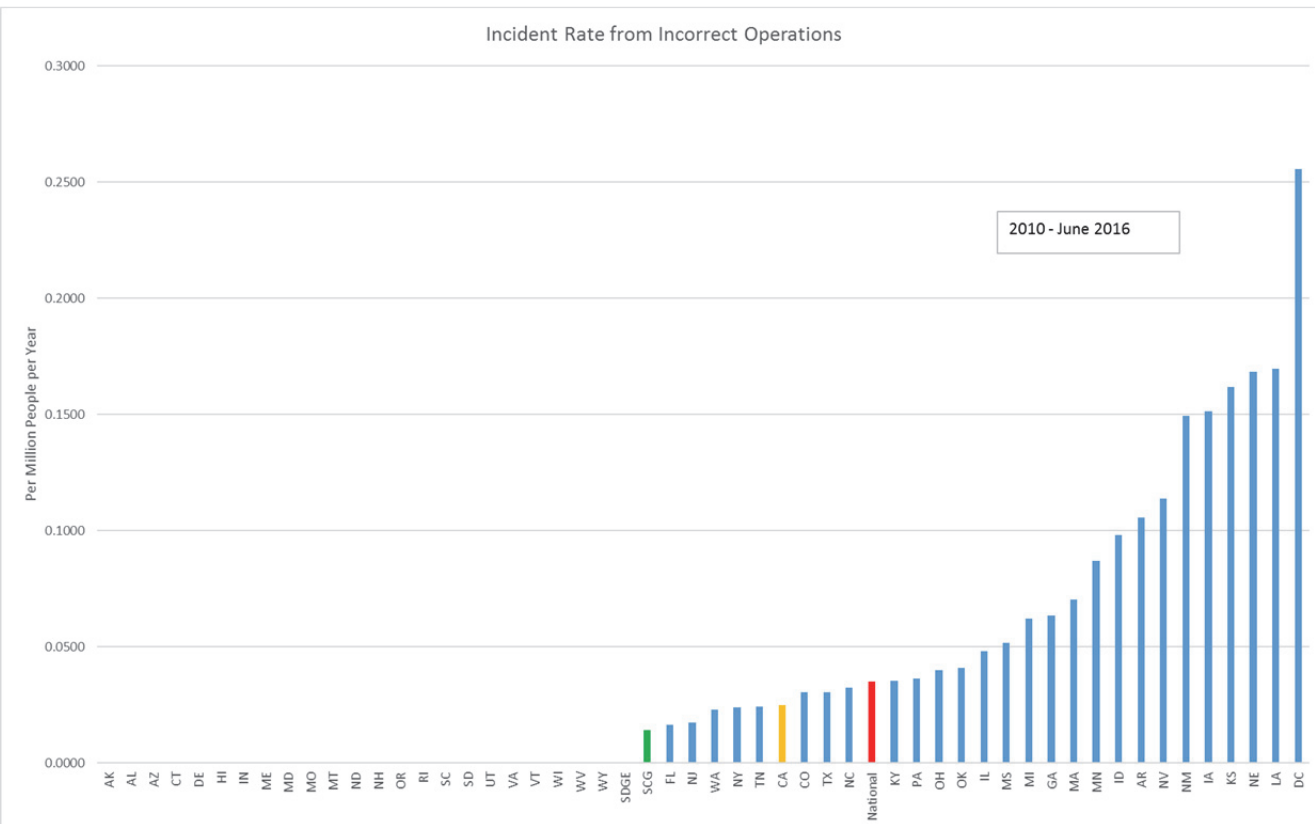
Analysis of Current Controls Grouping

[33] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

For estimating the risk reduction from current controls, the Federal Pipeline and Hazardous Materials Safety Administration (PHMSA) data of significant gas incidents caused by incorrect operations is considered a good indicator, or proxy. This is because incidents cause of "incorrect operations" is most closely related to employee human error.

With appropriate Workforce Planning controls in place, SoCalGas expects that safety incidents due to workforce planning would correspondingly decrease. Without current mitigations, it is assumed after one decade, the number of workforce planning-related incidents would equal those of the worst performing state as recorded in the PHMSA gas incident data. Using the worst performing state is a conservative approach because all major utilities have some type of basic workforce planning mitigations (e.g., training). Thus, the data represents minimum performance degradation expectations.

The chart below shows the gas incident rate from incorrect operations at SoCalGas compared to other states, SDG&E, and the national average for years 2010 to 2016. The current SoCalGas incident rate is 0.0142 incidents per million people per year while the worst performing state's rate (Louisiana) is 0.1697 incidents per million people per year over the same time period.



Using SoCalGas' service population of 21.6 million people, the incident rates can be converted to an incident expectation, given by the following calculation:

$$= \text{Expected Incident Rate} = \Delta(Incident\ Rate) * Service\ Population$$

$$= (0.1697 - 0.0142) \text{ incidents per million people per year X } 21.6 \text{ million people} = 3.358$$

The 2015 baseline assessment is that the frequency of an incident is 0.58 incidents per year. Since a decade will not have elapsed between years 2014 and 2019, the expected incident rate is divided by 3, which yields a multiplier of (3.358 / 058)/3 or 1.9. Thus, the mitigated risk estimate is the residual risk times 1.9.

Analysis of Incremental Mitigations

Typically, it is anticipated that incremental mitigations will further reduce the risk from baseline levels. However, a unique aspect of this risk is that incremental mitigations are needed to help maintain the status quo. In other words, due to the changing environment and workforce characteristics (e.g., attrition), risk reduction estimates capture how incremental activities both: 1) prevent the risk from worsening; and 2) further reduce the risk below 2015 levels.

For proposed mitigations, the change in risk reduction is calculated by considering the relationship between job proficiency and the number of expected incidents. Job proficiency was assumed to correlate to years of service.

SoCalGas is experiencing employee turnover because of retirements. As indicated by a PriceWaterhouseCoopers benchmarking study, it is estimated that 58% of management, and 32% of non-management employees are eligible for retirement through the end of year 2020. As a result, the expectation is that there is going to be a temporary drop in the level of workforce job proficiency.

An estimate of net workforce proficiency can be used as a proxy to get the benefit of proposed measures. As a significant number of people are replaced with less experienced personnel over a short period of time, it is logical to expect workforce proficiency challenges if there were a lack of appropriate mitigations to alleviate these challenges. It is assumed that there is a direct correlation between proficiency and safety.

In order to get the benefit in terms of a percent improvement in workforce proficiency, it is important to know how proficiency evolves for technical employees as a function of experience. Based on productivity information for engineers,[34] the function displayed below was derived:

[34] Source: Jaber, Mohamad. Learning Curves Theory, Models & Applications, p. 376, 2011.

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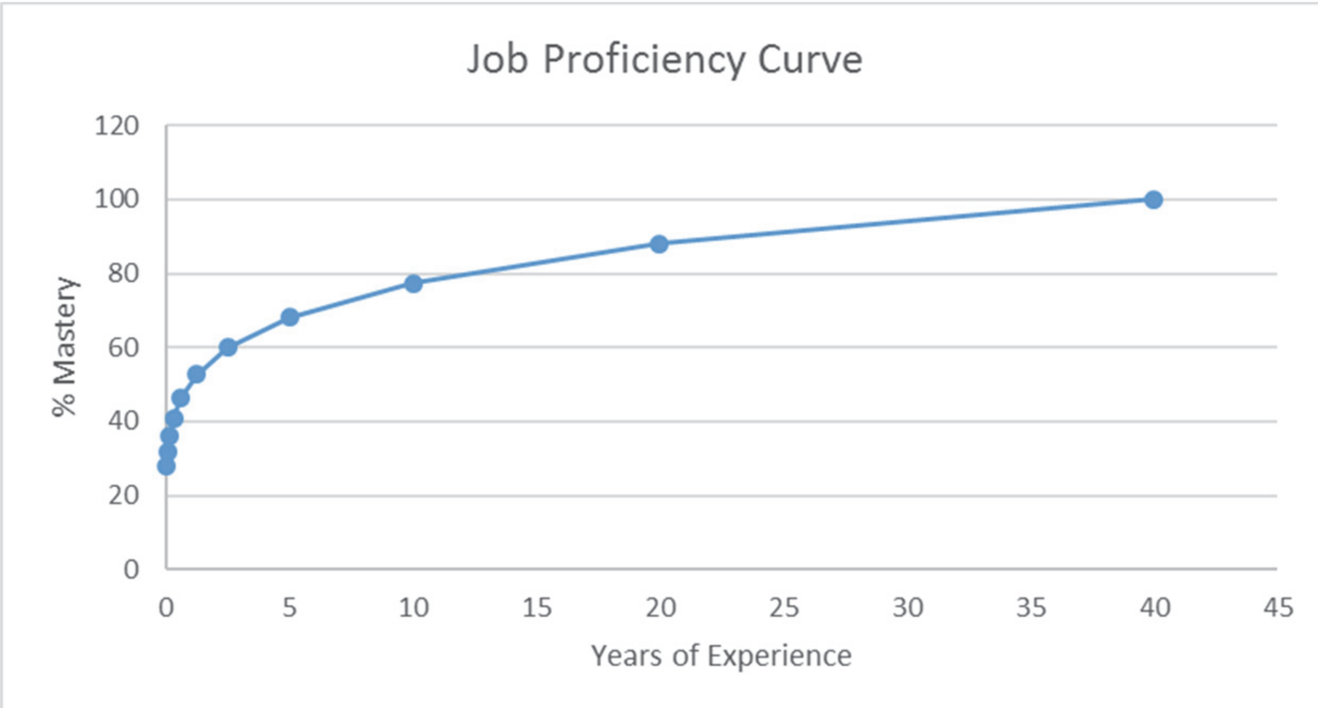
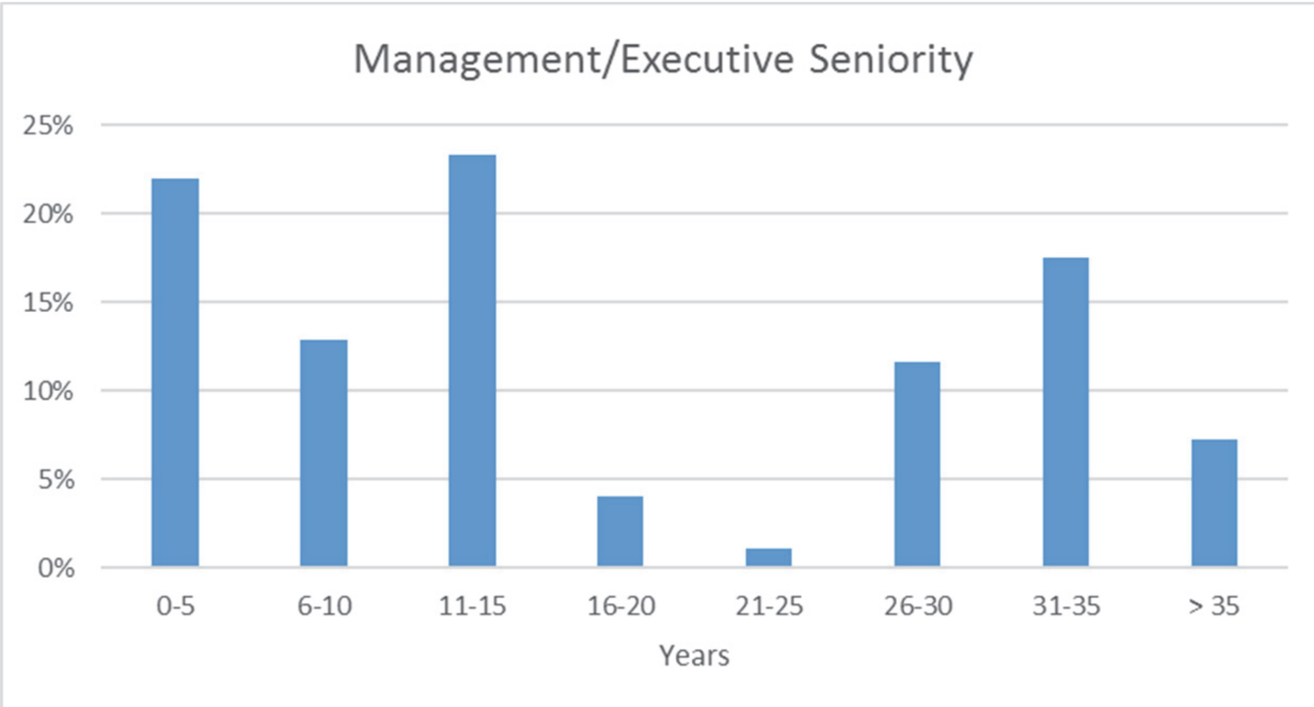
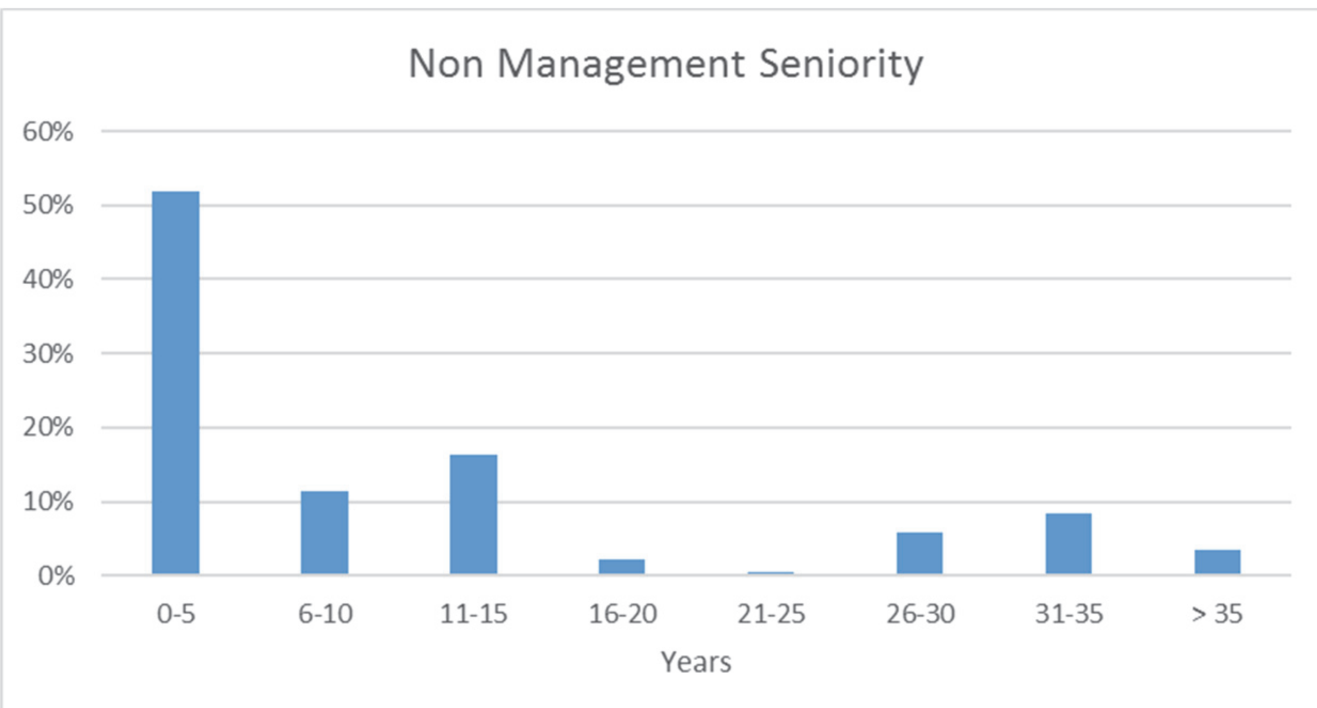


The above curve can be matched with a second curve that shows the range of work experience to get the desired net workforce proficiency. Actual work experience is not tracked for employees, but seniority is, so this will be used as a set of representative numbers. The graphs below show the current state of the workforce at SoCalGas for employees with a safety-connected job.





Merging the job seniority graphs with the proficiency curve yields the current net workforce proficiency. To derive the future state of the net workforce proficiency, the job seniority curves were modified by assuming a first in/first out pattern. The net result from these calculations is a 12% improvement.

Additionally, management estimated the incremental activities would further improve the risk by 3% for a total benefit of 15% of the residual risk.

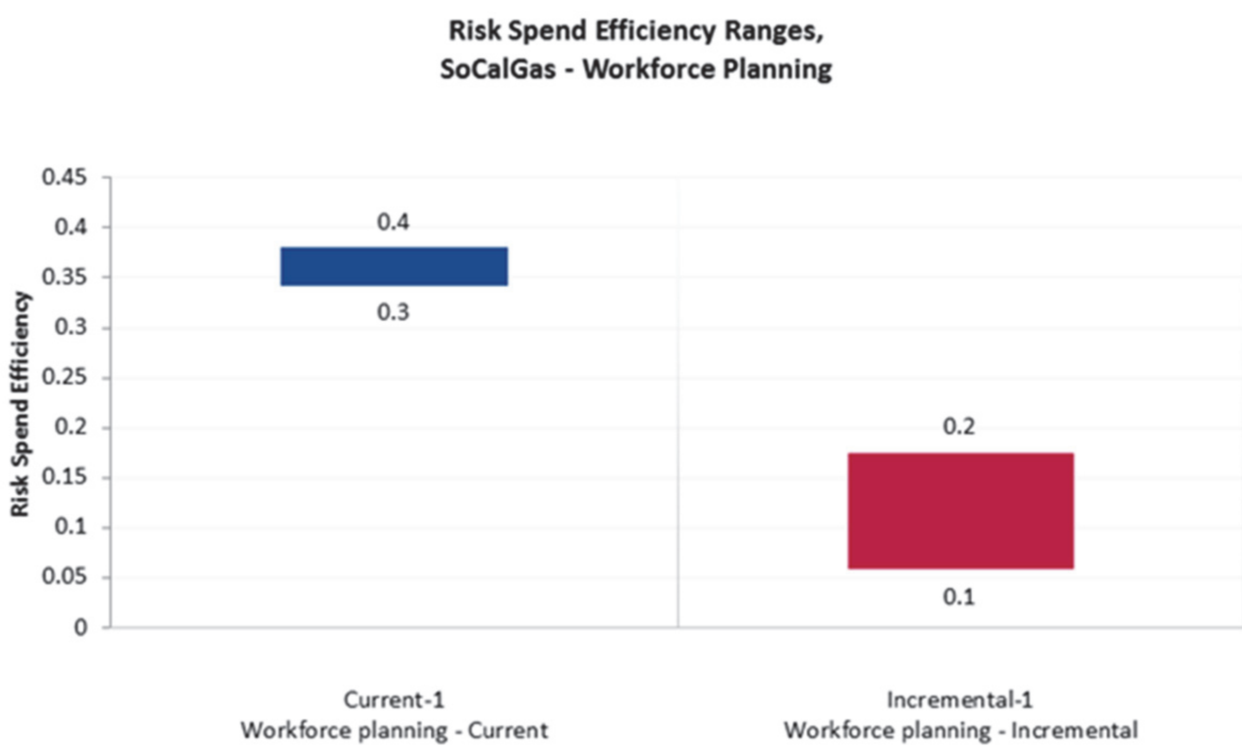
6.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SoCalGas calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Workforce planning (current controls)
2. Workforce planning (incremental mitigations)

Figure 3 displays the range[35] of RSEs for each of the SoCalGas Workforce Planning risk mitigation groupings, arrayed in descending order.[36] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

Figure 3: Risk Spend Efficiency



[35] Based on the low and high cost ranges provided in Table 4 of this chapter.
[36] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

7 Alternatives Analysis

SoCalGas considered various approaches to conducting workforce planning, knowledge management, and HR-sponsored training, including alternative strategies and resources (e.g., FTEs and software), as it developed the incremental mitigation plan for the Workforce Planning risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources. The following represents alternatives for workforce planning, knowledge management, and HR-sponsored training. The feasibility of the alternatives was considered in determining the best course of action. The viability of each alternative was determined through discussions with stakeholders. The alternatives were dismissed due to financial pressures, unique company knowledge, or lack of workforce planning data to justify the accelerated timeline, etc.

7.1 Alternative 1 – Current Workforce Planning Process

SoCalGas considered an alternative that would not implement proposed software and instead maintain the current manual workforce planning processes. This is not a feasible option because it would limit SoCalGas' workforce plans by making it static. Due to the high potential for changes, turnover, and retirements in the upcoming years, SoCalGas aims to provide workforce plans that are fluid and/or easily updatable. Real-time workforce planning data is essential in executing knowledge management, training, and succession planning activities as well; the manual process does not produce data in a timely manner nor does it have the same level of accuracy.

7.2 Alternative 2 – Changes to Knowledge Management

Another alternative SoCalGas considered was changes to knowledge management practices and tools. These changes contemplated by SoCalGas and the rationale for dismissing this alternative in favor of the proposed plan are as follows:

- Outsourcing knowledge management resources and development
    - This alternative was dismissed because the critical areas of knowledge are all SoCalGas specific and based on tenure and the understanding of how our internal processes work. External vendors or consultants may be unsuccessful in capturing the appropriate information.
- Maintaining the status quo of the succession planning process and not including the identification of critical roles for the purposes of knowledge transfer
    - This alternative would increase the risk of losing critical knowledge and gaps in creating knowledge transfer plans, especially with the number of anticipated retirements in the upcoming years.
- Expansion of Communities of Practice at a higher rate to expedite the transfer of critical knowledge
    - Detailed workforce planning data would be required to justify this alternative and the data would help determine the appropriate number of communities to launch in the future.

7.3 Alternative 3 – Accelerate Leadership Training Sessions

With respect to training, SoCalGas considered offering an increased number of leadership training sessions to expedite increasing leaders' skills. This would improve safety by verifying that company leaders are prepared and educated on how to do their job. Increased leadership training would also emphasize safety in the company culture and set the tone at the top of management that safety is a high priority. This alternative was dismissed because it would require detailed workforce planning data to justify this alternative and to specify which trainings to focus on. SoCalGas' proposed plan includes enhancements to workforce planning data though implementation of new technology and an analysis of critical roles and trainings. SoCalGas will reconsider this alternative once the proposed plan is in place.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Records Management
(Chapter SCG-8)

November 30, 2016

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Executive Summary

The Records Management risk relates to the potential public safety, property, regulatory, or financial impacts that may result from the use of inaccurate or incomplete records.

To assess this risk, Southern California Gas Company (SoCalGas) first identified a reasonable worst case scenario and scored the scenario against five residual impact categories (e.g., Health, Safety, Environmental; Operational & Reliability, etc., discussed in Section 3). Then, SoCalGas considered as a baseline, the SoCalGas mitigations in place for Records Management in 2015 and estimated the costs (costs are discussed in Section 4). SoCalGas identified the following controls as of 2015:

1. Administrative: adherence to existing records management policies and practices, including audits;
2. Training: biennial training for records management, and compliance team meetings;
3. Operational Compliance and Oversight: records management and quality assurance within business groups; and,
4. Information Management Systems: existing IT applications, including but not limited to Geographic Information Systems (GIS).

These controls focus on safety-related impacts (e.g., Health, Safety, and Environment) per guidance provided by the Commission in Decision16-08-018 as well as controls and mitigations that may address reliability.

Based on the foregoing assessment, SoCalGas proposed future mitigations. For Records Management, SoCalGas proposed to continue the four control categories from its 2015 baseline. In addition, SoCalGas proposed enhancements within each category. The enhancements include:

1. Administrative: SoCalGas proposes to hire a third-party records management expert to provide recommendations on its records management policies and practices.
2. Training: SoCalGas proposes to increase the frequency of training from biennial to annual, and to add training specific to operational asset records.
3. Operational Compliance and Oversight: SoCalGas proposes to launch a centralized operational records management organization.
4. Information Management Systems: SoCalGas proposes to continue the implementation of the Enterprise Asset Management System (EAM) solution, a solution that is intended to integrate existing records management systems, and proposes an effort to modernize its records.

Next, SoCalGas developed the risk spend efficiency (sometimes referred to as RSE). The risk spend efficiency is a new tool that SoCalGas developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The RSE leverages external records management-related criteria and subject matter expertise to determine an effectiveness of the mitigation activities.

Risk: Records Management

1 Purpose

The purpose of this chapter is to present the mitigation plan of Southern California Gas Company (SoCalGas or Company) for the risk of records management[1] with a focus on operational records that potentially implicate safety. The records management risk involves the use of inaccurate or incomplete information that could result in the failure to (1) construct, operate, and maintain SoCalGas' pipeline system safely and prudently; or, (2) to satisfy regulatory compliance requirements. However, due to the breadth of tasks associated with the management of records for the entire enterprise, this risk chapter focuses only on the enterprise-wide systems and processes for the management of operational records and is not intended to be a comprehensive discussion of all records. For example, this chapter does not address data created as a part of routine asset inspection and maintenance activities because it does not relate to the enterprise systems and processes involved in managing operational records. Other chapters included in the Risk Assessment Mitigation Phase (RAMP) Report address records-related activities, such as the chapter of Catastrophic Damage Involving Third Party Dig-Ins, Catastrophic Damage Involving a High-Pressure Pipeline Failure, Catastrophic Damage Involving a Medium-Pressure Pipeline Failure, and Catastrophic Event Related to Storage Well Integrity.

This risk is a product of SoCalGas' September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. While 2015 is used as a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SoCalGas and San Diego Gas & Electric Company (SDG&E) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a RAMP Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

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[1] SoCalGas considers records management as the practice of managing the records of an organization throughout the records' life cycle; from the time of creation to their eventual disposal. This includes identifying, classifying, storing, securing, retrieving, tracking and destroying or permanently preserving records, and recently, includes traceability, verifiability, completeness and ready availability (*See e.g.,* Decision (D.)11-06-017 at p. 19).

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[4] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP 2015 baseline does not take into account any new laws that have been passed since September 2015. However, some proposed mitigations (in e.g., Section 6) take those new laws into consideration, as practicable.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

2 Background[2]

For safety and compliance purposes, SoCalGas has implemented various recordkeeping controls for its system in accordance with, for example, the Code of Federal Regulation (CFR) Part 192, General Order (GO) 112-F, and Public Utility Code (PUC) §957 and §958. CFR Part 192 prescribes minimum safety and record requirements for pipeline facilities and the transportation of gas. GO 112-F complements and enhances the federal requirements and applies them to the state level. PUC §957 and §958 require gas corporations to prepare and submit to the Commission a proposed comprehensive valve location plan and pressure testing plan for transmission pipelines that have not been pressure tested or lack sufficient records related to the pressure testing. These plans are intended to bring transmission pipelines into modern standard requirements for pressure testing and recordkeeping.

In addition to the existing rules, SoCalGas recognizes the need to also comply with new or developing records management rules. For example, the federal Pipeline and Hazardous Material Safety Administration (PHMSA) recently issued a Notice of Proposed Rule Making (NPRM) on Pipeline Safety: Safety of Gas Transmission and Gathering Pipelines, which among other items, is intended to expand the recordkeeping requirements. See attached Appendix A for proposed "Appendix A" as part of the NPRM.

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[4] D.14-12-025 at p. 31.

[2] The records management risk and associated scores were originally determined by the Financial Systems and Compliance department (Financial Systems) within the Controller's organization because this organizational unit provides general policy oversight over company records, including administrative records. During the evaluation and development of this risk discussion, however, SoCalGas determined that operational and asset records are more likely to implicate safety than other records, such as administrative records, and shifted its focus to these operational records. Consistent with this focus, the risk was transitioned from Financial Systems to the System Integrity and Asset Management organization (System Integrity), which has greater visibility and knowledge of operational or asset records. This narrative, mitigations and proposals focus primarily on records management as it pertains to key operational activities in the Gas Operations organization.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-004, "SoCalGas is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand, analyze and categorize risks." The Enterprise Risk Management (ERM) process and lexicon that SoCalGas has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks. This includes identifying leading indicators of risk. Sections 3 through 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, Section 3 describes the risk classification, possible drivers and potential consequences of the Records Management risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SoCalGas and SDG&E in A.15-05-004, SoCalGas classifies this as a cross-cutting risk as shown in Table 1. This risk affects people and regulatory, and is a function of employee conduct and compliance.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
CROSS-CUTTING	PEOPLE REGULATORY	EMPLOYEE CONDUCT COMPLIANCE

3.2 Potential Drivers[3]

When performing the risk assessment for Records Management, SoCalGas identified potential indicators of risk, referred to as drivers. These include but are not limited:

- Insufficient training of employees
- Insufficient time or resources to devote to the appropriate records management practices
- Insufficient data back-up policies, procedures or processes

Subcategories of these potential drivers can include, for example, incomplete or incorrect records, delays in capturing asset data into records systems, enterprise systems issues, and failure of employees to follow procedures, processes or practices.

[3] An indication that a risk could occur. It does not reflect actual or threatened conditions.

3.3 Potential Consequences

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

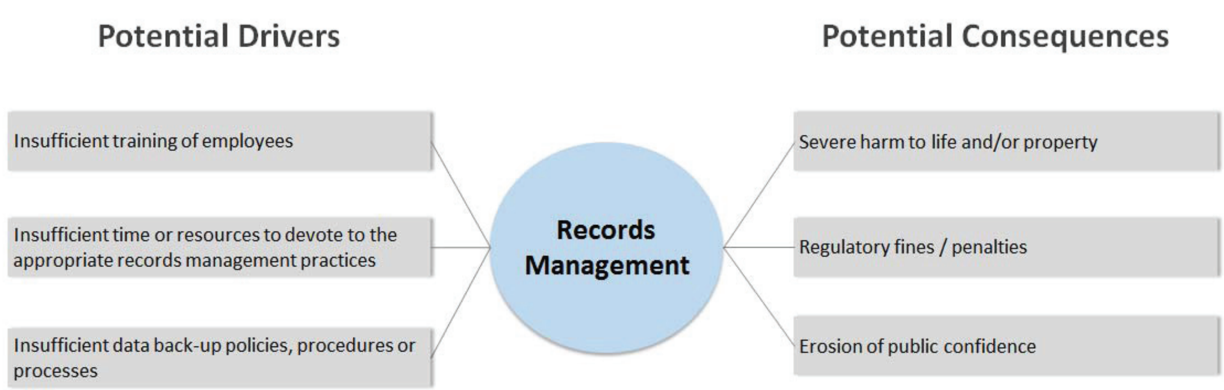
- Severe harm to life and/or property
- Regulatory fines / penalties; and,
- Erosion of public confidence.

These potential consequences were used in the scoring of Records Management risk that occurred during SoCalGas' 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown below in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SoCalGas applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



4 Risk Score

The SoCalGas and SDG&E ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Records Management as one of the enterprise risks. During the development of the risk register, subject matter experts (SMEs) assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.[4]

4.1 Risk Scenario - Reasonable Worst Case

There are many possible ways in which a records management related event can occur. For purposes of scoring this risk, SMEs used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The SMEs selected a reasonable worst case scenario to develop a risk score for Records Management:

- Employees, relying on inadequate records, mismark the location of a natural gas pipeline, which ultimately leads to a pipeline failure. This results in severe injuries and disruption of service for an extended period. This also results in a legal consequences including regulatory investigation with financial impacts.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using the scenario in Section 4.1, SMEs then evaluated the frequency of occurrence and potential impact of the risk using SoCalGas' 7X7 Risk Evaluation Framework (REF). The framework (sometimes referred to as a "matrix") includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[5] Using the levels defined in the REF, the SMEs applied empirical data to the extent it is available and/or their expertise to determine a score for each of the four residual impact areas and the frequency of occurrence of the risk.

Table 2 provides a summary of the Records Management risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

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[4] As explained in footnote 1, SMEs from the Financial Systems and Gas Operations scored the Records Management risk.
[5] D.16-08-018 Ordering Paragraph 9.

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Table 2: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
5	5	5	4	3	4,734

4.3 Explanation of Health, Safety, and Environmental Impact Score

Applying the risk scenario of a pipeline failure (described in Section 4.1), SoCalGas anticipated that such an incident could result in many permanent or serious injuries to employees or the public. Accordingly, SoCalGas scored Records Management a 5 (Extensive) in the Health, Safety, and Environmental impact.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SoCalGas gave the other residual impact areas the following scores:

- **Operational and Reliability:** SoCalGas scored the Operational and Reliability impact area a 5 (extensive). A serious incident could result in an interruption of service for greater than 10 days, and may impact a large number of customers.
- **Regulatory, Legal, and Compliance:** SoCalGas scored the Regulatory, Legal, and Compliance impact area a 5 (extensive) because of the potential for investigations and enforcement actions by the Commission and/or other local, state and federal government agencies that could result in in fines and penalties, restricted operations, or other potential remedies.
- **Financial:** SoCalGas scored the Financial impact area a 4 (major) because SoCalGas reasoned that the primary financial impact would be a result of potential litigation and/or penalties, followed by costs associated with injuries and property damage. SoCalGas estimated a potential financial impact range between $10 million to $100 million resulting in SoCalGas' score of 4.

4.5 Explanation of Frequency Score

SoCalGas SMEs used empirical data to the extent available and/or relied upon their expertise to determine that the likelihood of a Records Management incident is a 3 (infrequent), which is defined in SoCalGas' 7X7 matrix as having the potential to occur every 10-30 years in its service territory. SoCalGas assigned a score of 3 because SoCalGas records management incidents involving operational asset records are rare and are further mitigated by the Company's existing controls; at the same time, there are components of the program that can be improved. Accordingly, SoCalGas considered its score of 3 (infrequent) to be appropriate.

5 Baseline Risk Mitigation Plan[6]

As stated above, Records Management risk has potential public safety, property, regulatory, and financial impacts. The 2015 baseline mitigations discussed below includes the utilities' risk management of this risk as of September 2015. The baseline mitigations have been developed over many years to address this risk (and will continue to evolve over time). SoCalGas' baseline mitigation plan for this risk consists of four controls: (1) Administrative, (2) Training, (3) Operational Compliance and Oversight; and (4) Information Management Systems.

These controls focus on safety-related impacts[7] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[8] as well as controls and mitigations that may address reliability.[9] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily, which for the Records Management risk focuses on records management of Gas Operations. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Records Management risks, not just the scenario used for purposes of risk scoring.

1. Administrative

For this risk, the Administrative mitigation activities include SoCalGas' administration of and adherence with its record management policy and practices, resources to manage records, internal audits, and records retention.

In terms of policies, they include but are not limited to policies and systems containing records, definition and identification of records, organizational records (both paper and electronic) and document retention and disposal policy. The goal of records management policies and practices is to provide consistent responsibilities for records management, and to require the assignment of specific accountability for oversight and administration of records management.

SoCalGas also has records coordinators across the company. These record coordinators manage records and related issues, and are based within each of their respective business areas. The purpose is to give each operational area day-to-day control over records for which it has responsibility and knowledge. The record coordinators then coordinate with Financial Systems to promote and support the Company's records policies and procedures. In effect, this means that the management of operational asset records is decentralized.

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[6] As of 2015, which is the base year for purposes of this Report.
[7] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[8] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[9] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

Sempra Energy's Audit Services (Internal Audit) group performs periodic audits to verify compliance with policies related to records management and retention. Historically, these audits have occurred approximately every three years.

Lastly, SoCalGas uses physical storage space, both on-site and off-site, for records. SoCalGas manages the records storage so that it complies with SoCalGas' policies related to retention and disposal.

2. Training

SoCalGas currently provides training on records management concepts to employees biennially. Because every employee has a part in records management, including administrative records, this training reinforces guidelines about SoCalGas' records management policies and procedures. The training requirements include mandatory training on the SoCalGas record management policies and systems containing records, definition and identification of records, organizing records (both paper and electronic), retention and disposal, among other topics.

3. Operational Compliance and Oversight

Additionally, throughout the year, the records management compliance team holds meetings with records management coordinators throughout the operational areas to provide additional guidance on records management activities.

Within operations, SoCalGas resources are specifically tasked with collecting, inputting, and managing data. For example, the GIS Management organization manages two GIS databases; the first, for medium pressure pipelines operating at 60 psig or less, and the second, for high pressure pipelines operating at greater than 60 psig. The maintenance of these two GIS databases is required to reflect changes in the pipeline system based on the records created through maintenance, construction, replacement and abandonment activities for all companywide projects.

Furthermore, SoCalGas has recently created the Quality, Risk and Compliance team to provide quality assurance over the records related to high pressure construction activities including as-built documentation prior to reaching the mapping team, which includes completeness, accuracy and traceability of records.

The record coordinators, discussed in subparagraph 1 (Administrative), are also involved in operational compliance and oversight because they are based across operational units and are responsible for complying with records retention and management policies.

4. Information Management System

IMS is a broad category that encompasses the various applications that support records management such as the Geographic Information System, Work Management, Document Management and Real-time Monitoring Systems. These applications provide SoCalGas system attribute information such as design, materials and construction methods, pipeline condition, past and present operations and maintenance, local environmental factors, and failure data (*e.g*., leaks). The IMS allows employees and contractors to assist them in performing their operational work safely and accurately.

6 Proposed Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan to maintain, in most cases, the current residual risk level. In addition, SoCalGas proposes to enhance each of these mitigations, as discussed below.

1. Administrative

As SoCalGas continues to refine its records management program, SoCalGas is proposing to hire third-parties with a background on records management to provide feedback and/or recommendations on its records management policies and practices. Specifically, as SoCalGas attempts to benchmark against industry best practices, consultants may be able to assist SoCalGas determine common records management pitfalls or assist with best practices roadmaps. While the proposal for consultants is included in the administrative category, consultants may assist with any or all of the mitigation categories listed below.

2. Training

The current records management training occurs biennially. With increased focus on records management within the utility industry and a desire to further minimize risk exposure associated with safety, reliability, and other impacts, SoCalGas proposes to provide annual training. Annual training will allow key records management concepts to be communicated to employees more frequently, which refreshes employee knowledge and enhances employees' ability to more adequately prepare to manage records.

Due to industry incidents over the past several years, there is increased focus on operational asset records, specifically in the areas of accuracy, completeness, searchability, and traceability. This is because as noted in Section 3.2, Potential Drivers, human error can be a driver of incidents related to records management. While operating groups do provide task-specific training internally as well as in areas such as design, asset inspection, maintenance, construction, and mapping, SoCalGas believes additional training specific to operational asset records is a necessary mitigation to improve future risk reduction. By providing additional training specific to operational asset records and the management of those records over the entire lifespan of the record, avoidable human errors due to misunderstanding will be reduced. The additional training specific to operational asset records management would be explicitly for those individuals in Operations is meant to be between 4-12 hours of additional training for operational employees.

3. Operational Compliance and Oversight

SoCalGas proposes to launch a centralized records management organization and does so for a number of reasons. First, this will allow SoCalGas to continue executing on its proposal of EAM, discussed in detail, below, and the modernization of records while additionally identifying other potential opportunities to improve its records management program and oversight on day-to-day activities. In addition, this will allow SoCalGas to more nimbly respond to and implement new and proposed regulations, such as the PHMSA NPRM.

This organization would provide operational oversight for records management processes in specific operational areas and would provide dedicated full-time records management over the daily tasks and activities performed. In essence, records management specialists representing each functional area in Gas Operations would serve as the 'eyes and ears' of the centralized operational records management organization and be a bridge to provide real-time feedback on continual improvement of SoCalGas' records-related programs.

In order to launch this records management organization, SoCalGas anticipates needing an additional 5 to 15 employees who would effectively be records management specialists; at a minimum, one manager to oversee the team and 1-3 individuals for each functional area (transmission, distribution, storage and engineering). These resources would be in addition to Financial Systems and the record coordinators.

4. Information Management Systems

As discussed above, SoCalGas proposes to continue the process to consider the implementation of the EAM solution on a phased basis. The EAM solution is intended to be SoCalGas' core operating environment that will integrate historical and current data stored in various SoCalGas enterprise systems, including data stored in the Geographic Information System (GIS),[10] Document Management System,[11] Maintenance Management System,[12] and System Monitoring & Control.[13] EAM improves safety, integrity, transparency and availability of pipeline asset records by integrating asset data with equipment safety and handling information as well as validating the appropriate documentation is used. Experience has shown that effective integration with GIS, Work Management (WM), Material Management (MM), Document Management (DMS) and Real-time Monitoring Systems provides the ability to access, use, display, and manage pipeline related records and data in timely and efficient manner.

Overall, the EAM project implementation consists of analyzing, defining, reconciling and removing the inconsistencies of the pipeline related data in various systems, consolidate redundant systems, redefine business processes and install new hardware and software infrastructure. EAM will employ the enterprise application integration (EAI) approach. EAI is an open integration approach that will be incorporated in a hybrid approach with point-to-point application programming interfaces (APIs).

[10] GIS contains asset material attributes, locational and connectivity details, pipeline integrity assessment details, etc.
[11] Document Management System contains work order documents, pipeline condition maintenance reports, photographic records, etc.
[12] Maintenance Management System contains asset material attributes, inspection details, etc.
[13] System Monitoring & Control system contains system monitoring information, historical SCADA information, etc.

In parallel to EAM, SoCalGas proposes an initiative to digitize its records. This is an initiative that is being undertaken by many companies and government entities.[14] SoCalGas' records have evolved over the life of the operational assets, and transferring existing paper records to an electronic format (digitization) is one aspect of modernizing SoCalGas' records. In addition to digitization, SoCalGas' initiative will also add searchability and traceability functionality. Regulatory compliance standards increasingly require that utilities be able to efficiently and effectively identify specific attributes related to operational assets. As a result, having applications for records management that enable searchability and traceability functionality are important.

For example, SoCalGas will continue with its material traceability project. The material traceability project will allow for the traceability of pipe and related components from initial receipt from a supplier through installation and then will relate the operational maintenance activities until permanent removal from service. This will improve compliance with new and upcoming regulations mandating the maintenance of "traceable, verifiable, complete, and readily available" documentation for transmission pipelines as proposed in the NPRM previously mentioned.

SoCalGas has identified IT solutions to support the modernization effort. The intent of these projects is to leverage existing investments in information technology while providing improved functionality to address current operational needs in the records management area.

Currently, SoCalGas has committed resources within numerous departments charged with validating and managing the company's records, implementing the company's processes and practices, and maintaining the data systems, like GIS. This records management risk discussion will provide information about how SoCalGas plans to enhance its existing policies and practices.

7 Summary of Mitigations

Table 3 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) that a control addresses, and the 2015 baseline costs for Records Management. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SoCalGas does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 3 were estimated using assumptions provided by SMEs and available accounting data.

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[14] http://www.maximus.com/federal/technology/data-solutions/document-and-records-management.

Table 3: Baseline Risk Mitigation Plan[15]

(Direct 2015 $000)[16]

ID	Control	Risk Drivers Addressed	Capital[17]	O&M	Control Total[18]	GRC Total[19]
1	Administrative	• Insufficient training of employees • Insufficient time or resources to devote to the appropriate records management practices • Insufficient data back-up policies, procedures or processes	n/a	$650	$650	$650
2	Training*	• Insufficient training of employees	n/a	40	40	40
3	Operational Compliance and Oversight*	• Insufficient time or resources to devote to the appropriate records management practices	3,850	5,570	9,420	9,420
4	Information Management Systems*	• Insufficient data back-up policies, procedures or	12,860	5,440	18,300	18,300

[15] Recorded costs were rounded to the nearest $10,000.

[16] The figures provided in Table 3 and 4 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. These costs are also in 2015 dollars and have not been escalated to 2016 amounts.

[17] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the “baseline” costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.

[18] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).

[19] The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[17]	O&M	Control Total[18]	GRC Total[19]
		processes				
	TOTAL COST		$16,710	$11,700	$28,410	$28,410

* Includes one or more mandated activities

Table 4 summarizes SoCalGas' proposed mitigation plan and associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SoCalGas is identifying potential ranges of costs in this plan, and is not requesting funding approval. SoCalGas will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 4, the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 4: Proposed Mitigation Plan[20]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[21]	2019 O&M	Mitigation Total[22]	GRC Total[23]
1	Administrative	• Insufficient training of employees • Insufficient time or resources to devote to the appropriate records management practices • Insufficient data back-up policies, procedures or processes	n/a	$610 - 900	$610 - 900	$610 - 900
2	Training*	• Insufficient training of employees	n/a	570 - 1,720	570 - 1,720	570 - 1,720

20 Ranges of costs rounded to the nearest $10,000.
21 The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
22 The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
23 The GRC Total column shows costs typically represented in a GRC.

3	Operational Compliance and Oversight*	• Insufficient time or resources to devote to the appropriate records management practices	15,520 - 18,100	9,710 - 11,910	25,230 - 30,010	25,230 - 30,010
4	Information Management Systems*	• Insufficient data back-up policies, procedures or processes	81,120 - 99,150	5,360 - 6,550	86,480 - 105,700	86,480 - 105,700
	TOTAL COST		$96,640 - 117,250	$16,250 - 21,080	$112,890 - 138,330	$112,890 - 138,330

☐	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

The mitigations and costs presented in Tables 3 and 4 mitigate the risk of Records Management. Some of the activities also mitigate other risks presented in this RAMP Report. For example, Catastrophic Damage Involving Third Party Dig-Ins (Dig-Ins) included GIS-related costs. Because this activity mitigates Records Management as well as Dig-Ins, the costs and risk reduction benefits are being included in all applicable RAMP chapters.

1. Administrative

   This mitigation has an uncertain range of costs. The costs will depend on whether a third-party consultant is hired and how much time will be needed by that consultant to assess and provide recommendations to SoCalGas' records management policies and practices.

2. Training

   The cost to increase the frequency of the current records management training from biennially to annually is estimated to be $50,000-100,000 per year. The additional training specific to operational asset records management would be between 4-12 hours of additional training for operational employees, with an estimated cost of $500,000 - $1,000,000 annually.

3. Operational Compliance and Oversight

   As mentioned in Section 6, SoCalGas' proposed centralized, operational asset-focused organization would consist of an additional 5 to 15 employees. The expected cost of these additional resources is $500,000 - $1,500,000.

4. Information Management Systems

To support SoCalGas' modernization efforts, the proposed applications are estimated to be approximately $90 million in 2017 through 2019.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[24] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[25]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from

[24] D.16-08-018 Ordering Paragraph 8.
[25] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.

4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 2 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[26] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure 2 shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 4 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SoCalGas analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Records Management risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

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[26] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

To estimate the RSE, SoCalGas used the Maturity Model, which is a standard based on GARP developed by the ARMA International to identify and evaluate areas of records management risks. The Maturity Model is a performance-based standard that allows the user to assess the maturity of its records management program.

SoCalGas applied the Maturity Model to three different timeframes:

1. Ad Hoc: The level of maturity should SoCalGas abandon its current efforts for records management (i.e., administrative, training, operational compliance and oversight, and IT systems).
2. Current 2015: The level of maturity as of 2015.
3. Incremental 2019: The level of maturity if incremental mitigations are implemented in 2019.

The Current Controls were analyzed as one group; the Incremental Mitigations were analyzed as one group, also. Using the maturity model, SoCalGas estimated that reverting from the 2015 level of maturity to the Ad Hoc level will likely represent an approximately 600% increase in risk. On the other hand, progressing from the 2015 level of maturity to the 2019 prediction will likely represent a 55% reduction in risk.

8.3 Risk Spend Efficiency Results

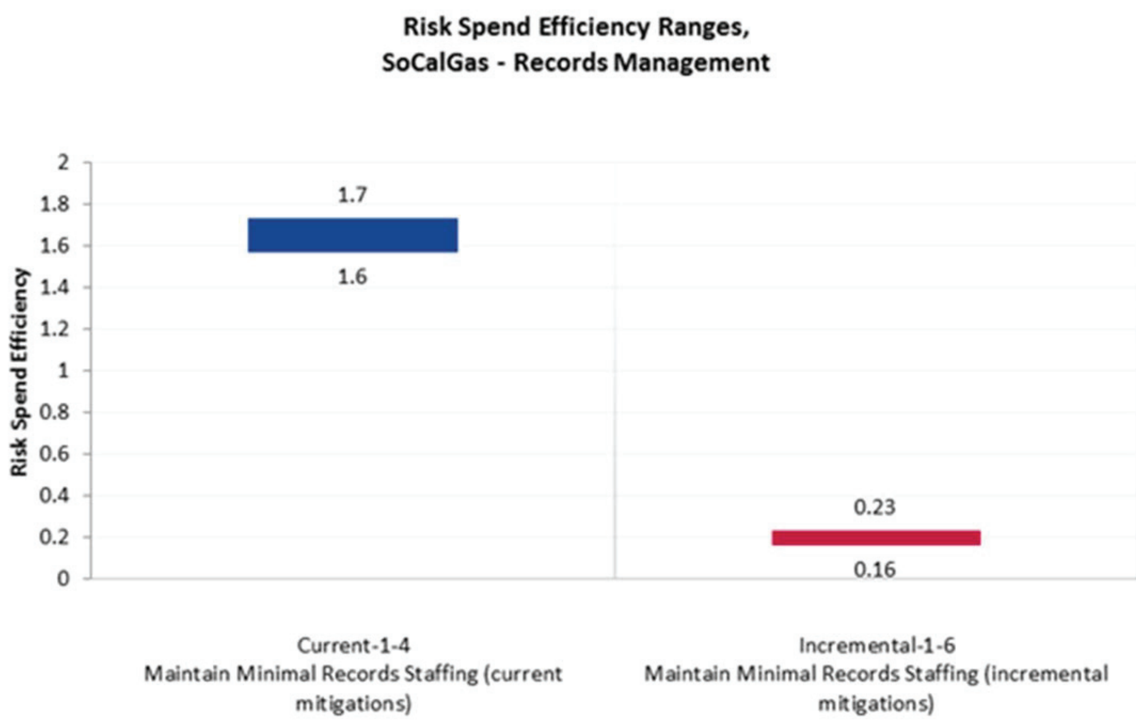
Based on the foregoing analysis, SoCalGas calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Maintain Minimal Records Staffing (current mitigations)
2. Maintain Minimal Records Staffing (incremental mitigations)

Figure displays the range[27] of RSEs for each of the SoCalGas Records Management risk mitigation groupings, arrayed in descending order.[28] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

[27] Based on the low and high cost ranges provided in Table 4 of this chapter.
[28] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 3: Risk Spend Efficiency



9 Alternatives Analysis

SoCalGas considered alternatives to the proposed mitigations as it developed the incremental mitigation plan for the Records Management risk. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources, and included discussions with key stakeholders.

9.1 Alternative 1 – Maintaining Current Practices and Policies

A potential alternative to the proposals discussed above is to maintain the current records management program, including the risk mitigations in their current state. Although current controls are strong, there may be areas that could be improved to further mitigate the risk and provide additional benefit. SoCalGas intends to leverage a records management expert (consultant) to identify any potential areas of improvement. Additionally, SoCalGas operations groups have identified specific areas for modernization of records. Maintaining the status quo may hinder these projects from moving forward.

9.2 Alternative 2 – Centralized IT Records Application

An alternative for IT applications is to implement one centralized records management IT system for all operational asset groups. This centralized system would replace all existing systems, like GIS, and implement in their place a single system. This alternative would minimize the potential for multiple systems to have differing records and may reduce some costs since SoCalGas could stop supporting many of its other IT applications. However, this alternative would also prevent each operational asset group from identifying, implementing and utilizing a system that best meets the needs of the specific operational asset group. A one-size-fits-all approach that does not allow specialization because not all records require the same attributes to be collected and retained.

Further, inputting records can take considerable time and resources. SoCalGas strives to create interfaces that allow its employees and contractors to quickly and efficiently input data into its systems. This is especially critical as it pertains to the accuracy and completeness of SoCalGas' records. Additionally, an effort of this magnitude may cause a significant disruption to the existing records management process and may adversely impact the effectiveness of current mitigations. Therefore, this alternative was rejected in favor of the proposed plan.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Climate Change Adaptation
(Chapter SCG-9)

November 30, 2016

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Executive Summary

The purpose of this chapter is to present the mitigation plan of the Southern California Gas Company (SoCalGas) for the risk of Climate Change Adaptation. The Climate Change Adaptation risk involves safety-related threats to gas infrastructure posed by global climate change, and addressing this risk through formal planning and adaptive actions. SoCalGas' 2015 baseline mitigation plan for this risk consists of the following controls:

- For 2015, SoCalGas' research partnership with the Pipeline Research Council International (PRCI) developed the geological hazard engineering program, including satellite monitoring. The geological hazard engineering program included research related to increase extreme weather events and subsidence. Also included are efforts to stabilize land movement and/or erosive forces at Storage facilities that were identified in the program.

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability. SoCalGas' proposed mitigation plan comprises both baseline and new mitigation activities.

Based on the foregoing assessment, SoCalGas proposed future mitigations. For Climate Change Adaptation, SoCalGas proposed to continue the controls, identified above, but included enhancements. The enhancements include:

1. Gas Infrastructure Resilience & Vulnerability Report
2. Geological Hazard Engineering Data Analysis and Flood Hazard Dashboard
3. Strain Gauge Installation Projects
4. Slope Stability & Erosion Control Projects

A risk spend efficiency analysis was not performed for the Climate Change Adaptation risk because there is no linkage to adaptive or corrective actions which would have any measurable effect on the probability of their predicted safety consequences.

Finally, SoCalGas considered two alternatives to the proposed mitigations, and in the final section of this chapter, SoCalGas explains the reasons those alternatives were not included into its proposal.

SoCalGas
A Sempra Energy utility

Risk: Climate Change Adaptation

1 Purpose

The purpose of this chapter is to present the adaptation assessment and mitigation plan of Southern California Gas Company (SoCalGas or Company) for the safety-related threats to gas infrastructure posed by global climate change.[1] The Intergovernmental Panel on Climate Change (IPCC) defines *Adaptation Assessment* as the practice of identifying options to adapt to climate change.[2] In addition, the IPCC also defines *Adaptation* as the adjustment in natural or human systems in response to actual or expected climatic changes.[3] This is different from *Mitigation*, which refers to human interventions to reduce anthropogenic forcing, including implementing processes to reduce greenhouse gas emissions.[4]

SoCalGas and San Diego Gas & Electric Company (SDG&E)(collectively, the utilities) take compliance and managing risks seriously, as can be seen by the amount of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of the utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[5] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

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[1] Impact of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phase 2, *available at* http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task3/task_3.1/page06.cfm.
[2] https://www.ipcc.ch/publications_and_data/ar4/wg2/en/annexessglossary-a-d.html.
[3] *See* https://www.ipcc.ch/publications_and_data/ar4/wg2/en/annexessglossary-a-d.html. Climate Change Adaptation – Adjustments to infrastructure and installation of monitoring systems in potential vulnerable infrastructure due to the threats posed by climate change. Climate Change Mitigation – Replacing Diesel operated fleet with natural gas operated fleet to reduce emissions.
[4] https://www.ipcc.ch/publications_and_data/ar4/wg2/en/annexessglossary-e-o.html.
[5] Commission Decision (D.) 14-12-025 at p. 31.

Climate change is an emerging issue projected to expand over the coming decades in the form of climate threats. As the impacts of climate change are likely to become more severe, and current climate shifts may become more long term, both public and private entities are developing adaptation plans to insulate their operations. This is particularly salient with energy resource infrastructure. For example, just in the last few years there has been an increased awareness of the impacts of severe weather events on the vulnerability of energy, communication and transportation infrastructure mainly caused by massive electric outages from these climate-driven events (severe storms, wind-storms, etc.). However, the gas system is one area of the energy infrastructure that tends to be resilient to these severe above ground threats due to its network being mostly underground.[6] As each community can be affected differently from climate change, formal planning and adaptive actions are needed to address these changes on a proactive basis. This can be done in the format of a climate adaptation plan. SoCalGas is adapting to this reality by completing a vulnerability assessment and identifying the following five threats that may have a broad reach across many departments and linkage to the mitigation plans presented in other RAMP risk chapters.

Identified Threats:

1. Increased frequency and severity of storm events
2. Sea level rise
3. Change in precipitation patterns and drought
4. Change in temperature extremes
5. Increased wildfire frequency and intensity

To address the risk of Climate Change Adaptation, SoCalGas focused on the drivers of climate change and the potential resulting impacts, which in turn yielded the adaptation assessment and mitigation efforts presented in this chapter. This chapter establishes the mitigation efforts that SoCalGas implemented in 2015 and the proposed subsequent efforts through 2019. In addition, this risk chapter will also address the connection and collaboration between the Climate Change Adaptation risk and other risk chapters in the RAMP, which describe mitigation efforts related to the safety of employees, the public, and the gas infrastructure. These other RAMP chapters are *Catastrophic Damage Involving High-Pressure Gas Pipeline Failure*, *Catastrophic Damage Involving Medium-Pressure Gas Pipeline*

[6] With a more protected and resilient underground system, natural gas can become a source of energy for many consumers when electricity infrastructure is interrupted. For example, one can use natural gas to generate electricity locally using distributed generation from fuel cells, micro-turbines and/or combined heat and power system. Also, vehicles and associated fueling infrastructure not wholly dependent on electricity either directly or indirectly can be more resilient to climate change threats. A fleet and fueling infrastructure where a company uses renewable natural gas or hydrogen to fuel their alternative fueled vehicles can further support mitigating the impacts of climate change by decarbonizing or reducing the carbon intensity of vehicle fuel while supporting long term resilience to climate change.

Failure, and the risk of *Employee, Contractor, Customer and Public Safety*. Please refer to these RAMP chapters for additional information about their specific risk mitigation plans.

Furthermore, climate risks are realized over long-term periods, and SoCalGas intends to continue its expansion of knowledge. It is not the role of SoCalGas to question the validity of climate change, but rather to interpret physical data and results of climate studies to responsibly determine the potential effect of said data on SoCalGas assets. Additionally, SoCalGas' current, not future, mitigation efforts to reduce its greenhouse gas emissions were not included in this RAMP chapter because this chapter is presenting the adaptation assessment and mitigation efforts for climate change adaptation, and not for climate change mitigation, as discussed above.

2 Background

SoCalGas conducted a literature review of sources, including federal and local studies. These sources include: (1) Impact of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study Phase 2, (2) Measuring Disaster Resilience: The Impact of Hurricane Sandy on Critical Infrastructure Systems, (3) Comparing the Impacts of Northeast Hurricanes on Energy Infrastructure, (4) the SDG&E Vulnerability Report and (5) the SoCalGas San Joaquin Valley Piping System Ground Deformation Geological Engineering study.[7] In 2015, SoCalGas identified potential regional risks due to climate change to its gas infrastructure, primarily the transmission pipelines. The transmission pipelines, which operate at a high pressure, were the initial target for assessment in 2015 because a failure or rupture due to a climate change-related risk may potentially result in a catastrophic event compared to a failure on medium-pressure pipelines.

The initial assessments led SoCalGas to focus on transmission pipelines in three major areas of the SoCalGas territory: the San Joaquin Valley, selected for its history of drought and subsidence, the Cajon Pass corridor, selected due to its history of landslides, and the Coastal Valley, also selected based on its history of landslides and mudslides. This information was reviewed by subject matter experts within the Company to verify, validate, and determine additional adaptation assessments needed. Within these

[7] "Impact of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phase 2," *available at* http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task3/task_3.1/page06.cfm; "Measuring Disaster Resilience: The Impact of Hurricane Sandy on Critical Infrastructure Systems," Paper by Tina Comes and Bartel Van de Walle, *available at* http://www.iscramlive.org/ISCRAM2014/papers/p18.pdf; "Comparing the Impacts of Northeast Hurricanes on Energy Infrastructure," Office of Electricity Delivery and Energy Reliability, U.S. Department of Energy, *available at* http://energy.gov/sites/prod/files/2013/04/f0/Northeast%20Storm%20Comparison_FINAL_041513b.pdf; "SDG&E Vulnerability Report," Department of Energy Partnership for Energy Sector Climate Resilience; "SoCalGas San Joaquin Valley Piping System Ground Deformation Geological Engineering Study," SoCalGas Geological Hazard Engineering Program.

three major areas, SoCalGas initiated projects to monitor land movement and respond to El Niño events, specifically landslides or mudslides.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Applications (A.) 15-05-004, "SoCalGas is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[8] The Enterprise Risk Management (ERM) process and lexicon that the Companies have put in place were built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Companies are committed to increasing the use of quantification within its evaluation and prioritization of risks.[9] This includes identifying leading indicators of risk. Sections 2 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Climate Change Adaptation risk.

3.1 Risk Classification

Consistent with the taxonomy presented by the Companies in A.15-05-004, SoCalGas classifies this risk this as a cross-cutting risk that affects both people and business function that stems from changes in global climate patterns not consistent with long-standing historical trends. The risk classification is provided in Table 1 below.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
Cross-cutting	People/Underground/Above-ground Facilities	Global temperature rise/Rainfall patterns

3.2 Potential Drivers[10]

When performing the risk adaptation assessment for Climate Change Adaptation, SoCalGas' subject matter experts (SMEs) assessed literature sources and locations to identify the potential leading indicators or factors of climate change, referred to as drivers. These high level climate change drivers were essential to identifying the five threats summarized in the Purpose section. By understanding these drivers, the five identified threats and their consequences, SoCalGas can then assess the potential impact to safety of the public, customers, contractors, and employees and the safety and reliability of the gas

[8] A.15-05-002/004, filed May 1, 2015, at p. JMD-7.
[9] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[10] An indication that a risk could occur. It does not reflect actual or threatened conditions.

infrastructure. The potential consequences are described in Section 3.3. It is important to note that climate change in itself is a driver to the realization of events discussed in other RAMP chapters as discussed above, such as a mudslide or landslide that results in pipeline failures. Nonetheless, potential drivers of climate change are listed below as the focus of this chapter, which in turn can result in the five threats.

Potential Drivers

- Increase in global temperatures[11]
- Storm Surge[12]

Identified Threats:

- Increased frequency and severity of storm events
  - Increased extreme weather events including, but not limited to, wind storms and heavy rainfall (El Niño events)
- Sea level rise
  - Coastal flooding due to sea level rise
- Change in precipitation patterns and drought
  - Subsidence due to drought/groundwater depletion
  - Effectiveness of Cathodic Protection systems diminish with drier soils
  - Landslides and mudslides due to drought induced vegetation loss in conjunction with changing rainfall patterns.
    - Reduce access to pipeline Right of Ways (ROWs)
- Change in temperature extremes
  - Increased electric generation and demand from natural gas
- Increased wildfire frequency and intensity
  - Weakened soil structure and erosion, which can expose underground pipelines

3.3 Potential Consequences

The natural gas system tends to be resilient to climate change threats because it is mostly underground and most impacts are above ground. If one looks at recent incidents, such as Hurricane Sandy affecting areas with gas infrastructure, those natural gas systems remained essentially intact and were resilient and

[11] Impact of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phase 2: http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task3/task_3.1/page06.cfm.

[12] Impact of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coat Study, Phase 2: http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task3/task_3.1/page06.cfm.

reliable in these above ground weather-related events.[13] Nationally, unlike the electric system that will have more regional wide impacts from above ground driven climate change events, natural gas systems tend to be impacted in isolated or distinct segments.

Table 2 below summarizes the key threats, events, and potential consequences that can occur as a result of climate change. These potential consequences, in a reasonable worst case scenario, could impact gas system planning and design, operation and maintenance, and emergency response in multiple departments in SoCalGas.

Table 2: Threat, Events, and Potential Consequences

Threat	Events	Potential Consequences
Increased Frequency and Severity of Storm Events	Storm Surge (El Niño events), Flooding, high winds, and heavy snow.	1. Increased frequency of emergency response from Gas Emergency Centers (GECs) and SoCalGas crews. 2. Levee erosion or failure causing asset repair, replacement or relocation to low-lying above and below ground gas assets. 3. Exposure of underground pipelines.
Change in Precipitation Patterns and Droughts	Subsidence, Landslides, Mudslides, weakened soil structure, drought induced vegetation loss.	1. Horizontal subsidence cause compressive stresses resulting in buckling of gas pipelines.[14] 2. Exposure of underground pipelines. 3. Reduce access to pipeline Right of Ways. 4. Effectiveness of cathodic protection system diminishes which can lead to increased corrosion. 5. Damage on pipelines in bridges or spans due to mudslides.
Sea Level Rise	Erosion, coastal inundation and flooding potential.	1. Levee erosion or failure causing asset repair, replacement or relocation to low-lying above and below ground gas assets. 2. Exposure of underground pipelines.

[13] "Comparing the Impacts of Northeast Hurricanes on Energy Infrastructure," Office of Electricity Delivery and Energy Reliability, U.S. Department of Energy, *available at* http://energy.gov/sites/prod/files/2013/04/f0/Northeast%20Storm%20Comparison_FINAL_041513b.pdf.
[14] SoCalGas is not aware of research indicating that the climate change threats noted would result in horizontal subsidence; however, oil extraction and water extraction can potentially cause subsidence.

Change in Temperature Extremes	Increase natural gas demand for electric generation for meeting more cooling days or air conditioning (HVAC) demand. Increased ambient temperatures.	1. Increased cycling of compressor station and maintenance schedules along with design requirements for Compressor Stations to support the increased cycling. 2. Damage on pipelines in bridges or spans due to thermal expansion.
Increase Wildfire Frequency and Intensity	Wildfires, vegetation loss, weakened soil structure, and landslides.	1. Increased frequency of emergency response from GECs and SoCalGas crews including standby to prevent damages to infrastructure by third parties responding to the fires. 2. Increased customer outages. 3. Increased risk of erosion and landslides due to vegetation loss.

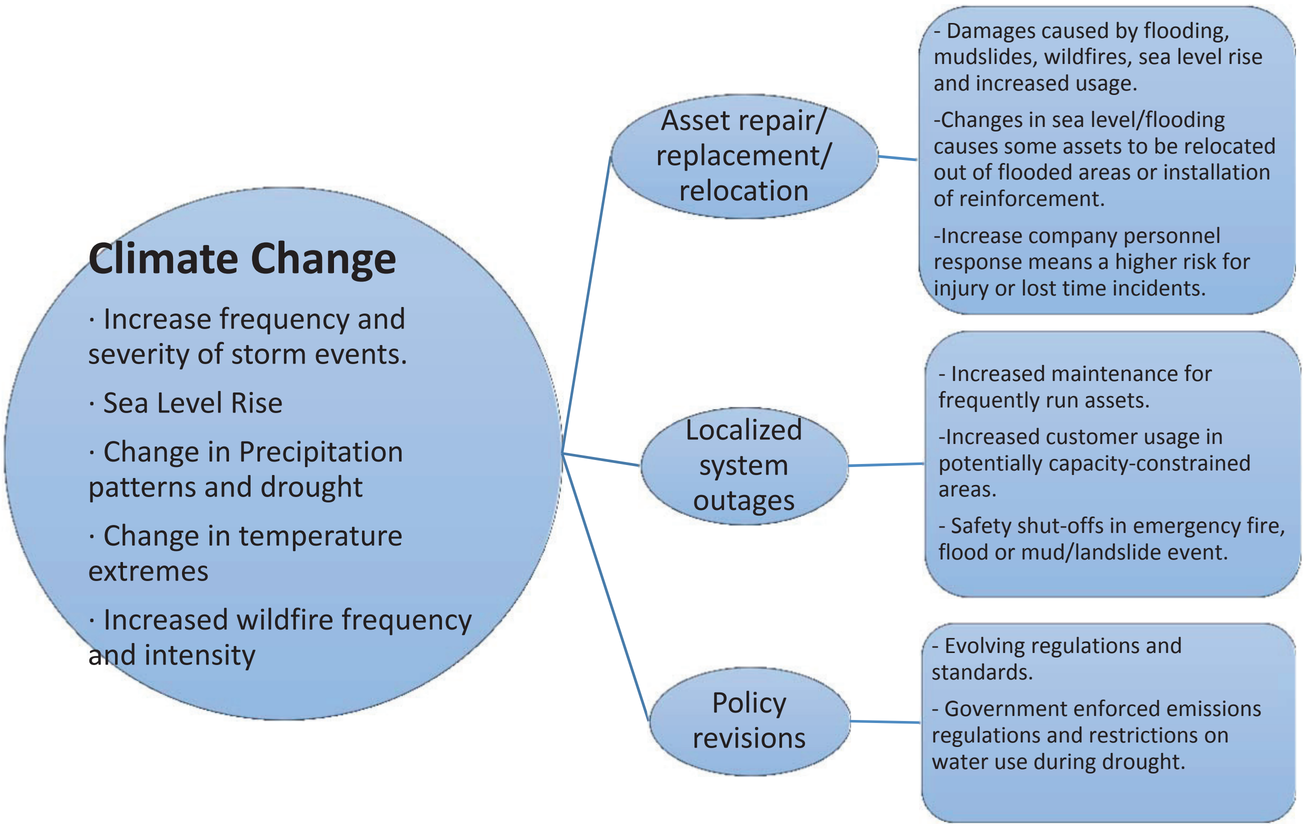
These potential consequences were used in the scoring of the Climate Change Adaptation risk that occurred during the Companies' 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Chart[15]

Figure 1 shown below is to pictorially depict the risk of Climate Change Adaptation. The large dot to the left illustrates the drivers that lead to a risk event, and the right side shows the potential consequences of a risk event. SoCalGas developed this risk chart for the Climate Change Adaptation risk to summarize all the information provided above.

[15] Climate change is a potential driver that can lead to a risk event. For example, a pipeline rupture (risk event) could occur because climate change may affect cathodic protection. Unlike other risks identified in this RAMP Report represented in the traditional bow tie diagram as the risk event, climate change as a driver did not suit that representation.

Figure 1: Risk Chart



4 Risk Score

The Companies' ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Climate Change Adaptation risk as one of the enterprise risks. During the development of the risk registry, SMEs assigned a score to this risk,[16] based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a Climate Change Adaptation threat can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and

[16] SoCalGas Risk Score was adopted from the risk assessment conducted by SDG&E.

frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Climate Change Adaptation:

- An extreme rain event known as El Niño has hit the SoCalGas territory after several years of drought resulting in high risk areas giving way to land/mudslides and flooding in low-lying areas. There are damages to access roads and multiple exposures of high pressure pipelines along with one of the pipelines failing. Multiple-year projects are required involving extensive permitting and repairs to restore the infrastructure with millions of dollars in costs.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using the Companies' 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[17] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the Climate Change Adaptation risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

[17] D.16-08-018 Ordering Paragraph 9.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
4	5	4	5	3	2,656

4.3 Explanation of Health, Safety, and Environmental Impact Score

A score of 4 (Major) was given in the Health, Safety, and Environmental impact area as there could likely be life threatening injuries based on the risk scenario if the public, customers, employees or contractors were near a damaged pipeline. A 5 (extensive) did not seem appropriate as it would have to involve many fatalities and/or injuries with many line ruptures occurring within the geological hazard threat area, which would likely be an isolated incident in areas not heavily populated.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SoCalGas gave the following scores to the remaining impact categories:

- **Operational & Reliability**: As discussed above, the gas infrastructure tends to be more reliable and resilient to climate change. Therefore, the scoring for 2015 was driven more by the electric side of the energy system for this chapter, which scored a 5 (Extensive) because of the potential outages that could likely be over 50,000 potential customers impacted. A lower score would be appropriate for the gas side and a higher score of 6 (Severe) was not appropriate as a pipeline rupture is more likely to occur in an isolated locale rather than across multiple critical locations.[18]
- **Regulatory, Legal, and Compliance**: Climate Change Adaptation was scored a 4 (Major) because any asset damage or failure would likely result from forces of nature beyond the control of SoCalGas; however, such an event may result in regulations for the utility to monitor climate change and the potential impacts to SoCalGas infrastructure and /or update greenhouse gas policy to aid in alleviation of the effects of climate change.[19]
- **Financial**: Climate Change Adaptation was scored a 5 (Extensive) mainly due to the impacts to both electric infrastructure in SDG&E and natural gas infrastructure cost of repairs. See SDG&E Climate Change Adaptation RAMP chapter.

[18] http://www.nbclosangeles.com/news/local/Timeline-The-Northridge-Earthquake-240665071.html

[19] http://www.energy.ca.gov/2008publications/CEC-100-2008-006/CEC-100-2008-006.PDF

4.5 *Explanation of Frequency Score*

Due to its definition as an emerging risk, in determining the scores for this risk, SMEs have reviewed recent climate projections, including the IPCC Fifth Assessment Report[20] and the U.S. Global Change Research Program's National Climate Assessment,[21] to determine that significant climate change impacts will slowly build over the next 10-30 years. For this reason, the frequency score has been listed as a 3 (Infrequent).

5 Baseline Risk Mitigation Plan[22]

As stated above, Climate Change Adaptation risk involves safety-related threats to gas infrastructure posed by global climate change, and addressing this risk through formal planning and adaptive actions. The 2015 baseline mitigations discussed below includes the current evolution of SoCalGas' management of this risk. They include the amount to comply with laws that were in effect at that time. SoCalGas' mitigation plan for this risk includes the following controls:

- For 2015, SoCalGas' research partnership with the PRCI developed the geological hazard engineering program, including satellite monitoring.
- The geological hazard engineering program included research related to increase extreme weather events and subsidence.
- The efforts to stabilize land movement and/or erosive forces at Storage facilities that were identified in the program.

SMEs from the Gas Engineering and Pipeline Integrity department collaborated to identify and document them. These controls focus on safety-related impacts[23] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[24] as well as controls and mitigations that may address reliability.[25] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Climate Change Adaptation threats, not just the scenario used for purposes of risk scoring.

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[20] *Available at* https://issuu.com/unipcc/docs/syr_ar5_final_full_wcover/1?e=25405816/36622773.
[21] *Available at* http://nca2014.globalchange.gov/report.
[22] As of 2015, which is the base year for purposes of this Report.
[23] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[24] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal of RAMP is to "make California safer by identifying the mitigations that can optimize safety."
[25] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan to, in most cases, maintain the current residual risk level. In addition, SoCalGas is proposing during the 2017-2019 timeframe to expand or add the mitigations addressed below.

1. Gas Infrastructure Resilience and Vulnerability Report

   Gas Engineering will be developing a gas infrastructure resiliency and vulnerability report with the help of external experts to provide guidance to internal operations and engineering design on long-term strategies for climate change adaptation. The report can also be used to support Cities and Counties subject to Senate Bill (SB) 379,[26] which requires updates to their safety elements to address climate adaptation and resiliency. For example, this report will assess what infrastructure is vulnerable to electric outages such as fueling infrastructure for fleets. Examples of questions that are anticipated to be answered in the report could include: What impact to the Companies could occur if they cannot refuel their fleet vehicles in the event of a major electric outage? How could the Companies design a fueling infrastructure to mitigate this impact? How can the Companies design a fleet portfolio that is resilient to electric outages?

2. Geological Hazard Engineering Data Analysis and Flood Hazard Dashboard

   Gas Engineering is developing an enhanced program to automate the assessment of land movement that could cause damages to the system by linking the satellite monitoring and flood hazard data to an enterprise Geographic Information System (eGIS) and create algorithms to identify problem areas with a viewable dashboard or GIS portal. The dashboard will include overlaying data on gas systems for areas that may be vulnerable to flash flooding and landslides to help identify potential problem areas, assets impacted, gas control points and gas service impacts. SoCalGas anticipates that the dashboard can be used to view ground surface changes after weather events to potentially provide early warning of landslides or subsidence. The range of cost for this project is based on historical capital spending for one full-time equivalent (FTE) in the eGIS groups and for the cost of the annual satellite monitoring.

3. Strain Gauge Installation Projects

   Based on the initial monitoring information from 2015, Gas Engineering identified locations where strain gauges[27] need to be installed and maintained by operations for 2016-2019. Gas Engineering will continue identifying locations of the gas infrastructure where strain gauges

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[26] Senate Bill 379: http://focus.senate.ca.gov/sites/focus.senate.ca.gov/files/climate/SB_379_Fact_Sheet.pdf.
[27] When pipelines cross landslides, strain gauges are installed on the pipeline to monitor the strain in the longitudinal axis of the pipe. http://www.slopeindicator.com/stories/douglaspass-pipeline.php.

should be installed to monitor vulnerable pipelines that could be exposed to excessive stresses from land movement as new information is assessed from the geological hazard and satellite monitoring programs.

4. Slope Stability & Erosion Control Projects
SoCalGas will continue its efforts in actively working with internal operations groups responsible for the safe operation and maintenance of distribution, transmission and storage pipelines to identify projects and areas where pipelines are prone to slope instability and erosion. SoCalGas intends to identify areas, include them in the eGIS dashboard, analyze adverse effects to assets, and provide appropriate monitoring and/or mitigation for each project identified. Mitigation plans for these types of projects will include, but are not limited to, the following:
    a. Identifying emergency replacement pipe and related equipment
    b. Increase pipeline patrols
    c. Implement satellite monitoring in the areas identified
    d. Install strain gauges in area identified
    e. Complete road and storm drainage improvements
    f. Implement construction storm water management plans
    g. Alter or create channel or drainage paths
    h. Install protective structural walls or retention ponds
    i. Install tie-back systems (soil nails) coupled with shotcrete[28]
    j. Install Riprap, shot rock, or vegetation

7 Summary of Mitigations

Table 4 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for Climate Change Adaptation. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SoCalGas does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

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[28] Structural walls, soil nails, and shotcrete consist of installing passive reinforcements in existing ground to stabilize and support slopes prone to erosion, mudslides and landslides.

http://www.slopeindicator.com/stories/douglaspass-pipeline.php

Table 4: SoCalGas Baseline Risk Mitigation Plan[29]
(Direct 2015 $000)[30]

ID	Control	Risk Drivers Addressed	Capital[31]	O&M	Control Total[32]	GRC Total[33]
1	Land Movement Satellite Monitoring	• Subsidence due to drought/groundwater depletion	n/a	$210	$210	$210
2	Geological Hazard Engineering Analysis	• Increase extreme weather events including, but not limited to wind storms and heavy rainfall	n/a	20	20	20
3	Storage Field Slope Stability & Erosion Projects	• Increase extreme weather events including, but not limited to wind storms and heavy rainfall	470	n/a	470	470
	TOTAL COST		$470	$230	$700	$700

Table 5 summarizes the SoCalGas' proposed mitigation plan (which comprises both baseline and new mitigation activities) and associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. The scope of the programs and projects in Table 5 extend to the gas infrastructure in SoCalGas and SDG&E territory. It is important to note that SoCalGas is identifying potential ranges of costs in this plan, and are not requesting funding

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[29] Recorded costs were rounded to the neared $10,000.

[30] The figures provided in Tables 4 and 5 are direct charges and do not include company loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.

[31] Pursuant to D.14-12-025 and D.16-08-018, the Companies are providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.

[32] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).

[33] The GRC Total column shows costs typically presented in a GRC.

approval. The Companies will request approval of funding, in their next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC.

Table 5: SoCalGas Proposed Risk Mitigation Plan[34]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[35]	2019 O&M	Mitigation Total[36]	GRC Total[37]
1	Gas Infrastructure Resilience & Vulnerability Report	• Increased frequency and severity of storm events • Sea level rise • Change in precipitation patterns and drought • Change in temperature extremes • Increased wildfire frequency and intensity	n/a	$200 - 400	$200 - 400	$200 - 400
2	Geological Hazard Engineering Data Analysis and Flood Hazard Dashboard	• Increased frequency and severity of storm events • Sea level rise • Change in precipitation patterns and drought	n/a	800 - 2,000	800 - 2,000	800 - 2,000
3	Strain Gauge Installation Projects	• Increased frequency and severity of storm events • Change in precipitation patterns and drought	1,200 - 2,100	50 - 100	1,250 - 2,200	1,250 - 2,200

[34] Ranges of costs were rounded to the neared $10,000.
[35] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for the Companies' Test Year 2019 GRC Applications.
[36] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[37] The GRC Total column shows costs typically represented in a GRC.

4	Slope Stability & Erosion Control Projects	• Increased frequency and severity of storm events • Sea level rise • Change in precipitation patterns and drought • Increased wildfire frequency and intensity	12,600 - 14,400	n/a	12,600 - 14,400	12,600 - 14,400
	TOTAL COST		$13,800 - 16,500	$1,050 - 2,500	$14,850 - 19,000	$14,850 - 19,000

☐	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

1. Gas Infrastructure Resilience & Vulnerability Report
   Costs associated with this mitigation are based on quotes from vendors that can provide this type of assessment.

2. Geological Hazard Engineering Data Analysis and Flood Hazard Dashboard
   The range of cost for this project is based on historical capital spending for one full-time equivalent (FTE) in the eGIS groups and for the cost of the annual satellite monitoring.

3. Strain Gauge Installation Projects
   The forecast for this mitigation is based on the costs experienced to date as a proxy.

4. Slope Stability & Erosion Control Projects
   Costs associated with this area are based on the costs experienced to date as a proxy.

8 Risk Spend Efficiency

The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. A risk spend efficiency analysis was not performed for the Climate Change Adaptation risk because there is no linkage to adaptive or corrective actions which would have any measurable effect on the probability of their predicted safety consequences. Climate drivers are not “events” to be mitigated; however, they can reveal drivers of potential events or vulnerabilities. These climate change-related vulnerabilities identified in other RAMP chapters are discussed in Section 4. Risk spend efficiency calculations have been performed on the other RAMP risks that are vulnerable to the threats brought about by climate change and are analyzed in those risks, rather than in this chapter.

9 Alternatives Analysis

SoCalGas considered alternatives to the proposed mitigations as it developed the incremental mitigation plan for the Climate Change Adaptation risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources. The following represents alternatives for the incremental mitigation plan. The viability of each alternative was determined through discussions with stakeholders.

9.1 Alternative 1 – Use Publicly Available Data instead of Satellite Monitoring

SoCalGas considered reducing satellite monitoring efforts in favor of static land movement information provided by publicly available government web sites. This data would not indicate actual land movement, but instead would provide information that the area is prone to a landslide. As a result, the data would not be useful for predicting potential failure of pipelines from land movement and thus not helpful for preventing damage to pipelines.

9.2 Alternative 2 – Reduce Satellite Monitoring with the Installation of Strain Gauges

The second alternative considered was to install strain gauges to reduce satellite monitoring. This alternative is acceptable for monitoring for stresses on the pipeline once the strain gauges are installed, but would not provide information on the surrounding land movement that could impact access issues to the right-of-way.

Risk Assessment and Mitigation Phase
Risk Mitigation Plan

Catastrophic Damage Involving a Medium-Pressure Pipeline Failure
(Chapter SCG-10)

November 30, 2016

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Executive Summary

The Catastrophic Damage Involving a Medium-Pressure Pipeline Failure (Medium-Pressure Pipeline Failure) risk relates to the public safety and property impacts that can result from failure of medium-pressure pipelines.

To assess this risk, SoCalGas first identified a reasonable worst case scenario, and scored the scenario against five residual impact categories (e.g., Health, Safety, Environmental; Operational & Reliability, etc., discussed in Section 4). Then, SoCalGas considered as a baseline, the SoCalGas mitigation in place as of 2015 for Medium-Pressure Pipeline Failure and estimated the costs (baseline mitigations are discussed in Section 5, and costs are discussed in Section 7). SoCalGas identified the controls that comply with Code of Federal Regulations Part 192 and General Order 112. The 2015 baseline controls include:

- Maintenance
- Qualifications of Pipeline Personnel
- Requirements for Corrosion Control
- Operations
- Gas Distribution Pipeline Integrity Management

These 2015 controls focus on safety-related impacts (e.g., Health, Safety, and Environment) per guidance provided by the Commission in Decision (D.)16-08-018 as well as controls and mitigations that may address reliability.

Based on the foregoing assessment, SoCalGas proposed future mitigations (discussed in Section 6) for the Medium-Pressure Pipeline Failure risk. SoCalGas will continue the controls, identified above, and proposes to accelerate the activity of Distribution Integrity Management Programs (DIMP) Distribution Risk Evaluation and Monitoring System (DREAMS), a program included in the Gas Distribution Pipeline Integrity Management baseline control.

Finally, SoCalGas developed the risk spend efficiency for Medium-Pressure Pipeline Failure. The risk spend efficiency is a new tool that SoCalGas developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The five mitigations were grouped into four for purposes of calculating the risk spend efficiency. The metric used to determine the risk spend efficiency of the mitigations was based on data relating to medium pressure pipelines, including data from PHMSA and asset data. Based on a benefit-cost assessment (i.e. risk spend efficiency), the four mitigations for this risk can be prioritized as follows, from highest risk spend efficiency to lowest:

1. Compliance activities
2. Technical training
3. DIMP/Distribution integrity
4. Expanded Integrity activities

Finally, SoCalGas considered two alternatives to the proposed mitigations for the Medium-Pressure Pipeline Failure risk, and summarizes the reasons that the two alternatives were not selected as a proposed mitigation.

Risk: Catastrophic Damage Involving Medium-Pressure Pipeline Failure

1 Purpose

The purpose of this chapter is to present the mitigation plan of the Southern California Gas Company (SoCalGas or Company) for the risk of damage caused by a medium-pressure pipeline (Maximum Allowable Operating Pressure [MAOP] at or lower than 60 psig) failure event, which results in catastrophic consequences (referred to herein as Medium-Pressure Pipeline Failure). This risk concerns a gas public safety event on a medium-pressure distribution pipeline or gas facility, and focuses on routine maintenance and pipeline replacement mitigations consistent with industry standard medium pressure pipeline operations of state of the art polyethylene pipelines and cathodically protected steel pipelines.[1]

This risk is a product of SoCalGas' September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used as a base year for mitigation planning purposes, risk management has been occurring, successfully, for many years within the Company. San Diego Gas & Electric (SDG&E) and SoCalGas (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[2] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

[1] Mitigation activities addressing damage to gas infrastructure caused by third parties, also referred to as dig-ins, is not addressed in this chapter, but rather discussed in the Risk Assessment Mitigation Phase chapter of Catastrophic Damage Involving Gas Infrastructure (Dig-Ins).
[2] Commission Decision (D.) 14-12-025 at p. 31.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a potential range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

2 Background

Typically, medium-pressure distribution systems use a series of mains, larger diameter pipe, to feed service lines. The service lines are smaller diameter pipes which feed customer homes, businesses, and some commercial applications. Medium-pressure pipelines are comprised of steel or plastic material.

For safety and compliance purposes, the Code of Federal Regulations (CFR) Part 192 and General Order (GO) 112 are the leading sources, among other legal and regulatory provisions, of requirements for SoCalGas' medium-pressure pipeline. CFR Part 192 prescribes minimum safety requirements for pipeline facilities and the transportation of gas and GO 112 complements and enhances the requirements set forth on a federal level at a state level.

With regard to medium pressure lines, the Company operates over 100,000 miles of medium pressure mains and services lines. Over 50,000 miles of medium-pressure main with nearly 24,000 miles being plastic and over 26,000 being steel along with nearly 32,000 miles of plastic services lines and over 18,000 miles of steel services lines (see Table 1 below). These medium-pressure pipelines serve over 21.4 million SoCalGas consumers.

Table 1: Medium-Pressure Pipelines

Medium-Pressure Pipelines	**SoCalGas Mains**	**SoCalGas Service Lines**	**Total**
Miles of Steel	26,191	18,131	44,322
Miles of Plastic	23,990	31,971	55,961
Total Miles Medium-Pressure Pipelines	50,181	50,102	100,283

Various causes and events can lead to medium pressure pipeline failures. Factors can range from improper installation techniques or material defects, aging/environmental factors such as corrosion and fatigue, and inadequate operations or maintenance of the pipeline infrastructure. However, for the purposes of this chapter, the Medium-Pressure Pipeline Failure risk focuses on the more serious results of failures that lead to a release of natural gas with a potential hazard to life and property.

SoCalGas
A Sempra Energy utility

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-004, "SoCalGas is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand, analyze and categorize risks." The Enterprise Risk Management (ERM) process and lexicon that SoCalGas has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks. This includes identifying leading indicators of risk. Sections 3 through 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, potential drivers and potential consequences of the Medium-Pressure Pipeline Failure risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SoCalGas and SDG&E in A.15-05-004, SoCalGas classifies this risk as an operational gas risk as shown in Table 2.

Table 2: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	GAS	MEDIUM AND LOW-PRESSURE (<=60 PSI)

3.2 Potential Drivers[3]

When performing the risk assessment for Medium-Pressure Pipeline Failure, SoCalGas identified potential indicators of risk, referred to as potential drivers. The potential drivers for this risk are derived from the listing of cause categories from the Pipeline and Hazardous Materials Safety Administration (PHMSA) database, along with historical events and credible scenarios developed by Subject Matter Experts (SMEs). The potential drivers considered include, but are not limited to:

1. **Corrosion** is a naturally occurring phenomenon commonly defined as the deterioration of a material (usually a metal) that results from a chemical or electrochemical reaction with its environment.[4]

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[3] An indication that a risk could occur. It does not reflect actual or threatened conditions.
[4] Corrosion Basics, An Introduction, L.S. Van Delinder, ed. (Houston, TX: NACE, 1984).

2. **Natural Forces** attributable to causes not involving humans, such as earth movement, earthquakes, landslides, subsidence, heavy rains/floods, lightning, temperature, thermal stress, frozen components, high winds
3. **Other Outside Force Damage** is attributable to outside force damage other than excavation damage or natural forces such as damage by car, truck or motorized equipment not engaged in excavation, etc.
4. **Pipe, Weld or Joint Failure** is attributable to material defect within the pipe, component or joint due to faulty manufacturing procedures, design defects, or in-service stresses such as vibration, fatigue and environmental cracking.
5. **Equipment Failure** is attributable to malfunction of component including but not limited to regulators, valves, meters, flanges, gaskets, collars, couples, etc.
6. **Incorrect Operations** can include a pipeline incident attributed to insufficient or incorrect operating procedures or the failure to follow a procedure.

In accordance with the taxonomy of SoCalGas, the potential drivers above can be classified as an asset failure, employee incident, contractor incident, public incident, or force of nature. Table 3 below maps the potential risk drivers of Medium-Pressure Pipeline Failure to SoCalGas' taxonomy.

Table 3: Potential Operational Risk Drivers

Potential Driver Category	Potential Medium-Pressure Pipeline Failure Driver(s)
Asset Failure	• Corrosion • Pipe, Weld, or Joint Failure • Equipment Failure
Asset-Related Information Technology Failure	Not applicable
Employee Incident	• Other Outside Forces • Incorrect Operation • Pipe, Weld, or Joint Failure
Contractor Incident	• Other Outside Forces • Incorrect Operation
Public Incident	• Other Outside Forces
Force of Nature	• Natural Forces

3.3 Potential Consequences

If one of the potential risk drivers listed above were to occur resulting in a Medium-Pressure Pipeline Failure incident, the potential consequences in a reasonable worst case scenario could include:

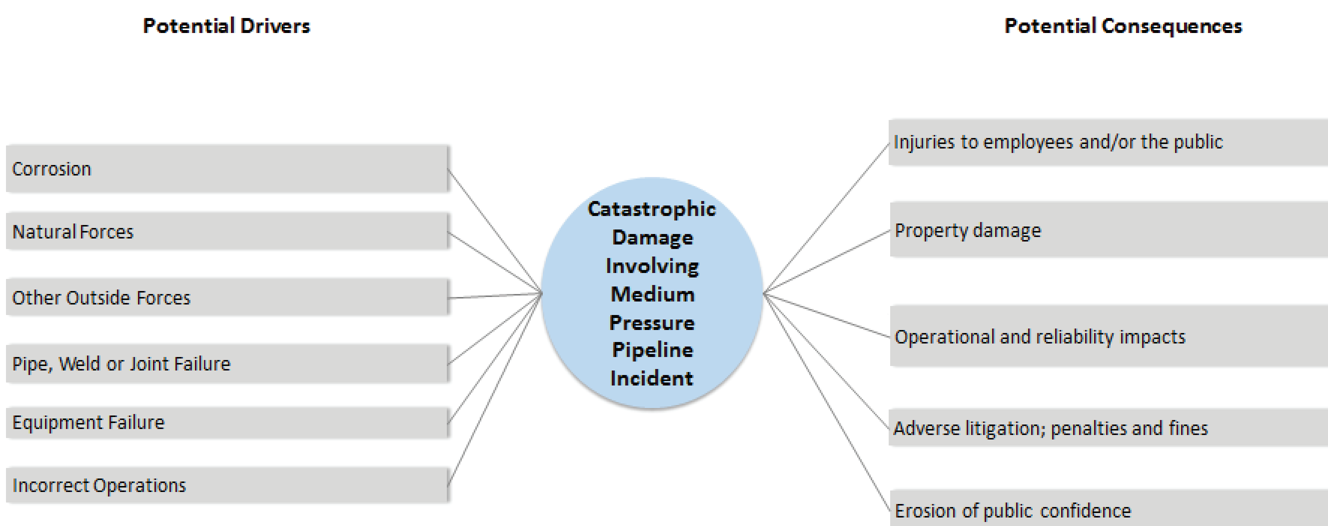
- Injuries to employees and/or the public.
- Property damage.
- Operational and reliability impacts.
- Adverse litigation and resulting financial consequences.
- Increased regulatory scrutiny.
- Erosion of public confidence.

These potential consequences were used in the scoring of Medium-Pressure Pipeline Failure that occurred during the 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SoCalGas applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Medium-Pressure Pipeline Failure as one of the enterprise risks. During the development of the risk register, SMEs assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process discussed in this section.

4.1 Risk Scenario – Reasonable Worst Case

For purposes of scoring this risk, SMEs used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The SMEs selected a reasonable worst case scenario to develop a risk score for Medium-Pressure Pipeline Failure, which was:

- A medium pressure pipeline failure due to a control device malfunction, which results in uncontrolled gas release causing injuries to employees and the public. This also results in over 1,000 customers without gas supply for at least 24 hours.

Note that the following narrative and scores are based on this reasonable worst case risk scenario; they do not address all consequences that may happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, SMEs then evaluated the frequency of occurrence and potential impact of the risk using SoCalGas' 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[5] Using the levels defined in the REF, the SMEs applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 4 provides a summary of the Medium-Pressure Pipeline Failure risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 4: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
5	3	3	3	3	2,344

[5] D.16-08-018 Ordering Paragraph 9.

4.3 Explanation of Health, Safety, and Environmental Score

The Company scored this risk a 5 (extensive) in the Health, Safety, and Environmental impact area due to the potential of an event resulting in serious injuries to the public or employees, as well as environmental impacts. For example, from 2010-2016 there have been 37 material failure/weld/fitting incidents in the United States on distribution mains, causing 2 fatalities and approximately 40 injuries.[6] On the other hand, fatalities are rarer for these types of incidents compared to other risk events such as dig-ins or failures on high-pressure pipelines. Accordingly, SoCalGas determined that a score of 6 (severe) was not appropriate.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SoCalGas scored the other residual impact areas in the following manner:

- Operational and Reliability: A score of 3 (moderate) was given in this impact category. A risk score of 3 is defined in the 7X7 matrix as greater than 1,000 customers affected, impacts a single critical location or customer, or disruption of service for one day. Based on the risk scenario, a significant customer disruption may occur in which a whole street, several homes, or a whole block loses gas service depending if the damages involved medium pressure gas main or service lines.
- Regulatory, Legal, and Compliance: SoCalGas scored this impact category as a 3 (moderate). SoCalGas scored in this manner because of potential for lawsuits and resulting financial impacts. The most common legal issue associated with this risk scenario typically involves lawsuits.
- Financial: The Company could suffer financial repercussions as a result of the other risk areas. Potential litigation and penalties from the CPUC and PHMSA are prime examples of the costs associated with the medium-pressure pipeline system failing. Though the exact cost of litigation and other potential financial consequences can vary depending on the type of incident, if a failure were to occur, the potential losses could be between $1 million and $10 million. The risk score of a 3 (moderate) is assigned due to the fact that all incidents are collateral damages of the first risk area, health, safety, and environment assigning it a secondary type of risk.

4.5 Explanation of Frequency Score

The frequency of an event occurring was assumed to be once every 10-30 years; a risk score of 3 (infrequent). According to PHMSA, between 1996-2015, the number of fatalities that have occurred associated with medium-pressure failures in California are nine (9) persons. See below.

[1]http://www.phmsa.dot.gov/portal/site/PHMSA/menuitem.6f23687cf7b00b0f22e4c6962d9c8789/?vgnextoid=fdd2dfa122a1d110VgnVCM1000009ed07898RCRD&vgnextchannel=3430fb649a2dc110VgnVCM1000009ed07898RCRD&vgnextfmt=print.

PHMSA Pipeline Incidents: (1996-2015)
Incident Type: Serious **System Type:** GAS DISTRIBUTION **State:** CALIFORNIA

Calendar Year	Number	Fatalities	Injuries
1996	1	0	3
1997	1	1	2
1998	3	0	4
1999	3	0	3
2000	2	0	2
2001			
2002	1	1	0
2003	3	1	2
2004			
2005	1	0	1
2006	1	0	1
2007	4	0	5
2008	4	1	5
2009			
2010			
2011			
2012	2	3	1
2013			
2014	2	2	1
2015	1	0	2
Grand Total	**29**	**9**	**32**

Therefore, the risk score is a reasonable estimate of how frequently these types of events happen.

5 Baseline Risk Mitigation Plan

As stated above, Medium-Pressure Pipeline Failure risk potentially impacts the public and/or property damage. The 2015 baseline mitigations discussed below includes the 2015 evolution of the utilities' risk management of this risk. The baseline mitigations have been developed over many years to address this risk and they include activities to comply with applicable laws. SoCalGas' baseline mitigation plan for this risk consists of controls based on CFR Part 192 and GO 112-E.

The primary areas highlighted in the risk registry are:

1. CFR 192 Subpart M – Maintenance
2. CFR 192 Subpart N – Qualifications of Pipeline Personnel
3. CFR 192 Subpart I – Requirements for Corrosion Control
4. CFR 192 Subpart L – Operations
5. CFR 192 Subpart P – Gas Distribution Pipeline Integrity Management

These controls focus on safety-related impacts[7] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[8] as well as controls and mitigations that may address reliability.[9] Accordingly, the controls and mitigations described in this section and in Section 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed risk mitigation plans are intended to address various events related to Medium-Pressure Pipeline Failure and are not limited to the reasonable worst case risk scenario used for the Risk Score.

1. <u>CFR 49 Part 192 Subpart M – Maintenance</u>

   Federally mandated activities provide the minimum safety requirements for medium-pressure pipelines. These activities include performing pipeline patrol, bridge and span inspections and meter set assemblies, valve and regulator inspection and maintenance on a regular basis throughout the year. These activities are intended to address threats as identified by PHMSA, specifically outside forces (vandalism, fault lines, liquefaction, etc.), equipment failure (pipeline facilities and components) and corrosion. The activities include but are not limited to:

   - Inspections of natural gas pipeline over bridges and land crossings at least once every 2 calendar years, but with intervals not exceeding 27 months
   - Each pressure limiting station, relief device, signaling device, and pressure regulating station and its equipment must be inspected and tested at intervals not exceeding 15 months, but at least once each calendar year.
   - Each valve must be checked and serviced at intervals not exceeding 15 months, but at least once each calendar year. (CFR 192.747).
     - Prompt remedial action must be taken to repair an inoperable valve unless an alternative valve is used to divert gas.
   - Region operations may perform tests and inspections at times other than the compliance period but cannot be substituted for federally mandated valve inspection in CFR 192.747.

2. <u>CFR 49 Part 192 Subpart N – Qualifications of Pipeline Personnel</u>

   The training, set forth in CFR 49, Part 192, Subpart N, requires a qualification program on covered tasks, recordkeeping, and evaluation. Each covered task is attached to a gas standard which contains a full description of what the employee/contractor will have to perform. For distribution programs, the following training subsets are the most prominent:

   1. Distribution construction technician training
   2. Energy technician distribution training

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[7] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[8] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[9] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

3. Distribution Lead construction technician
4. Distribution system protection specialist
5. Distribution lead system protection specialist

By properly training employees and contractors through the distribution technician training, the frequency of potential accidents can be lowered because the training educates the employees and contractors on proper safety techniques and standards. After a prescribed amount of years, SoCalGas employees are evaluated and requalified to reflect any changes in Company or federal standards.

3. <u>CFR 49 Part 192 Subpart I –Requirements for Corrosion Control Operations</u>

As prescribed by CFR 192 Subpart I, the minimum safety requirements include monitoring of cathodic protection (CP) areas, remediation of CP areas that are out of tolerance, and preventative installations to avoid areas out of tolerance. These activities are intended to address threats as identified by PHMSA specifically corrosion both external and internal. The following summarizes the required intervals for completing these preventative measures:

- Each pipeline that is under cathodic protection must be tested at least once each calendar year, but with intervals not exceeding 15 months, to determine whether the cathodic protection meets the requirements of §192.463.
- Each cathodic protection rectifier or other impressed current power source must be inspected six times each calendar year, but with intervals not exceeding two and a half months, to insure that it is operating.

4. <u>CFR 49 Part 192 Subpart L – Operations</u>

The minimum safety requirements prescribed by CFR 192 Subpart L – Operations include locate and mark, emergency preparedness and odorization. These activities are intended to address threats as identified by PHMSA. Locate and mark activities are specific to third party damage while emergency preparedness and odorization are intended to address all threats. The following provides the required intervals for completing these preventative measures as prescribed in Subpart L:

- To assure the proper concentration of odorant in accordance with this section, each operator must conduct periodic sampling of combustible gases using an instrument capable of determining the percentage of gas in air at which the odor becomes readily detectable

5. <u>CFR 49 Part 192 Subpart P – Gas Distribution Pipeline Integrity Management</u>

PHMSA established Distribution Integrity Management Programs (DIMP) requirements to enhance pipeline safety by having operators identify and reduce pipeline integrity risks for distribution pipelines, as required under the Pipeline Integrity, Protection, Enforcement and Safety Act of 2006. SoCalGas has implemented various Programs and Activities to Address Risk (PAARs) to address potential drivers such as corrosion, other outside forces and equipment failure, and some of the PAARs specific to this risk are discussed below.

(a) The DREAMS PAAR prioritizes certain early-vintage steel (pre-1960) and plastic (pre-1986), including Aldyl-A, for replacement. With regard to plastic, PHMSA Advisory Bulletin ADB-07-01 states that "the number and similarity of plastic pipe accident and non-accident failures indicate past standards used to rate the long-term strength of plastic pipe may have overrated the strength and resistance to brittle-like cracking for much of the plastic pipe manufactured and used for gas service from the 1960s through the early 1980s." Within the SoCalGas system, there are approximately 20,000 miles of early-vintage pipe in the distribution system. SoCalGas has implemented a risk evaluation system to accelerate replacements on a targeted basis. The risk evaluation considers the leakage history, cathodic protection (for steel), vintage of the pipe and the location using E-GIS.
   - SoCalGas mitigation includes the replacement of 17 miles

(b) The Gas Infrastructure Protection Program (GIPP) PAAR addresses potential vehicular damage associated with above-ground distribution facilities. To address vehicular damage to Company facilities, SoCalGas has identified, evaluated and implemented a damage prevention solution that includes a collection of mitigation measures to address this threat. The collection of mitigation measures includes: construction of barriers (bollards or block wall); relocation of the facility; or installation of an Excess Flow Valve. This program is responsive to PHMSA guidance indicating that operators should address low frequency, but potentially high consequence, events through the DIMP.
   - SoCalGas mitigation includes the inspection of 7,764 assets

(c) The Sewer Lateral Inspection Program (SLIP) PAAR addresses an emerging issue concerning pipeline damage associated with sewer laterals. The integrity threat comes from the use of trenchless technology during installation of pipelines. Trenchless technology provides a means of installing a pipeline without having to excavate a trench along the entire length of the pipeline. Instead of excavating a trench along the entire length of a pipeline, the operator can use advanced boring or directional drilling technology to install the pipeline from a single point of entry. An auger, or drill, is affixed to the tip of the pipeline segment and is used to bore or drill the pipeline through existing terrain.
   - SoCalGas mitigation includes 35,157 sewer lateral inspections per year and review of installation records

(d) The Distribution Riser Inspection Program (DRIP) PAAR addresses the potential failures of anodeless risers. Anodeless risers are service line components that could fail before the end of their useful lives. The anodeless riser issue has a potential consequence because they are attached to a meter set assembly (MSA), which is usually located next to a residence. There are approximately 2,600,000 anodeless riser units in SoCalGas' territory.
   - SoCalGas mitigation includes inspection and repair/replacement of 100,000 anodeless risers.

6 Proposed Risk Mitigation Plan

SoCalGas is proposing to continue with its baseline activities described in Section 5 above. In addition, SoCalGas is proposing to expand and add new mitigations to further address the risk of medium pressure pipeline incident through an incremental replacement rate of early vintage steel. The proposed activities and costs are for controls that are primarily based on the Code of Federal Regulation Part 192 and General Order 112-F state requirements.

It should be noted that the proposed activities do not account for the Notice of Proposed Rule Making (NPRM) issued by PHMSA on Pipeline Safety: Safety of Gas Transmission and Gathering Pipelines which may expand the integrity requirements beyond HCAs, require the verification of Maximum Allowable Operating Pressure (MAOP), and records requirements among other items.

The primary areas highlighted in the risk registry are:

1. CFR 192 Subpart M – Maintenance: Patrolling, Leak Survey, Pressure Limiting and Regulator Station Inspections and Maintenance, Valve Maintenance intended to address Equipment Failure and Natural Forces
2. CFR 192 Subpart N – Qualifications of Pipeline Personnel: Training and procedures intended to address Incorrect Operations
3. CFR 192 Subpart I – Requirements for Corrosion Control: Corrosion control and monitoring intended to address corrosion
4. CFR 192 Subpart L – Operations: Locate and Mark, Odorization, Emergency Preparedness, Continual Surveillance intended to address Equipment Failure, Incorrect Operations and Natural Forces
5. CFR 192 Subpart P – Gas Distribution Pipeline Integrity Management: Threat Evaluation, Risk Analysis, and Program and Activities to Address Risk of all threats

According to the 2015 end of year Department of Transportation (DOT) report, there are a total of approximately 8,000 miles of unprotected steel mains in the SoCalGas system. SoCalGas proposes to modify its DIMP DREAMS program to target a population of 2,200 miles of unprotected steel mains that have historical records of three or more leak repairs in the last 10 years. In addition, SoCalGas proposes to accelerate the current effort by replacing three times the mileage of priority pipe totaling 150 miles per year. This plan will require a step up period in which the cost will increase from a projected \$61 - 65 million in 2017-2018, and increase to about \$168 - 180 million in the year 2019. The acceleration of DIMP DREAMS aims to reduce the frequency of a potential event occurring related to this risk.

7 Summary of Mitigations

Table 5 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) addressed, and the 2015 baseline costs for Medium-Pressure Pipeline Failure. While control or mitigation activities may address both potential risk drivers and potential consequences, potential risk drivers link to the likelihood of a risk event. Thus, potential risk drivers are specifically highlighted in the summary tables.

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SoCalGas does not account for or track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 5 were estimated using assumptions provided by SMEs and available accounting data.

Table 5: Baseline Risk Mitigation Plan Overview[10]
(Direct 2015 $000)[11]

ID	Mitigation	Potential Risk Drivers Addressed	Capital[12]	O&M	Control Total[13]	GRC Total[14]
1	Maintenance*	• Asset Failure • Force of Nature • Public Incident	$2,110	$14,290	$16,400	$16,400
2	Qualifications of Pipeline Personnel*	• Contractor Incident • Employee Incident • Human Error	n/a	3,100	3,100	3,100
3	Requirements for Corrosion Control*	• Asset Failure • Force of Nature • Public Incident	3,640	10,240	13,880	13,880
4	Operations*	• Asset Failure • Contractor Incident • Employee Incident • Public Incident	10	1,310	1,320	1,320
5	Gas Distribution Pipeline Integrity Management*	• Asset Failure • Public Incident	60,090	14,530	74,620	74,620
	TOTAL COST		$65,850	$43,470	$109,320	$109,320

* Includes one or more mandated activities

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[10] Recorded costs were rounded to the nearest $10,000.
[11] The figures provided in Tables 5 and 6 are direct charges and do not include Company loaders, with the exception of vacation and sick. This is consistent with the presentation in previously GRCs. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[12] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[13] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[14] The GRC Total column shows costs typically presented in a GRC.

In developing costs, SoCalGas utilized accounting data, where available, and SMEs' high level assumptions. Generally, SoCalGas does not account for costs by activity, but rather, by cost center and capital budget code. Specifically, as it relates to training, SoCalGas does not track its employees' and contractors' labor in a manner that distinguishes when and how long an employee or contractor attended training compared to when they were performing their "typical" job function. Accordingly, for training, assumptions were used based on the known number of students that attended the safety-related distribution training, the duration of the training and a derived labor rate. Training materials and instructor costs were also included in the cost of the Qualifications of Pipeline Personnel control.

Table 6 summarizes SoCalGas' proposed mitigation plan and associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SoCalGas is identifying potential ranges of costs in this plan, and is not requesting funding approval. SoCalGas will request approval of funding, in its next GRC. As set forth in Table 6, the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

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Table 6: Proposed Risk Mitigation Plan Overview[15]
(Direct 2015 $000)

ID	Mitigation	Potential Risk Drivers Addressed	2017-2019 Capital[16]	2019 O&M	Mitigation Total[17]	GRC Total[18]
1	Maintenance *	• Asset Failure • Force of Nature • Public Incident	$6,500 - 8,220	$21,050 - 23,260	$27,550 - 31,480	$27,550 - 31,480
2	Qualifications of Pipeline Personnel*	• Contractor Incident • Employee Incident • Human Error	n/a	4,050 - 4,470	4,050 - 4,470	4,050 - 4,470
3	Requirements for Corrosion Control *	• Asset Failure • Force of Nature • Public Incident	12,900 - 16,290	19,240 - 21,270	32,140 - 37,560	32,140 - 37,560
4	Operations*	• Asset Failure • Contractor Incident • Employee Incident • Public Incident	30 - 40	1,610 - 1,780	1,640 - 1,820	1,640 - 1,820
5	Gas Distribution Pipeline	• Asset Failure • Public	356,940 - 468,240	33,390 - 41,080	390,330 - 509,320	390,330 - 509,320

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15 Ranges of costs were rounded to the nearest $10,000.
16 The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SoCalGas' Test Year 2019 GRC Application.
17 The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
18 The GRC Total column shows costs typically represented in a GRC.

	Integrity Management*	Incident				
	TOTAL COST		$376,370 - 492,790	$79,340 - 91,860	$455,710 - 584,650	$455,710 - 584,650

☐	Status quo is maintained
☐	Expanded or new activity
*	Includes one or more mandated activities

Costs for the acceleration of the DIMP programs were calculated using a zero based approach which varied from year to year. The amount of inspections, repairs, replacements, etc. are generated by the respective project manager and approved by a director. Based on previous GRC testimony as well as available resources, that number will typically be lower or higher in the cost projection in 2017-2019. For a small group, other costs in the risk mitigation template, a variation of linear regressions and averages were used based on the historical cost found in 2011-2015. For programs that did not show wide variations in expenditures year to year such as training, the cost is based on a three or five year average, whichever has a more linear behavior. For other costs not zero based, averaged, or linear trended, a cubic spline approach was used to capture varying peaks and troughs of the graph. By using costs in 2017-2019 as a point constraint, the curve was adjusted to follow the trend of the historical years 2011-2015 and ultimately “flattening” in 2019 to stabilize and reach a more linear trend.

While all the mitigations and costs presented in Tables 5 and 6 mitigate the Medium-Pressure Pipeline Failure risk, some of the activities also mitigate other risks presented in this RAMP Report, including: Catastrophic Damage Involving Third Party Dig-Ins (Dig-Ins) and Employee, Contractor, Customer and Public Safety. Because these activities mitigate Medium-Pressure Pipeline Failure as well as these aforementioned risks, both the costs and risk reduction benefits are included in all applicable RAMP chapters.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent." [19] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[20]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of RSE Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts.

[19] D.16-08-018 Ordering Paragraph 8.
[20] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.

4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 4 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[21] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another.

Figure shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 6 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SoCalGas analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Medium Pressure Pipeline Incident risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

To calculate the RSE, SoCalGas began with the five mitigations in its proposed plan:

---

[21] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

1. Maintenance
2. Qualifications of Pipeline Personnel
3. Requirements for Corrosion Control
4. Operations
5. Gas Distribution Pipeline Integrity Management

SoCalGas then analyzed and arranged these mitigations into common groupings that address similar potential drivers or potential consequences, for purposes of analysis:

(a) DIMP/Distribution integrity (current controls)
(b) Technical training (current controls)
(c) Regulatory compliance activities (current controls)
(d) Expanded Integrity activities (incremental mitigations)

For each of the four mitigation groupings used for the RSE, SoCalGas determined the preferred methodology for quantifying the RSE. The primary assumption for the RSE for the Medium Pressure Pipeline Failure risk was that performance would deteriorate in absence of the mitigation. Data from the PHMSA and asset data, where applicable, was used to model the deterioration boundaries. The appropriate data was selected based on the judgment of SMEs.

- ***Distribution Integrity***

The RSE modeling approach for distribution integrity programs was to find the level of possible performance deterioration if these programs did not exist, which would represent the baseline, inherent risk level. It is assumed that should the program not be funded, then performance would deteriorate to at best the incident rate of the worst state in the nation. The term "at best" is used because even the worst-performing states are assumed to have some programs in place.

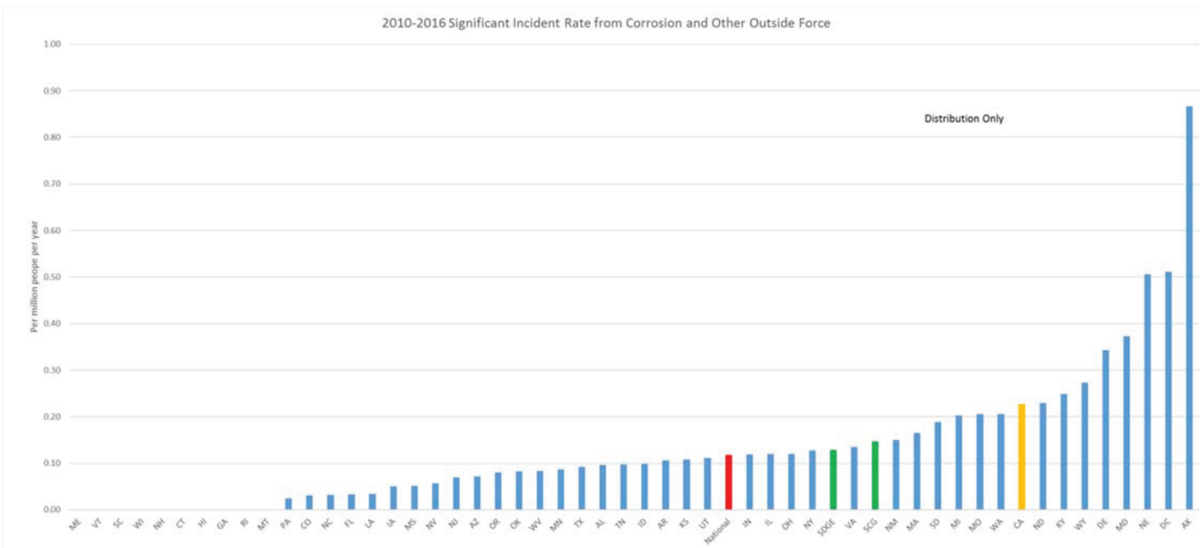
The potential drivers associated with a medium pressure pipeline incident were corrosion, and other outside forces for the DIMP programs, and corrosion and material failure of pipe or weld for the unprotected steel program. This was compared to the incident rate due to all potential drivers so as to attain the projected deterioration which is the ratio of future to current performance. Not all targeted assets will be remediated within the time period of interest. To account for this, the residual risk multiplier was prorated proportionally comparing the number of assets remediated to the total assets.

Additionally, to take into account that the worst of the poor-performing assets are targeted for replacement first, an effectiveness factor was applied that reflects the relative impact of replaced assets versus the average condition of targeted poor-performing assets.

Once the new risk score is calculated, a true-up factor is applied to account for the fact that SoCalGas' risk exposure is 6 times greater than SDG&E's exposure due to its significantly larger gas distribution system. This factor was necessary in order to compare to the SDG&E risk and score.

The chart shown below applies to the DIMP programs, and contains the pipeline failure incident rates of all 50 states, in addition to SoCalGas and the national average. SoCalGas has a rate of 0.147 incidents per million people per year, and the worst-performing state is Alaska at a rate of 0.867. Using SoCalGas' service population of 21.6 million people, the incident rates can be converted to an incident expectation, given by the following calculation:

$$
\begin{aligned}
&\mathit{Expected\ Incident\ Rate} = \Delta(\mathit{Incident\ Rate}) * \mathit{Service\ Population} \\
&= (0.867 - 0.147)\ \mathit{incidents\ per\ million\ people\ per\ year} * 21.6\ \mathit{million\ people} \\
&= 15.5\ \mathit{incidents\ per\ year}
\end{aligned}
$$



When the calculation is repeated for the unprotected steel program the number of incidents per year comes out to be 4.8.

The average number of SoCalGas incidents per year from all potential drivers for the same time period is 4.3[22], the proportion of targeted miles being addressed is 7.8%, and the assumed replacement effectiveness is 5. Putting it all together, the residual risk multiplier for the bundled set of distribution integrity programs is given by the following calculation:

$$
\begin{aligned}
&\mathit{Residual\ Risk\ Multiplier} \\
&\qquad = \mathit{Projected\ deterioration\ factor} * \mathit{Proportion\ of\ Remediated\ Assets} \\
&\qquad * \mathit{Effectiveness}
\end{aligned}
$$

$$\mathit{Residual\ Risk\ Multiplier} = \frac{15.5 + 4.8\ \mathit{incidents\ per\ year}}{4.3\ \mathit{incidents\ per\ year}} * 7.8\% * 5$$

$$\mathit{Residual\ Risk\ Multiplier} = 1.8$$

[22] Expected Incidents per year for All Causes for SCG = Current Incidents per year per million people * Service population
= 0.1987 incidents per year per million people * 21.6 million people
= 4.3 incidents per year

After applying the factor to this residual risk multiplier to align it with the SDG&E risk and score, the new multiplier becomes 11.5. Therefore, if the mitigation is not funded, the projected risk is 11.5 times the current residual risk.

- **Technical Training**

The RSE modeling approach for these programs was the same as that used for distribution integrity programs with a couple of slight differences. The first difference was that a different set of potential incident drivers was used to establish the worst state performance level. The potential drivers considered as applicable to this category were: incorrect operations. The second difference was that there is no secondary adjustment for the percentage of targeted assets and no effectiveness factor, but it was assumed that the effect of structured training takes time to fade as time and turn over increase, up to a decade. The fading effect is accounted for by dividing by 3.

For this category of projects, the residual risk multiplier is (5.5 / 4.3) X (100%) X (1) / (3) = 0.4. After applying the true-up factor to this residual risk multiplier, the new multiplier becomes 2.7. Therefore, if the mitigation is not funded, the projected risk is 2.7 times the current residual risk.

- **Regulatory Compliance Systems**

The RSE modeling approach for these programs was the same as that used for distribution integrity programs with two exceptions. The first exception was that a different set of potential incident drivers was used to establish the worst state performance level. The potential drivers considered as applicable to this category were: all causes. The second exception was that there is no secondary adjustment for the percentage of targeted assets and no effectiveness factor.

For this category of projects, the residual risk multiplier is (21.2 / 4.3) X (100%) X (1) = 4.9. After applying the true-up factor to this residual risk multiplier, the new multiplier becomes 30.7. Therefore, if the mitigation is not funded, the projected risk is 30.7 times the current residual risk.

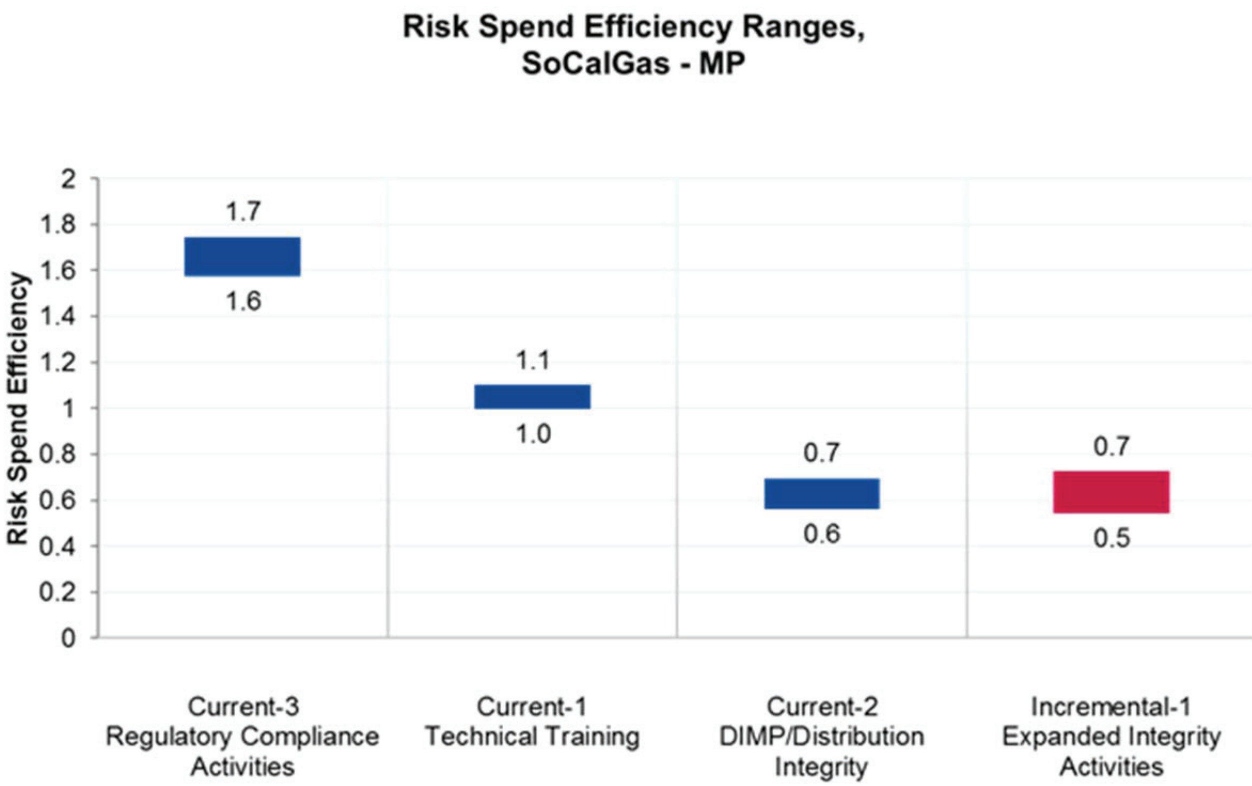
8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SoCalGas calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Regulatory compliance activities (current controls)
2. Technical training (current controls)
3. DIMP/Distribution integrity (current controls)
4. Expanded Integrity activities (incremental mitigations).

Figure displays the range[23] of RSEs for each of the SoCalGas Medium Pressure Pipeline Incident risk mitigation groupings, arrayed in descending order.[24] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

Figure 3: Risk Spend Efficiency



9 Alternatives Analysis

SoCalGas considered alternatives when developing its proposed plan for this risk. After consideration, these alternatives were dismissed in favor of the proposed plan, as described below.

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23 Based on the low and high cost ranges provided in Table 6 of this chapter.
24 It is important to note that the risk mitigation prioritization shown in this Report is not comparable across other risks in this Report.

9.1 Alternative 1 – Further Acceleration of Unprotected Steel Mains Work

SoCalGas considered an acceleration of the current program or status quo. This alternative would target all 8,000 miles of DOT reported unprotected steel mains. The project would be completed in an estimated 20 years while replacing over 400 miles/year and targeting the districts with the highest concentration of bare, unprotected steel mains. This program involves the creation of a very large capital intensive program as it would need a multitude of resources to accommodate an aggressive ramp up period. Based on the current replacement cost, each year the program would *require over $600 million per year* to operate and reach the aforementioned target. Due to the fact that a large percentage of non-state-of-the-art pipes are still functioning well in the system, this plan was not selected because of its less-focused approach (relative to proposed incremental activities), the amount of resources needed to implement, and the lack of focus on assets with a greater risk profile. SoCalGas believes that its proposed plan, which proposes to target certain unprotected steel pipe, balances affordability and risk reduction.

9.2 Alternative 2 – Acceleration of Pipeline Replacement

SoCalGas considered an alternative that involved further accelerating the replacement of aging steel pipelines under cathodic protection to address the medium pressure risk. In general, the more time that steel pipelines have been installed/buried, the more susceptible they are to corrosion even when cathodic protection is applied. This is due to a variety of factors which may include vintage coating types and their degradation over time, vintage methods of pipe preparation and coating application, localized soil stresses on pipe, and local soil corrosivity and resistivity being some of the more common. Due to these and other factors, over time, certain pipelines become more susceptible to corrosion. This in turn requires significant increases in operation and maintenance time and money to maintain necessary cathodic protection levels. This alternative would target steel mains where the utility is experiencing increased and ongoing performance issues with the pipeline and the applied cathodic protection system. To address these pipelines, one alternative that was considered was to replace specific identified pipelines with new plastic pipelines, thus providing a benefit to the system and reducing the risk of a medium pressure failure. This program, however, would involve creating an additional capital program. Importantly, these pipelines are still functioning well in the system despite their challenges. Although this option is viable, this plan was not selected because this replacement strategy would not appreciably advance pipeline performance-based approaches already in place via the SoCalGas DIMP strategy.

Risk Assessment Mitigation Phase
Risk Mitigation Plan

Catastrophic Event Related to Storage Well Integrity
(Chapter SCG-11)

November 30, 2016

310356

Southern California Gas Company
A Sempra Energy utility

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Executive Summary

The Catastrophic Event Related to Storage Well Integrity risk addresses the risk drivers, potential consequences, and baseline and proposed mitigations related to the risk of a catastrophic event related to storage well integrity.

To assess this risk, Southern California Gas Company (SoCalGas) first identified a reasonable worst case scenario for such a catastrophic event related to storage well integrity. This risk is described as an uncontrolled release of gas that occurs over an extended period of time due to a storage well structural integrity issue that requires complex well control operations and results in gas reliability issues or other extensive customer impacts. This scenario was then scored against five residual impact categories (i.e., Health, Safety, Environmental; Operational & Reliability; Regulatory, Legal, Compliance; Financial; and Frequency), as further discussed in Section 3 below. This process resulted in a residual risk score for the identified risk. The residual risk score establishes a baseline and is then used to help assess the effectiveness of existing and proposed mitigations.

Concurrent with this process, SoCalGas examined the risk mitigation activities in place in 2015 and the estimated costs associated with these activities (costs are discussed in Section 4). SoCalGas identified the following categories of risk mitigation activities as of 2015:

1. Existing Maintenance Well Work; and
2. Existing Capital Well Work.

The above activities focus on safety-related impacts (e.g., Health, Safety, and Environment) per guidance provided by the Commission in Decision (D.) 16-08-018, as well as controls and mitigations that may address reliability. These activities establish a baseline that is used to help assess the effectiveness of proposed mitigations.

Based on the foregoing assessment, SoCalGas identified and proposes additional mitigation activities to mitigate the risks associated with the risk of a Catastrophic Event Related to Storage Well Integrity. Here, SoCalGas proposes to continue the two control categories, identified above, and to further mitigate risk through accelerated implementation of its Storage Integrity Management Plan (SIMP). SoCalGas' SIMP was modelled after the federally mandated distribution and integrity management programs, and was designed to provide a proactive, methodical, and structured approach, using state-of-the-art inspection technologies and risk management disciplines to address storage field and well integrity issues. For purposes of risk mitigation analysis, SoCalGas split SIMP activities into two categories:

1. SIMP – Assessments: SIMP includes the expanded use of workover rigs to evaluate downhole casing and tubing conditions. Surface equipment such as valves, wellheads, and well laterals are also evaluated using enhanced integrity management methods.

2. SIMP – New Integrity and Risk Management Regulations: SIMP also involves the development, management and support of the assessment activities, as well as materials and labor associated with new regulatory compliance activities and enhancements.

Using the above proposals, SoCalGas developed a risk spend efficiency. The risk spend efficiency is a new tool that SoCalGas developed to quantify how the proposed mitigations will incrementally reduce risk. The risk spend efficiency was based on subject matter expert input on risk reduction.

SoCalGas then considered potential alternatives to its proposal to continue baseline activities and accelerate SIMP implementation. SoCalGas determined that its proposal was the preferred means by which to enhance safety, reduce risk, and comply with applicable regulations.

Risk: Catastrophic Event Related to Storage Well Integrity

1 Purpose

The purpose of this chapter is to present the mitigation plan of Southern California Gas Company (SoCalGas) for the risk of a Catastrophic Event Related to Storage Well Integrity. For purposes of this analysis, SoCalGas defines a reasonable worst case scenario for such a catastrophic event to include an uncontrolled release of gas that occurs over an extended period of time due to a storage well structural integrity issue that requires complex well-control operations and results in gas reliability issues or other extensive customer impacts. This risk implicates and this chapter considers risks associated with the following storage field components: (1) process and well servicing operations, well design, corrosion/ erosion to casing, tubing, annulus or tree/wellhead; and (2) lateral piping integrity. This risk is applicable to SoCalGas' four active underground storage facilities: Aliso Canyon, Honor Rancho, La Goleta, and Playa del Rey.[1] In 2015, the internal organizations responsible for scoring and managing this risk mainly resided within Storage Operations. As of 2016, Storage Operations and the newly created Storage Risk organization are primarily responsible for managing this risk.

This chapter addresses 2015 baseline risk mitigation activities and costs, and includes analyses of proposed 2017-2019 risk mitigation activities and costs. The risk assessment for Catastrophic Events Related to Storage Well Integrity was completed in September 2015, prior to the October 23, 2015 Aliso Canyon SS-25 well incident.[2] Although the investigation into the cause of the incident is ongoing, the event prompted heightened awareness of underground storage operations risks. As a result, new regulations have been issued by the Division of Oil, Gas, and Geothermal Resources (DOGGR), Pipeline and Hazardous Materials Safety Administration (PHMSA), California Air Resources Board (CARB), and South Coast Air Quality Management District (SCAQMD), and SoCalGas has implemented additional enhancements and improvements of its own.

As mentioned above, this risk is a product of SoCalGas' September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used as a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SoCalGas and San Diego Gas & Electric Company (SDG&E) (collectively, the Utilities) take compliance and managing risks seriously, as can be seen by the number and scope of actions taken to mitigate each risk. As this is the first time, however, that the Utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015;

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[1] The risk does not include the Montebello facility, which was approved for abandonment in Decision 01-06-081.
[2] On October 23, 2015, SoCalGas' Aliso Canyon Well SS-25 failed, causing a sustained and uncontrolled natural gas leak at the Aliso Canyon facility in Los Angeles, California. Ultimately, a relief well was drilled to permanently plug the leaking well on February 18, 2016. The investigation into this incident is ongoing, and the cause of the failure and resulting leak has not yet been determined.

however, because the Utilities do not currently track expenditures in this way, the baseline amounts are the best effort of the utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety-related risks and mitigating those risks.[3] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the Utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, and the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the Utilities have made efforts to identify those costs.

2 Background

Gas storage wells are a necessary and critical component of California's reliable gas delivery infrastructure. SoCalGas operates four underground storage fields with a combined working capacity of approximately 136 Bcf.[4] These fields are: Aliso Canyon (86.2 Bcf), La Goleta (21.5 Bcf), Honor Rancho (26.0 Bcf), and Playa del Rey (2.4 Bcf).

- Aliso Canyon is located in Northern Los Angeles County and is the largest of the four gas storage fields, with a working capacity of approximately 86 Bcf and deliveries to the Los Angeles pipeline loop. As of September 2015, Aliso Canyon had 114 injection/withdrawal/observation wells and was designed for a maximum withdrawal rate of approximately 1.8 Bcf per day at full-field inventory.

- Honor Rancho is also located in Northern Los Angeles County, approximately ten miles north of Aliso Canyon, with a working capacity of approximately 26 Bcf and deliveries to the Los Angeles pipeline loop. Honor Rancho has 40 gas injection/withdrawal wells and is designed for a maximum withdrawal capability of 1.0 Bcf per day.

- La Goleta is located in Santa Barbara County near the Santa Barbara Airport and the University of California–Santa Barbara campus, and provides service to the northern

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[3] Commission Decision (D.) 14-12-025 at p. 31.
[4] The volumetric capacity of a natural gas storage field reservoir is measured in units of billion cubic feet (Bcf).

coastal area of the SoCalGas territory. La Goleta has a working capacity of approximately 21 Bcf and has 20 gas injection/withdrawal/observation wells and is designed for a maximum withdrawal capability of 0.4 Bcf per day.

- Playa Del Rey is located in central Los Angeles County, near the Los Angeles International Airport. It is the smallest of the storage fields, yet, due to its location, is a critical asset with a design working capacity of approximately 2.4 Bcf. Playa Del Rey has 54 gas injection/withdrawal/observation wells. Playa Del Rey is designed for a maximum withdrawal rate of 0.4 Bcf per day to meet residential, commercial and industrial loads throughout the western part of Los Angeles, including electric generators and oil refineries.

The four storage facilities help SoCalGas provide safe and reliable gas service to more than 21 million customers and helps provide gas to half the electric generation in its territory. The four storage facilities are an integral part of the energy infrastructure necessary to provide Southern California businesses and residents with safe and reliable energy and gas storage services at a reasonable cost.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-004, "SoCalGas is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand, analyze and categorize risks."[5] The Enterprise Risk Management (ERM) process and lexicon that SoCalGas has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks.[6] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Catastrophic Events Related to Storage Well Integrity.

3.1 Risk Classification

Consistent with the taxonomy presented by SoCalGas and SDG&E in A.15-05-004, SoCalGas classifies this risk as a gas, operational risk as shown in Table 1.

[5] A.15-05-002, filed May 1, 2015, at p. JMD-7.
[6] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	GAS	COMPRESSION
OPERATIONAL	GAS	STORAGE

3.2 Potential Drivers[7]

The 2015 risk assessment for Catastrophic Events Related to Storage Well Integrity identified potential drivers that could lead to this risk occurring. The specific drivers for uncontrolled releases of gas at a storage field are the following:

1. **Aging infrastructure** – this risk driver is based on the age of the wells at SoCalGas' storage fields. Although the four SoCalGas storage fields have been in service for various timeframes, the average age of all wells is approximately 54 years.[8]

2. **Factors including internal/external corrosion** – this risk driver is based on the potential for corrosion on the inside or outside of buried steel casing. Internal corrosion and/or erosion may be caused by the corrosive effect of fluid, sand, and/or reactive constituents such as carbon dioxide in the gas withdrawn from the storage formations and the natural degradation of buried steel casing. External corrosion to buried steel casing may be caused by contact with certain underground soil formation conditions.

3. **Forces of Nature** – this risk driver is based on the known reservoir and geologic conditions and surrounding geological characteristics including such items as fault line and landslide potential. Each storage field has a geologic map that contains the storage field's faulting and landslide potential, which can be used to better understand the outside forces-natural cause risks specific to each well location.

4. **Human Error** – this risk driver is based on the potential for maintenance functions to be performed incorrectly by employees or contractors resulting in an uncontrolled release of gas. The cause of this could be inadequate procedures, failure to follow procedures, inadequate training, or inexperienced personnel.

5. **Incomplete or incorrect records** – this risk driver addresses that an incident could occur if the attributes of a well is unknown or inaccurate. The missing or incorrect information could result from an inadvertent mistake by an employee or contractor.

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[7] An indication that a risk could occur. It does not reflect actual or threatened conditions.
[8] *See* Testimony of Phillip Baker, Underground Storage (SCG-06) at p. PED-17, submitted on November 14, 2014 in A.14-11-003.

Table 2 below maps these five specific risk drivers of Catastrophic Events Related to Storage Well Integrity to SoCalGas' taxonomy.

Table 2: Operational Risk Drivers

Driver Category	Catastrophic Event Related to Storage Well Integrity Driver(s)
Asset Failure	• Aging infrastructure • Factors including internal/external corrosion
Asset-Related Information Technology Failure	Not applicable
Employee Incident	• Human Error • Incomplete or incorrect records
Contractor Incident	• Human Error • Incomplete or incorrect records
Public Incident	Not applicable
Force of Nature	• Forces of Nature (e.g., fault line and landslide)

3.3 Potential Consequences

The following is a list of potential consequences that may result from an uncontrolled release of gas due to storage well blowout or systems failures, in a reasonable worst case scenario:

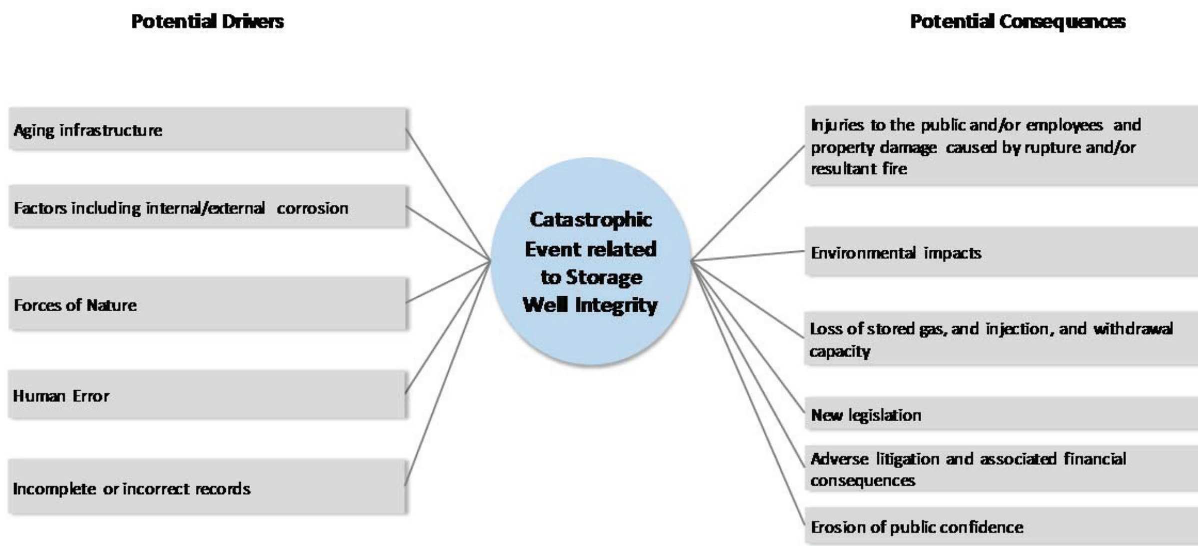
- Injuries to the public and/or employees and property damage caused by rupture and/or resultant fire
- Environmental damage
- Loss of stored gas
- Loss of injection and withdrawal capacity
- New legislation and/or regulations
- Adverse litigation and associated financial consequences
- Erosion of public confidence

These potential consequences were used in the scoring of Catastrophic Event Related to Storage Well Integrity risk that occurred during SoCalGas' 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown below, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SoCalGas applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



4 Risk Score

The SoCalGas and SDG&E ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Catastrophic Event Related to Storage Well Integrity as one of the enterprise risks. During the development of the 2015 risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are multiple possible ways in which an event related to storage well integrity can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Catastrophic Event Related to Storage Well Integrity:

- An uncontrolled release of gas that occurs over an extended period of time due to a storage well structural integrity issue that requires complex well control operations and results in numerous reports of public impacts, supply issues and extensive customer impacts. The release of gas into the atmosphere results in an environmental impact and increased regulatory oversight in the form of new regulations and requirements.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SoCalGas and SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[9] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the Catastrophic Event Related to Storage Well Integrity risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
5	5	5	5	2	1,826

4.3 Explanation of Health, Safety, and Environmental Score

Although natural gas is non-toxic, a well failure in populated areas may result in a rupture and/or fire, which could lead to injuries to the public and employees, property damage, and/or impacts to the environment. Should the wells be located near the public as compared to a more remote location (such as the middle of the storage field), the impacts to real property caused by the rupture and/or fire may be increased. Therefore, SoCalGas scored this risk a 5 (extensive) in the Health, Safety, and Environmental impact area due to the potential for injuries, property damage, and environmental impacts.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SoCalGas gave the other residual impact areas each a score for the following reasons:

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[9] D.16-08-018 at Ordering Paragraph 9.

A loss of stored gas may cause reduced withdrawal and injection capacity from the storage fields. This could also lead to operational impacts if the loss of stored gas was significant. Accordingly, SoCalGas scored this risk a 5 (extensive) in the Operational and Reliability impact area since there is potential to affect service to more than 50,000 customers, multiple critical locations and result in substantial disruption of service for greater than 10 days.

An uncontrolled release of gas due to storage well structural integrity issues would likely result in litigation, regulatory investigations, and/or financial-related penalties. A catastrophic event related to storage well integrity would likely also result in increased regulatory oversight and erosion of public confidence. SoCalGas, therefore, scored the Regulatory, Legal, Compliance impact a 5 (extensive). SoCalGas estimates that the financial impacts of an event similar to the risk scenario identified above could have an impact in the range of $100 million to $1 billion. As such, SoCalGas scored the Financial risk impact a 5 (extensive).

4.5 Explanation of Residual Frequency Score

In connection with the risk registry completed in September 2015 and used in the analysis, SoCalGas considered significant incidents at storage facilities across the United State, which were isolated and infrequent. Prior to September 2015, the last significant storage well incident in SoCalGas service territory had occurred in 1975.[10] Recent incidents of note that occurred elsewhere in the country were the leaks that occurred at Market Hub Partners' Moss Bluff Storage in Liberty County, Texas and the wellbore failure at Kansas Gas Service's Yaggy storage field in Hutchinson, Kansas.

- <u>Market Hub Partners' Moss Bluff Storage</u>: On August 19, 2004, the Market Hub Partners' Moss Bluff storage facility located in Liberty County, Texas, had a well control incident and natural gas fire at Cavern #1. Over a period of six and one-half days, approximately 6 billion cubic feet of natural gas in the cavern was released and burned.

- <u>Kansas Gas Service's Yaggy Storage Field</u>: On January 17 and 18, 2001, an accident occurred at the Yaggy underground natural gas storage field operated by Kansas Gas Service, where a wellbore failure led to a <u>series</u> of gas explosions in Hutchinson, Kansas. The storage field injected natural gas at a depth of 600 to 900 feet underground into salt caverns. Gas leaked from the storage field well production casing, migrated approximately nine miles underground, and then traveled to the surface through old brine, or salt wells, in the Hutchinson, Kansas area. An explosion in downtown Hutchinson destroyed two businesses, damaged 26 other businesses, and killed two persons in a mobile home park.

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[10] In 1975, at SoCalGas' Aliso Canyon storage facility, sand eroded aboveground piping adjacent to the wellhead which lead to a leak and fire.

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Based on SoCalGas' history and incidents that occurred elsewhere, SoCalGas assessed the frequency of an event occurring related to storage well integrity as a 2 (rare), defined as once every 30-100 years.

5 Baseline Risk Mitigation Plan[11]

In 2015, the risk baseline mitigations included:

- Existing Maintenance Well Work
- Existing Capital Well Work

These controls focus on safety-related impacts[12] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[13] as well as controls and mitigations that may address reliability, which is inherently related to safety. Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various events related to storage well integrity, not just the scenario used for purposes of risk scoring.

5.1 Existing Maintenance Well Work

Storage Operations is responsible for the operation, maintenance, integrity, and engineering functions associated with the use of the wells within the perimeter of the fields. This responsibility also extends beyond the plant perimeter in some limited areas, where gas storage wells exist outside of the storage field processing and compression facilities. In general, the activities are performed to comply with increasing regulatory requirements that drive historical and future O&M costs. These activities include salaries and expenses associated with routinely operating storage reservoirs including, but not limited to: turning wells on and off, well testing and pressure surveys, and wellhead and down-hole activities for contractors that perform subsurface leak surveys on injection/withdrawal facilities. Other activities include patrolling field lines, lubricating valves, cleaning lines, disposing of pipeline drips, injecting corrosion inhibitors, pressure monitors, and maintaining alarms and gauges. Existing maintenance well work mitigates risks associated with asset failure, forces of nature, human error, and other factors including internal/external corrosion.

Also in 2015, as part of maintenance well work, SoCalGas continued its effort to develop the Storage Integrity Management Plan (SIMP) proposed in the Test Year 2016 General Rate Case (GRC).[14] These

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[11] As of 2015, which is the base year for purposes of this Report.
[12] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[13] D.16-08-018 at 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[14] The SIMP was approved by the CPUC in D.16-06-054. As explained in greater detail below, SoCalGas' SIMP was modelled after the federally mandated distribution and integrity management programs and designed to provide a proactive, methodical, and structured approach, using state-of-the-art inspection technologies and risk management disciplines to address storage field and well integrity issues.

efforts continued the efforts began by the Company in 2014[15] and included running well inspection logs during well workovers and preparing electronic well history files for the Risk and Threat Analysis to be performed as part of SIMP.

5.2 Existing Capital Well Work

The activities associated with capital well work include: replacing failed components on existing wells, and the design, abandoning existing wells, drilling and completion of replacement wells for the injection and withdrawal of natural gas and reservoir observation purposes. This includes well workover contractors (major well work), drilling contractors, and component materials such as tubing, casing, valves, pumps, and other down-hole equipment. By replacing and upgrading storage assets, the existing capital well work mitigates the risks associated with asset failure, forces of nature, human error, and other factors including internal/external corrosion.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 – Routine Maintenance Well Work and Capital Well Work – will continue to be performed in the proposed plan. In addition, SoCalGas proposes to accelerate and expand SIMP activities – including the acceleration SIMP baseline assessments and additional risk and integrity management activities. These incremental changes, along with updates about other controls are described in below.

6.1 Maintenance Well Work

The proposed maintenance well work is consistent with the baseline maintenance well work addressed in Section 5.

6.2 Capital Well Work

The proposed capital well work is consistent with the baseline capital well work addressed in detail in Section 5.

6.3 SIMP

In 2016, in D.16-06-054, the Commission approved SoCalGas' SIMP. SIMP was proposed as a proactive, methodical, and structured integrity management approach to storage facilities that uses state-of-the-art inspection technologies and risk management disciplines to address storage field and well integrity issues. The SIMP is designed to:

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[15] The SIMP pilot was conducted primarily in 2014. As part of the pilot, SoCalGas began using well inspection tools during scheduled rig work. This included various inspection tools, including: Magnetic Flux Leakage (MFL), Multifinger Imaging Caliper, UltraSonic Imager Tool (USIT), Ultrasonic Casing Imager Tool (UCIT), and Ultrasonic Radial Scanner (URS). These efforts succeeded in developing an initial understanding of SIMP costs for purposes of the 2016 GRC forecast and the assessment of the currently available inspection tools.

- Identify threats and perform risk assessment for all wells
- Develop an assessment plan for all wells
- Remediate conditions identified in the risk assessments
- Develop preventative and mitigation measures for the storage field
- Maintain associated SIMP assessment data and develop more detailed metrics to identify threats and guide integrity management actions

6.3.1 SIMP Assessments

SIMP includes the expanded use of workover rigs to evaluate downhole casing and tubing conditions. Surface equipment such as valves, wellheads, and well laterals are also evaluated using enhanced integrity management methods. Once an issue is identified, repair work is initiated to enhance safety. Lesser-risk integrity work will be prioritized to plan and efficiently execute mitigation or preventative actions. SoCalGas will establish detailed baseline assessments on its underground assets.[16] This risk management approach will enhance the proactive assessment, management, planning, repair, and replacement of below-ground facilities to eliminate situations that could potentially expose the public or employees to uncontrolled well-related situations.

In order to prioritize well inspections, SoCalGas developed a new threat-assessment matrix using existing well data that includes consideration of the following:

- Age of well
- Proximity to sensitive areas or populations
- Workover history
- Inspection data
- Historical withdrawal rates (energy release potential)
- Known reservoir and geologic conditions
- Surrounding geologic conditions (fault lines, landslide potential, etc.)

As proposed in the 2016 GRC, the SIMP baseline assessment was to last 6 years. However, SoCalGas is now planning to complete the SIMP baseline assessment in 4 years or less. The accelerated pace will enhance safety, validate well integrity, and reduce the risk profile of SoCalGas' storage facilities. In addition to enhancing safety and validating well integrity more expeditiously, accelerating the SIMP baseline physical integrity assessments is consistent with recent regulations mandating comprehensive well assessments (e.g., 14 California Code of Regulations (CCR) Section 1724.9, DOGGR Emergency Order 1109, Senate Bill 380, and Senate Bill 887), PHMSA guidance,[17] and federal recommendations on

[16] The goals and objectives of SIMP are similar to those of the Distribution and Transmission Integrity Management Programs. SIMP would be focused on vertical casing pipe and components (wells) and associated above-ground facilities.
[17] PHMSA's Advisory Bulletin ADB-2016-02 ("In this Advisory Bulletin, PHMSA recommends that all operators of underground storage facilities used for the storage of natural gas, as defined in 49 CFR parts 192, have processes, procedures, mitigation measures, periodic assessments and reassessments, and emergency plans to

well integrity.[18] SoCalGas' accelerated SIMP will expeditiously validate well integrity and increase the margin of safety of the storage fields.

After the baseline assessment (which includes threat identification, risk assessment, inspection and preventative and mitigation measures) period of the SIMP, it is expected that expanded well assessments (and reassessments) will be performed on a regular basis as part of ongoing SIMP efforts. Through these periodic assessments, SoCalGas will gather more well data, allow for additional inspections, seek to manage and predict possible risk, and better assess the potential of leaks occurring. If any significant conditions are encountered during the evaluation, the well will be idled and a detailed work prognosis will be prepared, which may include, but is not limited to, running inner liners, new tubing, cement squeezing of holes, or well-abandonment.

6.3.2 SIMP – New Integrity and Risk Management Regulations

In addition to the assessments conducted for the SIMP, SIMP also drives other integrity enhancements and compliance with new integrity and risk management regulations. These new regulations not only require the SIMP inspections that were described above, but also additional ongoing maintenance and integrity management activities. Some examples of the new activities include:

- Fence line Monitoring System will detect methane crossing the fence line between the storage field and the surrounding area. SoCalGas is currently investigating a high resolution, commercially available and field-deployable sensor to be installed along the fence line and transmit alarms and regular methane level reads over the facility radio and Advanced Meter (AM) Networks, to be monitored by SoCalGas personnel. In some instances, SoCalGas may install similar area monitoring systems.

- As part of new thermal imaging leak detection requirements, SoCalGas will implement daily well inspections pursuant to DOGGR Emergency Regulations, Title 14 of the California Code of Regulations, Section 1724.9(e), at all underground storage facilities owned and operated by SoCalGas. The daily well inspections are already being performed at Aliso Canyon pursuant to the SCAQMD Order for Abatement Case No. 137-76.

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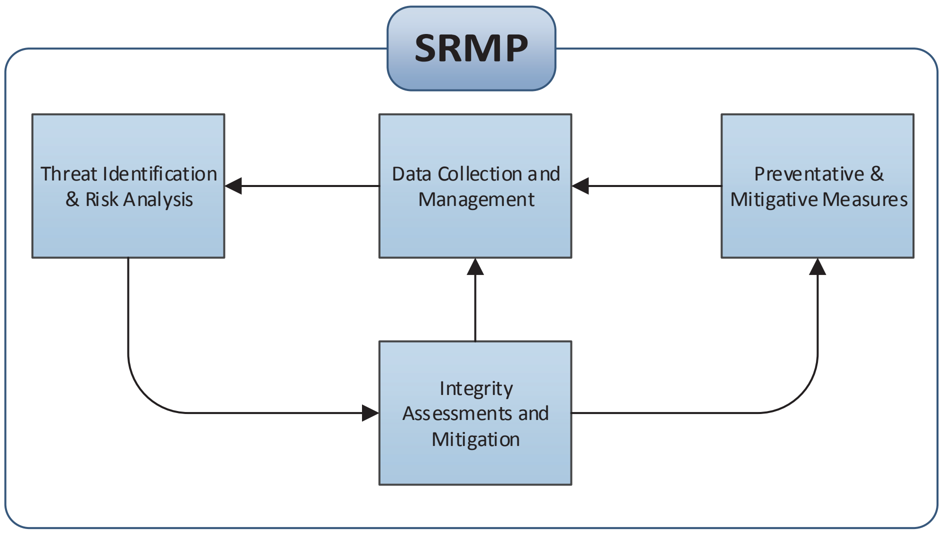
maintain the safety and integrity of all wells and associated storage facilities whether operating, idled, or plugged.")

[18] Interagency Task Force Well Integrity Observations and Recommendations, *Ensuring Safe and Reliable Underground Gas Storage: Final Report of the Interagency Task Force on Natural Gas Storage Safety*, at 55-56 (October 2016) ("All operators should undertake a rigorous evaluation of the current state of their well inventories… Evaluations should include: (1) a compilation and standardization of all available well records relevant to mechanical integrity; (2) an integrity testing program that includes usage of leakage surveys and cement bond and corrosion logs to establish that all wells are currently performing as expected; (3) documentation of a risk management plan to guide future monitoring, maintenance, and upgrades; (4) establishment of design standards for new well casing and tubing; and (5) establishment of safe operating pressures for existing casing and tubing.").

Finally, to focus SIMP activities and analytics and promote robust and dynamic data gathering and analysis, SoCalGas has also created a Storage Risk Management Program (SRMP). The SRMP is applicable to the Underground Storage Facility assets noted above and was created consistent with14 CCR 1724.9(g). The SRMP organization will provide a centralized organization that will mitigate risk by providing added focus on monitoring new compliance activities, emerging technology to mitigate risks, and developing data and analysis to focus funding and mitigation activities. The diagram below displays an overview of the elements in SRMP.



At this time, SoCalGas anticipates that these new regulations and requirements will begin in the 2016-2017 timeframe.

7 Summary of Mitigations

Table 4 summarizes SoCalGas' 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for Catastrophic Event Related to Storage Well Integrity. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SoCalGas does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data. These baseline costs include both capital and O&M activities.[19]

[19] Additionally, in 2014 and 2015, SoCalGas conducted inspections as part of a Storage Integrity Management Plan pilot and engaged in initial SIMP developmental activities. These early efforts helped support SoCalGas' 2016 General Rate Case SIMP proposal. The SIMP pilot occurred primarily in 2014 and the SIMP initial

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Table 4: Baseline Risk Mitigation Plan[20]
(Direct 2015 $000)[21]

ID	Control	Risk Drivers Addressed	Capital[22]	O&M	Control Total[23]	GRC Total[24]
1	Maintenance work performed on gas storage wells and SIMP Pilot and programmatic costs *	• Asset Failure • Forces of Nature • Factors including internal/ external corrosion • Human Error • Incomplete or Incorrect Records	n/a	$3,480	$3,480	$3,480
2	Abandonment, replacement materials and labor associated with each activity *	• Asset Failure • Forces of Nature • Factors including internal/ external corrosion • Human Error • Incomplete or	43,580	n/a	43,580	43,580

development and implementation work occurred primarily in 2015. Costs in Table 4 below only include 2015 SIMP activities. SIMP is discussed in greater detail in Section 6.

[20] Recorded costs were rounded to the nearest $10,000.

[21] The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.

[22] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.

[23] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).

[24] The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[22]	O&M	Control Total[23]	GRC Total[24]
		Incorrect Records				
	TOTAL COST		$43,580	$3,480	$47,060	$47,060

* Includes one or more mandated activities

7.1 Existing Maintenance Well Work

The O&M activities include salaries and expenses associated with routinely operating storage reservoirs such as: turning wells on and off, well testing and pressure surveys, and wellhead and down-hole activities for contractors that perform subsurface leakage surveys on injection/withdrawal facilities. Other O&M expenses include the costs associated with patrolling field lines, lubricating valves, cleaning lines, disposing of pipeline drips, injecting corrosion inhibitors, pressure monitors, and maintaining alarms and gauges.

7.2 Existing Capital Well Work

The capital activities include: abandonments, wellhead valve replacements, well tubing replacements, wellhead leak repairs, well inner-string replacements, and drilling new wells.

Table 5 summarizes SoCalGas' proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SoCalGas is identifying potential ranges of costs in this plan, and is not requesting funding approval. SoCalGas will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 5, the Utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 5: Proposed Risk Mitigation Plan[25]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[26]	2019 O&M	Mitigation Total[27]	GRC Total[28]
1	Maintenance work performed on gas storage wells *	• Aging Infrastructure • Forces of Nature • Factors including internal/ external corrosion • Human Error • Incomplete or Incorrect Records	n/a	$3,310 - 3,650	$3,310 - 3,650	$3,310 - 3,650
2	Well abandonments, replacement materials and labor associated with each activity *	• Aging Infrastructure • Forces of Nature • Factors including internal/ external corrosion • Human Error • Incomplete or Incorrect Records	117,140 - 129,470	n/a	117,140 - 129,470	117,140 - 129,470
3	SIMP – Well Assessments *	• Aging Infrastructure • Forces of Nature	159,300 - 230,100	8,100 - 11,700	167,300 - 241,800	167,300 - 241,800

[25] Ranges of costs were rounded to the nearest $10,000.
[26] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SoCalGas' Test Year 2019 GRC Application.
[27] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[28] The GRC Total column shows costs typically represented in a GRC.

		• Factors including internal/ external corrosion • Human Error • Incomplete or Incorrect Records				
	SIMP – New Integrity and Risk Management Regulations *	• Aging Infrastructure • Forces of Nature • Factors including internal/ external corrosion • Human Error • Incomplete or Incorrect Records	7,650 - 11,050	13,500 - 19,500	21,150 - 30,550	21,150 - 30,550
	TOTAL COST		$284,090 - 370,620	$24,910 - 34,850	$308,900 - 405,470	$308,900 - 405,470

☐	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

7.3 Maintenance Well Work

Because the proposed maintenance well work is consistent with SoCalGas' 2015 mitigation activities, the forecast was established using a five-year trend. However, because there is some variability and uncertainty related to the cost of maintenance well work from one year to another,[29] SoCalGas utilized a range in Table 5 for forecasted costs of maintenance well work.

[29] Examples of uncertainty associated with storage facilities are large complex interconnected industrial equipment that continues to age; the increasing volume, frequency and complexity of above-ground and below-ground maintenance work; and the declining availability of replacement components for older assets exposed to demanding field conditions.

7.4 Capital Well Work

Similar to the maintenance well work, due to the variability in costs in a given year, a five-year trend was selected with a range to account for potential fluctuations and uncertainty in the future.

7.5 SIMP

The SIMP costs forecasted in Table 5 were developed using a zero-based forecast which are based SoCalGas' experience engaging in similar work (e.g., past workover experience) as a reference. A range was developed to account for potential uncertainty with the timing of incurring and the potential scope for these costs.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[30] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[31]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies

[30] D.16-08-018 at Ordering Paragraph 8.
[31] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

(e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).

2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score).** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[32] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure 2 shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

[32] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 5 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SoCalGas analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Storage risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

For purposes of calculating Risk Reduction, the mitigations for this risk were group as follows:

1. Maintenance Work (current controls)
2. Abandonments and New Wells Drilled (current controls)
3. SIMP-Inspections, Abandonments, New Wells (incremental mitigations)
4. SIMP-New Integrity and Risk Management Regulations (incremental mitigations)

- **Maintenance Work (current controls)**

An assessment was performed for routine well maintenance activity. Well maintenance activity consists of ongoing maintenance work and labor performed on existing and newly constructed gas storage wells as had been done in 2015.

SoCalGas currently has 228 wells in place. Of these, 26 are slated to be abandoned and nine new wells are to be drilled. The resulting number of wells that will require maintenance work are 211. SoCalGas subject matter experts estimated that if maintenance work on these 211 wells were discontinued, the likelihood of an incident will move from a score of 2 (one every 30-100 years) to a 3 (one every 10-30 years) on the 7-point frequency scale. Thus, based on the forecasted cost of the activity and the risk increase if the activity were discontinued, SoCalGas calculated a Risk Spend Efficiency of 1.05.

- **Capital Well Work – Abandonments and New Wells Drilled (current controls)**

As part of the baseline risk mitigation projects, SoCalGas plans to abandon 26 wells and drill 9 new wells. SoCalGas subject matter experts determined that if the abandonment projects did not occur, the likelihood of an incident would increase to a score of 3 from a baseline likelihood score of 2, for the 26 wells. To represent the small risk of operating newly drilled wells, the risk for 9 new wells would increase slightly, from a 0 to a 1 (once every 100+ years). Thus, based on the forecasted cost of the projects and the risk increase if the projects did not occur, SoCalGas calculated a Risk Spend Efficiency of 0.26.

The abandonments will reduce the likelihood of an incident, and thus reduce the risk. The new wells, however, are required to maintain the capacity requirements for gas storage, but will increase the risk. These projects were thus combined into a single mitigation, the net effect of which is an overall risk reduction.

- **SIMP – Inspections, Abandonments, and New Wells (incremental mitigations)**

SIMP activities consist of well inspections and resultant repairs, abandonments, and construction of additional wells. SoCalGas subject matter experts estimated that approximately 160 wells will be inspected under the SIMP program, approximately 46 wells will be abandoned, and approximately 18 new wells will be drilled.

SoCalGas subject matter experts estimate that if the well inspection programs are done, the likelihood score for the 160 wells will move from a 2 to a 1. If the 46 wells are abandoned, the likelihood score for the 46 wells will move to a 0. For the 18 new wells, the likelihood score will increase from 0 to a 1. Thus, based on the forecasted cost of the projects and their risk reduction benefits, SoCalGas calculated a Risk Spend Efficiency of 0.09.

- **SIMP – New Integrity and Risk Management Regulations (incremental mitigations)**

This mitigation consists of the development, management and support of the SIMP, as well as materials and labor associated with new regulatory compliance activities and enhancements. This mitigation affects the risks associated with all wells in the system. SoCalGas SMEs determined that if these programs and activities were done the likelihood score would move from its baseline level of a 2 to a 1. Thus, based on the forecasted cost of the projects and activities, and their risk reduction benefits, SoCalGas calculated a Risk Spend Efficiency of 0.07.

8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SoCalGas calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

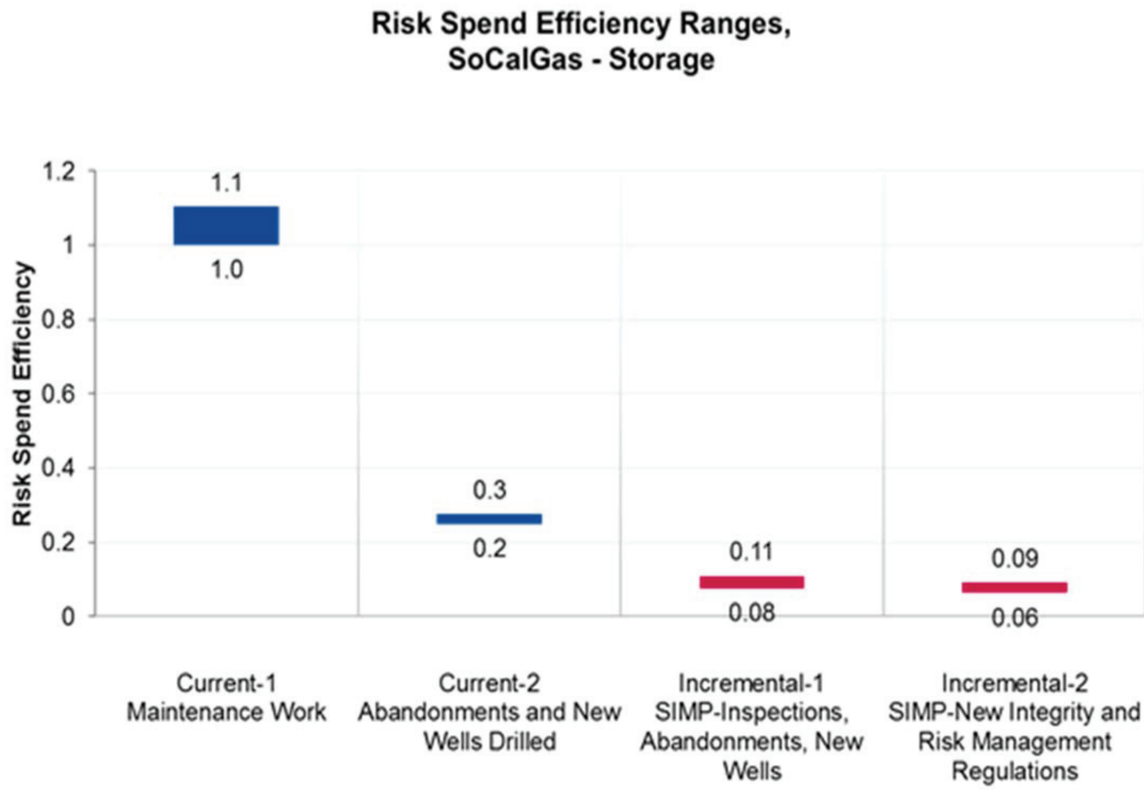
1. Maintenance Work (current controls)
2. Abandonments and New Wells Drilled (current controls)
3. SIMP-Inspections, Abandonments, New Wells (incremental mitigations)
4. SIMP-New Integrity and Risk Management Regulations (incremental mitigations)

Figure 3 displays the range[33] of RSEs for each of the SoCalGas Storage risk mitigation groupings, arrayed in descending order.[34] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

[33] Based on the low and high cost ranges provided in Table 5 of this chapter.

[34] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 3: Risk Spend Efficiency



9 Alternatives Analysis

The alternatives considered by SoCalGas Storage Operations took into account risk reduction, cost, new and existing requirements and compliance obligations, and the 2016 GRC decision approving the SIMP.

9.1 Alternative 1 – 6-Year SIMP Baseline

The first alternative considered was to complete the SIMP baseline assessments in six years. This alternative would align with the original SIMP 6-year assessment completion timeframe. Although a 6-year timeframe results in costs being spread out over a longer timeframe compared to SoCalGas' proposed plan to accelerate this work, this alternative was not chosen for multiple reasons. First, new DOGGR regulations and state law includes inspection requirements that can more readily be met on a 4-year SIMP timeframe.[35] Second, federal and state guidance has been issued indicating the importance of integrity assessments to validate well integrity. Third, although the proposed 4-year SIMP timeframe result in accelerated costs, it will improve the risk profile of the SoCalGas storage facilities. As such, the 6-year alternative was rejected in favor of the 4-year proposal in order to better comply with new

[35] See e.g., 14 CCR 1724.9.

laws and regulations, respond to federal and state well integrity guidance, and more expeditiously validate well integrity, enhance safety, and improve the risk profile of SoCalGas' storage fields.

9.2 Alternative 2 – Abandon Additional Wells

The second alternative considered was to abandon additional wells and drill new wells over a 6-year time period. This alternative proposal would result in SoCalGas abandoning 90 wells among all four storage fields and drilling 45 new replacement wells to maintain deliverability at a 2:1 ratio. This alternative was not chosen for two reasons. First, it was determined to be more cost effective to first inspect the wells and make any necessary repairs to maintain safety and deliverability to the customers. Second, the 4-year option is expected to cost less and enhance safety more effectively than drilling 45 new wells in 6 years. As such, the alternative to abandon additional wells and drill new wells over a 6-year period was rejected in favor of the 4-year SIMP proposal in order to expeditiously validate well integrity and improve the risk profile of SoCalGas' storage fields.

Risk Assessment Mitigation Phase

Risk Mitigation Plan

Wildfires Caused by SDG&E Equipment (Including Third Party Pole Attachments)

(Chapter SDG&E-1)

November 30, 2016

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Executive Summary

This is the risk of wildfires caused by SDG&E equipment, including third-party pole attachments. SDG&E has built a company-wide focus on addressing and minimizing wildfire-related risks to public health, safety and welfare since the catastrophic wildfires which devastated San Diego County in 2007. SDG&E's commitment to fire safety, prevention, mitigation, control, and recovery is a central focus within SDG&E. SDG&E's 2015 baseline mitigation plan for this risk consists of six controls:

1. **Inspection, Repair, Maintenance and Replacement Programs** – SDG&E evaluates the electric equipment in the field to verify, to the best of SDG&E's knowledge, that everything is in proper working condition.
2. **Vegetation Management** – SDG&E inspects each tree in accordance with a programmatic approach and is trimmed according to its assumed growth rate, supplemented by field observations.
3. **Design and Engineering Approaches** – SDG&E rebuilds its overhead system in a systematic way, while using the most current design and engineering standards and the large amount of weather and fuel data it has collected in recent years.
4. **Legal and Regulatory** – SDG&E seeks to work with regulators to create a safer system for its community.
5. **Rapid Response** – SDG&E coordinates with other first responder entities to develop plans to create a rapid response to emergencies that allows SDG&E more control in the event of an incident.
6. **Monitoring and Protection Programs** – SDG&E has continuous monitoring and detection programs for fire conditions.

These baseline mitigations focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability. The 2015 baseline mitigations will continue to be performed in the proposed plan. In addition, SDG&E is proposing to expand and add new mitigations within the six mitigations above to further address the risk of Wildfires. Examples of proposed activities are as follows:

- SDG&E proposes to add more funding to its existing wire mitigation program that would increase the rate of replacement of existing hardware and changing out of smaller copper conductor with stronger aluminum conductor within the Fire Threat Zone.
- SDG&E proposes to join with CalFire to create a program whereby SDG&E and CalFire personnel would jointly inspect certain areas of higher fire concern so that issues can be resolved as soon as possible, reducing concern from both agencies.

The risk spend efficiency was developed for the Wildfire risk. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk.

The following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Inspection, Repair & Hardening – Distribution (incremental mitigations)
2. Inspection, Repair & Hardening – Distribution (current controls)
3. Vegetation Management (incremental mitigations)
4. Monitoring and Detection Programs (incremental mitigations)
5. Advanced Protection (incremental mitigations)
6. Inspection, Repair & Hardening – Transmission (incremental mitigations)
7. Rapid Response (current controls)
8. Legal and Regulatory Mitigation (current controls)

Risk: Wildfires Caused by SDG&E Equipment (Including Third Party Pole Attachments)

1 Purpose

The purpose of this chapter (or plan) is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of wildfires caused by SDG&E equipment, including third-party pole attachments (referred to herein as Wildfires).

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

The catastrophic wildfires which devastated San Diego County in 2007, unprecedented in their sheer magnitude, have resulted in an enduring and lasting change reflected throughout SDG&E's' utility operations, systems, facilities, organization, goals and objectives. As evidenced by the many programs

[1] Commission Decision (D.) 14-12-025 at p. 31.

employed since these fires of 2003, 2007 and 2014, SDG&E has built a company-wide focus on addressing and minimizing wildfire-related risks to public health, safety and welfare. SDG&E's commitment to fire safety, prevention, mitigation, control, and recovery is a central focus within SDG&E. SDG&E has taken a leadership role in proactively addressing fire threats in the communities it serves and shares its personnel, resources, information, communications facilities, and fire-defense assets to help enhance the capabilities of the local communities to defend against any recurrences of catastrophic wildfire events in Southern California.

SDG&E performs a broad range of activities throughout the Company related to fire prevention and mitigation, all of which are subject to the direct supervision of senior management. The effectiveness of several of these activities is a performance measure for many SDG&E employees, some of whom are directly or indirectly responsible for contributing to and/or performing the mitigation efforts. Core to the mitigation activities are system design, construction, operation, maintenance and inspection aimed at significantly reducing the potential for SDG&E facilities to become the source of ignition for a fire. Nevertheless, the ubiquity of SDG&E's facilities and the range of operating conditions faced in the SDG&E service territory present some risk that SDG&E facilities might become the initiating or contributing source of ignition for a fire, regardless of how diligent these practices may be.

SDG&E's efforts continuously evolve. In coordination with many stakeholders, community leaders and the public, SDG&E shares and discusses, both formally in forums and informally in more casual meetings, its methods, programs and mitigation efforts with all interested parties. This helps to assure continuous improvement and maximum effectiveness across all affected areas. This outreach provides a platform for better coordination and idea sharing among emergency and first responder groups as well as local officials, cities and counties which are located within SDG&E's service territory.

The assessment and analysis performed in this chapter largely focuses on those Wildfires that could be caused by SDG&E's overhead electric transmission and distribution system and associated equipment. SDG&E strives to reduce or eliminate sources of ignition coming from its facilities, especially at times of peak weather when a small fire can turn into a large catastrophic fire. The mitigation activities discussed herein address and are applicable to all Wildfires, including those that do not involve utility facilities.

2 Background

Over the past several years, the risk of catastrophic Wildfires has increased significantly in Southern California due to a variety of factors. These can include drought, climate change, bark beetle infestations, and population growth into fire-prone areas. Environmental conditions such as dried fuels (e.g., chaparral) and severe wind events can turn a Wildfire that might otherwise be quickly contained by firefighting resources into an explosive and devastating situation.

For example, in the Wildfires of 2003, there were nearly 400,000 acres burned, 3,200 poles destroyed or damaged, and over 500 pieces of electric facilities and transformers destroyed. In addition, there were 148 vehicles destroyed, 14 deaths, and 104 injuries. During the 2007 Wildfires, there were 368,566 acres burned, 2,665 electric facilities destroyed, 117 electric facilities damaged, 239 vehicles destroyed, 7 deaths, and 127 injuries. In 2014, 14 Wildfires occurred that resulted in 26,000 acres burned, 65 structures destroyed (including 46 homes), 1 fatality, 135 poles replaced and over $60 million in damages.

Although Wildfires are a significant risk across the entire service territory, SDG&E focuses its fire prevention efforts primarily in the Fire Threat Zone where the risk of Wildfire is highest. Currently, SDG&E's service territory is divided into the non-Fire Threat Zone (non-FTZ) and the Fire Threat Zone (FTZ), the latter also encompassing specific areas designated the Highest Risk Fire Areas (HFRA). These designations result from an examination of the location and amount of natural fuels available for a fire, topography, weather, wind patterns, and knowledge of historical fire and fire spread. As such, the bulk of the fire prevention effort occurs in the FTZ, although the guiding principles of SDG&E's fire prevention plan also apply to the non-FTZ as well. The Fire Threat Zone comprises approximately 3,400 miles of overhead distribution system.

In addition, on October 31 of each year, SDG&E submits to the CPUC a Fire Prevention Plan (FPP) in accordance with General Order (GO) 166. The FPP outlines in detail what SDG&E does to prevent and mitigate wildfires. It includes operating practices, maps including the FTZ, and other relevant information. SDG&E is incorporating it by reference.[2]

2.1 Safety Model Assessment Proceeding

SDG&E presented how it models and assesses its risk of Wildfires in the Safety Model Assessment Proceeding (S-MAP) on May 1, 2015. SDG&E submitted its Application (A.) 15-05-002 in that proceeding, which was accompanied by the supporting testimony of Mason Withers. Mr. Withers addressed SDG&E's quantitative prioritization method for Wildfire-related hardening projects including the Fire Risk Mitigation (FiRM) program and the Wildfire Risk Reduction Model (WRRM). "FiRM addresses fire risk by hardening critical areas, by replacing older line elements, by utilizing advanced technology, and by improving facilities to adequately handle known local weather conditions."[3] It focuses on mitigating risk via pole and conductor replacement in the FTZ. Due to the complexity of the Wildfire risk, SDG&E also developed a sophisticated modeling tool, the WRRM. The WRRM is a probabilistic computer model that can perform nearly 70 million fire behavior simulations. It conducts a risk assessment at every pole, using that pole's characteristics and environmental conditions. WRRM utilizes the following as a quantitative approach to risk management:

- Failure rates (before compared to after hardening);

[2] See http://www.sdge.com/documents/fire-prevention-plan.
[3] A.15-05-002 S-MAP, Direct Testimony of Mason Withers, at p. MW-4 lines 7-9.

- Change of ignition;
- Environmental conditions;
- Fire behavior;
- Consequence; and
- Cost of hardening project.

WRRM is also flexible to accommodate future development.

SDG&E uses both FiRM and WRRM to help inform its risk-related decision-making and prioritize projects. For RAMP, SDG&E utilized the WRRM to derive benefits for some of the applicable hardening proposals presented herein. This is discussed in detail in Section 8 below. SDG&E's Wildfire tools are extremely beneficial, especially given the budgetary and resource-intensive nature of hardening projects. That being said, the methods and level of detail associated with SDG&E's Wildfire risk tools may not be appropriate for other risks.

As Mr. Withers stated in his S-MAP testimony, "(a)n important notion is the idea of continuous improvement from a risk perspective. In general, it is unlikely SDG&E will ever know everything about wildfire risk. But it is possible for SDG&E to continue to increase its understanding of risk and evolve the processes, tools, and models used to mitigate wildfire risk."[4] SDG&E is currently working on improvements to its Wildfire tools. These include enhancements to the WRRM model along with a variant of the WRRM called the WRRM Ops model that will allow SDG&E more real time analysis during a weather event. SDG&E continues to strive towards enhancing its Wildfire tools to manage and mitigate risk.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in A.15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[5] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, SDG&E is committed to increasing the use of quantification within its evaluation and prioritization of risks.[6] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

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[4] *Id*., at p.MW-7 lines 24-27.
[5] A.15-05-002, filed May 1, 2015, at p. JMD-7.
[6] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Wildfire risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in the S-MAP, SDG&E classifies this as an operational, electric risk that may be related to overhead transmission and/or distribution lines. The risk classification is provided in Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset Category	Asset Type
OPERATIONAL	ELECTRIC	TRANSMISSION (OVERHEAD) DISTRIBUTION (OVERHEAD)

3.2 Potential Drivers[7]

When performing the risk assessment for Wildfires, SDG&E identified potential indicators of risk, referred to as drivers. The identification and consideration of these drivers was based on studying SDG&E's history of wildfires in addition to wildfires in other utilities' service territories. These drivers are examples of ignition sources and are discussed more fully below. These include, but are not limited to:

- **Downed Conductor**: A downed conductor (or 'wire down') occurs when a conductor drops or breaks from its designed location on the pole and cross arm and ends up on the ground, sometimes in an energized mode. A wire down can result from a variety of factors, many of which are outside of SDG&E's control.

- **General Equipment Failure**: Electric equipment failure can be a source of a downed conductor or ignition. Failure of components such as connector, hot line clamps, and insulators can result in wire failure and end up in a wire down situation, sometimes in the energized mode.

- **Weather-Related Failure of SDG&E Equipment**: Weather plays a large part in the potential failure of SDG&E equipment. Excessive wind, lightning, and exposure to weather over time can degrade the integrity of the electrical components and lead to failure of one or more of the electrical parts causing a failure of the conductor.

- **Contact by Foreign Object**: Foreign objects coming into contact with SDG&E's facilities can also present sources of ignition. For example, Mylar balloons are highly conductive and will result in phase to phase faulting. In the worst-case this can cause the conductor to fail and land in an

[7] An indication that a risk could occur. It does not reflect actual or threatened conditions.

energized mode, causing arcing and sparking in dry conditions. In addition, vehicular contact will bring down conductors, and sometimes the entire pole, resulting in conductors laying on the ground in an energized fashion.

- **Failure of Third-Party Attachments**: As mandated by the CPUC, SDG&E must allow communication infrastructure providers to attach to utility poles when space is available. These providers may not properly install or inspect their equipment. This has led to contact of these attachments with the electrical facilities, leading to fire related incidents.

- **Vegetation Contact**: During storms and severe wind events, branches are shed by trees in the vicinity of SDG&E facilities. These can fall on conductors leading to conductor failure or, in the case of palm fronds, phase to phase contact and a cascade of sparks. In addition, trees that are many feet away from an energized conductor sometimes uproot and fall on the conductor, causing failure or sparking.

- **Not Observing Operational Procedures**: SDG&E revises its protocols and procedures based on certain conditions. For example, during red flag or fire warnings, SDG&E and its contractors may not perform welding or other activities that may generate potential ignition sources. If an employee or contractor does not adhere to such a procedure, it can cause an adverse consequence.

- **Lack of Internal or External Coordinated Response**: A well-coordinated response to a downed conductor aids in the suppression of a fire as well as the de-energization of the conductor in a safe manner. Lack of coordination could lead to uncontrolled fire, electrical exposure to first responders, and, possibly, injury or death.

- **Extreme Force of Nature Events**: SDG&E's overhead electrical facilities are fully exposed to the elements. Significant weather and wind-related events can cause a variety of problems related to equipment failure and downed conductors. Also, continual exposure to natural elements can degrade or weaken key components, conditions which may not be found until the following, scheduled inspection and repair cycle.

- **Climate Change Adaptation Impacts on Wildfires Caused by SDG&E Equipment:** Despite the proactive approach to mitigating fire risk, increases in temperature and prolonged periods of drought in the decades to come will likely lead to high risk fire areas expanding from the foothills and mountains into the lower elevation coastal canyons and wildland interfaces that were previously considered at lower risk for fire growth. These prolonged periods of drought will also likely result in a longer wildfire season, potentially extending the focus of our threat monitoring and potential response from the fall months to year-round -- with the greatest increased threat in the spring and summer months.

These climate trends have already been realized across the region, culminating in previously unseen wildfire outbreak across coastal San Diego County in May of 2014. SDG&E also employed the help of the Skycrane in San Diego on July 1, 2016 (earlier than in prior years), in response to an increase in summertime wildfire activity across the region. Based upon the most recent climate science, these trends are likely to continue and worsen into the future.

Table 2 maps the specific drivers of Wildfires to SDG&E's risk taxonomy.

Table 2: Operational Risk Drivers

Driver Category	Wildfire Driver(s)
Asset Failure	• Downed Conductor. • Failure or ignition due vegetation contact with SDG&E equipment. • Failure or ignition due to third party attachment. • General equipment failure on system. • Contact by foreign object. • Weather related failure of SDG&E equipment.
Asset-Related Information Technology Failure	Not applicable
Employee Incident	• Not observing operational procedures (e.g. welding during fire warnings). • Lack of internal or external coordinated response.
Contractor Incident	• Not observing operational procedures (e.g., welding during fire warnings). • Lack of internal or external coordinated response.
Public Incident	• Contact by foreign object. • Downed conductor due to vehicle contact. • Lack of internal or external coordinated response. • Failure or ignition due to third party attachment.
Force of Nature	• Extreme force of nature events such as high winds, earthquakes, • Failure or ignition due vegetation contact with SDG&E equipment. • Weather-related failure of SDG&E equipment.

3.3 *Potential Consequences*

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario could include:

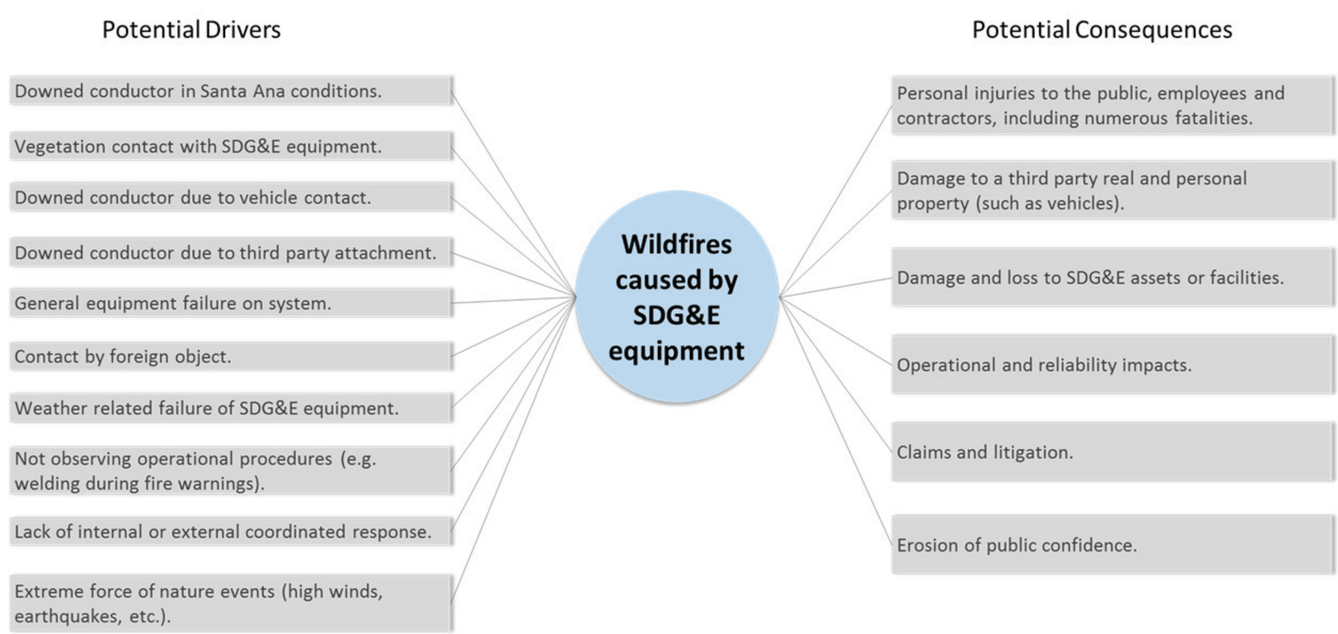
- Personal injuries to the public, employees and contractors, including numerous fatalities.
- Damage to third party real and personal property.
- Damage and loss of SDG&E assets or facilities.
- Operational and reliability impacts.
- Claims and litigation.
- Erosion of public confidence.

These potential consequences were used in the scoring of Wildfires that occurred during the development of SDG&E's 2015 risk registry process. See Section 4 for more detail.

3.4 *Risk Bow Tie*

The risk "bow tie," shown in Figure 1 is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Wildfires as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a wildfire can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Wildfires:

- An ignition coming from an overhead SDG&E electric facility results in a catastrophic wildfire that causes multiple fatalities, numerous injuries, property damage, operational impacts, claims, and litigation.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[8] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the Wildfire risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

[8] D.16-08-018 Ordering Paragraph 9.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
7	6	5	6	5	2,551,888

4.3 Explanation of Health, Safety and Environmental Impact Score

In the 2003 and 2007 Wildfires in SDG&E's service territory, there were a total of 648,844 acres burned, 5,485 electric facilities destroyed, 180 electric facilities damaged, 387 vehicles destroyed, 21 deaths and 231 injuries. Based on magnitude of this damage, the Wildfire risk was scored a 7 (catastrophic) in the impact area of Health, Safety, and Environmental as there is a demonstrated potential for many fatalities and life threatening injuries to the public or employees, as well as immediate, severe and possibly irreversible impacts to the environment.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SDG&E gave the following scores to the remaining impact areas:

- **Operational and Reliability**: In the Operational and Reliability impact area, Wildfires were rated a 6 (severe). In the past, Wildfires have resulted in loss of electricity to customers. Using the 7X7 matrix, an impact score of 7 was deemed inappropriate because previous Wildfires in SDG&E's service territory did not operationally affect over a million customers. Therefore, a score of 6, potentially affecting more than 100,000 customers from an operational perspective, was selected for this category.
- **Regulatory, Legal, and Compliance**: Following the past two Wildfire events, SDG&E was subject to governmental and regulatory investigations. Therefore, Wildfires was given a 5 (extensive) for the Regulatory, Legal, and Compliance category, as there is the potential for governmental and regulatory investigations.
- **Financial**: Wildfires were given a 6 (severe) in the Financial impact area. Wildfires can cause widespread destruction resulting in numerous lawsuits and increases in SDG&E's insurance premiums. By looking at the outcome from past events, the subject matter experts estimated that Wildfires can create a financial impact in the $1-3 billion range.

4.5 Explanation of Frequency Score

As described above, San Diego County experienced large Wildfires in 2003 and 2007. In addition, in 2014 San Diego had fires along the coast, areas not typical for large fires. SDG&E has assigned a frequency score of 5 (frequent) which reflects the occurrence of a Wildfire every 1-3 years. The reasoning was based on the historical record of wildfires in the San Diego area, the potential new trend of wildfires along the coast, and the consideration of the potential of any one of those fires turning into a wildfire under the right conditions.

5 Baseline Risk Mitigation Plan[9]

SDG&E has extensive operational programs in place to mitigate Wildfires risk. The 2015 baseline mitigations discussed below include the current evolution of the utilities' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time. These programs are designed to monitor the system closely whenever and wherever the threat of fire is elevated so that, in the event of an ignition, the threats to public safety from fire are abated or mitigated as fully and quickly as possible. SDG&E's baseline mitigation plan for this risk consists of six controls: (1) Inspection, Repair, Maintenance and Replacement Programs, (2) Vegetation Management, (3) Design and Engineering Approaches, (4) Legal and Regulatory, (5) Rapid Response, and (6) Monitoring and Protection Programs. Within these baseline mitigations, many of the projects and programs are mandated, compliance activities pursuant to CPUC General Orders and other directives.

Subject matter experts from Electric Transmission and Distribution Engineering and Electric Distribution Operations collaborated to identify and document them. These controls focus on safety-related impacts[10] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[11] as well as controls and mitigations that may address reliability.[12] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various events related to Wildfires, not just the scenario used for purposes of risk scoring.

1. <u>Inspection, Repair, Maintenance and Replacement Programs</u>

The purpose of the Inspection, Repair, Maintenance and Replacement Programs is to evaluate the SDG&E electric equipment in the field to verify, to the best of SDG&E's knowledge, that everything is in proper working condition. Many of the projects and programs within this mitigation are mandated in accordance with General Orders and other Commission directives. SDG&E performs its inspections in

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[9] As of 2015, which is the base year for purposes of this Report.
[10] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[11] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[12] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

accordance with GO 165. If the equipment does not meet SDG&E standards, it is repaired or replaced. This process is in place to improve and maintain safety levels for employees, contractors and the public.

An example of one of the Repair, Maintenance and Replacement Programs is SDG&E's Quality Assurance/Quality Control (QA/QC) program whereby one-third of the poles and facilities within the HRFA are inspected and repaired, as needed, on a three-year rolling cycle. This program helps to determine that the system will perform as designed and minimize the potential of downed conductors.

In addition to the QA/QC program, the FiRM program activities and WRRM model, discussed in Section 2, are included in this mitigation.

2. Vegetation Management

SDG&E currently has a robust and award-winning vegetation management program. This program catalogs over 460,000 trees that are near existing power lines. Each tree is inspected in accordance with a programmatic approach and is trimmed according to its assumed growth rate, supplemented by field observations. SDG&E also inspects for tree disease and root stability, and if necessary will seek to remove a diseased or unstable tree and replace it with a more appropriate species. This program complies with mandatory regulatory requirements (i.e., General Order 95 Rule 35, and California Public Resource Codes (PRC) 4292 and 4293), and, in some areas, exceeds the minimum regulatory requirements.

3. Design and Engineering Approaches

Using the large amount of weather and fuel data it has collected in recent years, SDG&E hardens its overhead system in a systematic way, while using the most current design and engineering standards, many of which are mandated by the CPUC or are industry best practices. In doing so, SDG&E is hardening its system to be safer and more resilient to the negative effects of weather and fire. An example of one of the Design and Engineering Approach programs is SDG&E's wood-to-steel program for both the transmission and distribution facilities. This program evaluates the condition of poles in the FTZ/HRFA and, where indicated, replaces wood with steel poles, which have higher design load criteria and associated higher factors of safety.

4. Legal and Regulatory

SDG&E seeks to work with regulators to create a safer system for its community. Two examples of programs under the Legal and Regulatory category include the use of marker balls and avian protection equipment. Marker balls are used as a visual warning to pilots to prevent aircraft from contacting electric facilities. On rare occasions, aircraft can be the cause of wildfire ignitions, and contact avoidance mitigates that risk. Avian protection uses non-conductive material to cover-up electric facilities so that large birds are not electrocuted. Birds that contact electric facilities typically fall and can cause fires. The use of avian protection both prevents a fire from occurring and protects the bird. Both programs are required by the CPUC's General Order 165.

5. Rapid Response

There is a need for SDG&E to be able to coordinate with other first responder entities before, during and after an event in order to minimize the impact of a fire as well as minimize disruption in service to electric customers. An example is SDG&E's mitigation efforts in firefighting and fire-recovery activities. SDG&E has plans in place to mobilize an appropriate range of resources, including trained firefighters, communications capabilities, data and information collection, and command facilities, to address fire threats and to assure the earliest possible recovery from a fire event. These plans have generally served to create a rapid response to emergencies that allows SDG&E more control in the event of an incident.

6. Monitoring and Detection Programs

Continuous monitoring and detection programs for fire conditions have become a cornerstone of SDG&E's fire safety program. With early notice, SDG&E can move towards more conservative operation of its system, provide customers in affected areas with early warning of specific fire conditions, and stage crews in appropriate areas to monitor for potential sources of ignition. An example of one of these programs is the gathering and analyzing of data from SDG&E's extensive weather network, which includes over 170 weather stations. This network is one of the largest and densest networks of weather stations in the country and is used to determine where and when the threat of a wildland fire will present itself. The system facilitates the immediate organization and implementation of an SDG&E response to the threat. The program has developed into a highly sophisticated early warning detection program that allows SDG&E to monitor and predict issues before they occur.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. In addition, SDG&E proposes to expand and add new mitigations to further address the risk of Wildfires.

While SDG&E acknowledges that it has a mature and comprehensive fire mitigation program, it is continuously analyzing and developing new technologies, systems and processes to further its ability to prevent wildfires. As such, SDG&E's proposed plan includes additional measures to be added to the baseline activities to enhance fire prevention. The information provided below describes the proposed (with a focus on expanded and new) mitigations for the years 2017, 2018 and 2019.

1. Inspection, Repair, Maintenance & Replacement Programs

With inspection programs comes the recognition of what needs to be repaired. SDG&E proposes to add more funding to its existing wire mitigation program that would increase the rate of replacement of existing hardware and changing out of smaller copper conductor with stronger aluminum conductor within the FTZ. The replacement effort would focus on feeder and branch lines in particular. This would expand existing rebuild efforts in areas where the threat of fire is higher. Further, it should be noted that there can be potential challenges in implementing hardening and replacement work, such as obtaining applicable permits. Therefore, the amount and timing of work related to this mitigation in a given period of time may be uncertain and/or vary.

2. Vegetation Management

SDG&E proposes to join with CalFire to create a program whereby SDG&E and CalFire personnel would jointly inspect certain areas of higher fire concern so that issues can be resolved as soon as possible reducing concern from both agencies. The benefit of joint inspection is that SDG&E's electric facilities would be scrutinized from two different perspectives, with the goal of reducing ignition sources and creating a safer system.

3. Design & Engineering Approaches

Improved design and engineering practices will hopefully result in a strong, more resilient system. Accordingly, SDG&E anticipates that the Design and Engineering Approaches mitigations will continue through 2019 at the same level as described in the baseline plan.

4. Legal and Regulatory

SDG&E anticipates that the Legal and Regulatory mitigations will continue through 2019 at the same level as the baseline plan.

5. Rapid Response

Based on SME experience, SDG&E has found that climate change will impact its efforts on preventing Wildfires which may be caused by SDG&E Equipment. As discussed in Section 3.2, these climate trends have already been realized across the region culminating in SDG&E employing the help of the Skycrane earlier than in historical experience. Based upon the most recent climate science, these trends are likely to continue and worsen into the future. The anticipated, prolonged fire season is likely to result in an increase in performing Rapid Response activities

6. Monitoring and Detection Programs

SDG&E proposes to add two programs. The first provides for a situational, web-based fire awareness tool that allows SDG&E access to fire perimeter data from the fire agencies as they update their systems, allowing SDG&E to see and react if necessary to threats to its electric system. The second proposed program is a cutting-edge fire awareness tool that uses imaging equipment on firefighting aircraft to provide real-time fire perimeter data as the aircraft is helping to fight a fire. This allows SDG&E to react with a more concerted effort to address the threats to its overhead electric system.

7 Summary of Mitigations

Table 4 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for mitigating Wildfires. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in were estimated using assumptions provided by SMEs and available accounting data.

Table 4: Baseline Risk Mitigation Plan[13]
(Direct 2015 $000)[14]

ID	Control	Risk Drivers Addressed	Capital[15]	O&M	Control Total[16]	GRC Total[17]
1	Inspection, Repair, Maintenance and Replacement Programs*	• Asset Failure	$102,080	$640	$102,720	$69,680
2	Vegetation Management	• Asset Failure • Force of Nature	n/a	23,100	23,100	23,100
3	Design and Engineering Approaches	• Asset Failure • Force of Nature	3,840	n/a	3,840	1,750
4	Legal and Regulatory*	• Public Incident	600	740	1,340	190
5	Rapid Response	n/a	n/a	5,660	5,660	5,660
6	Monitoring and Detection Programs	• Asset Failure • Force of Nature	830	450	1,280	1,280
	TOTAL COST		$107,350	$30,590	$137,940	$101,660

* Includes one or more mandated activities

While all the controls and baseline costs presented in Table 4 mitigate Wildfires, some of the controls also mitigate other risks presented in this RAMP Report. Specifically, customer communication related to fire preparedness is also included in the risk of Employee, Contract and Public Safety. In addition, SCADA programs and falling conductor protection (FCP) programs are included as mitigations for both the Wildfire risk herein as well as the Electric Infrastructure Integrity risk.

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[13] Recorded costs were rounded to the nearest $10,000.
[14] The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[15] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[16] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[17] The GRC Total column shows costs typically presented in a GRC.

Table 5 summarizes SDG&E's proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan, and is not requesting funding approval. SDG&E will request approval of funding in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 5, the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 5: Proposed Risk Mitigation Plan[18]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[19]	2019 O&M	Mitigation Total[20]	GRC Total[21]
1	Inspection, Repair, Maintenance & Replacement Programs*	• Asset Failure	$895,080 - 1,163,600	$1,250 - $1,630	$896,330 - 1,165,230	$506,790 - 522,230
2	Vegetation Management	• Asset Failure • Force of Nature	n/a	23,550 - 30,620	23,550 - 30,620	23,550 - 30,620
3	Design & Engineering Approaches	• Asset Failure • Force of Nature	36,150 - 46,990	n/a	36,150 - 46,990	32,030 - 32,990
4	Legal & Regulatory*	• Public Incident	1,270 - 1,650	580 - 750	1,850 - 2,400	80 - 100
5	Rapid Response	n/a	n/a	6,350 - 8,260	6,350 - 8,260	6,350 - 8,260
6	Monitoring and Detection Programs	• Asset Failure • Force of Nature	1,350 - 1,760	1,640 - 2,130	2,990 - 3,890	2,990 - 3,520
	TOTAL COST		$933,850 - 1,214,000	$33,370 - 43,390	967,220 - 1,257,390	$571,790 - 597,720

☐ (white)	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

1. Inspection, Repair, Maintenance and Replacement Programs

The costs associated with this item may vary due to specific unknown field conditions encountered at a specific job site, along with other unknown specific environmental factors.

2. Vegetation Management

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[18] Ranges of costs were rounded to the nearest $10,000.
[19] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
[20] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[21] The GRC Total column shows costs typically represented in a GRC.

The costs for this new program were estimated based on high level assumptions only and will need to be refined in SDG&E's Test Year 2019 GRC, as well as scaled to the actual number of facilities inspected.

3. Design and Engineering Approaches

The costs associated with the Design & Engineering Approaches mitigation are consistent with historical recorded costs. The range shown in Table 5 provides flexibility given that the mandates and scope of work may change in the 2017-2019 timeframe.

4. Legal and Regulatory

The costs associated with the Legal and Regulatory mitigation are consistent with the recorded costs in 2015. The range shown in Table 5 provides flexibility given that the mandates and scope of work may change in the 2017-2019 timeframe.

5. Rapid Response

The ranges shown in Table 5 were estimated based on a known expansion of the fire season. However, if the season continues to grow, additional dollars will be needed to permit the use of mitigations such as the Skycrane even earlier.

6. Monitoring and Detection Programs

The costs for the Monitoring and Detection Programs were estimated based on high level assumptions only and will need to be refined in SDG&E's Test Year 2019 GRC.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[22] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[23]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

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[22] D.16-08-018 Ordering Paragraph 8.

[23] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[24] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

[24] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure 2 shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 5 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Wildfires risk. The RAMP Approach chapter in this Report, provides a more detailed example of the calculation used by the Company.

The analysis addresses eight mitigation groupings:

(a) Rapid Response
  - Response readiness focuses on anticipating fires and being prepared to extinguish them should they spark. Initiatives include Crew Staging, Mobilization, Mobile Command Centers, Wildfire Prevention Teams, Fire Brigades and Community Outreach programs.

(b) Vegetation Management
  - Programs include tree trimming, removing brush from the vicinity of poles, and improving joint pole attachment agreements. These mitigations focus on eliminating contact between trees and energized lines, as well as removing combustible fuel from the base of poles where sparks may drop when equipment operates and/or fails.

(c) System Hardening, Inspection & Repair Programs - Distribution
  - Programs include strengthening lines through conductor replacement, replacing wood poles with steel, assessing tie lines and long spans along with other inspection and maintenance programs. These mitigations focus on eliminating system failures which could result in direct contact between energized components and the ground triggering sparks.

(d) Aviation Protection

- o Program increases the number of locations where highly visible balls are suspended, decreasing the likelihood of an aircraft versus wire collision in which both downed infrastructure and downed aircraft could trigger fires.

(e) Advanced Detection (Situational Awareness)
- o This set of activities focus on enhancing situational awareness to inform and enable all of the other programs. Programs include maintaining weather stations, highly localized weather forecasting, development of the Fire Prevention Index (FPI), data sharing including fuel studies and the WRRM.

(f) Advanced Protection
- o Program enables SDG&E to remotely disable automatic protection equipment so that, under heightened fire risk situations, equipment can be prevented from operating in the field, pushing operations and potential sparks to the controlled environment of the substation.

(g) Incremental System Hardening, Inspection & Repair Programs – Distribution
- o Programs include wood to steel pole program (D) and work in the Cleveland National Forest.

(h) System Hardening, Inspection & Repair Programs – Transmission
- o Programs include wood to steel pole program (T) and work in the Cleveland National Forest.

The risk reduction analysis drew on several data sources, including: Outage Management System (OMS) Data, the log of SDG&E-triggered fire events, SDG&E's WRRM, NTSB Aviation Accident Database, and estimates based on subject matter expertise.

- **Rapid Response (current control)**

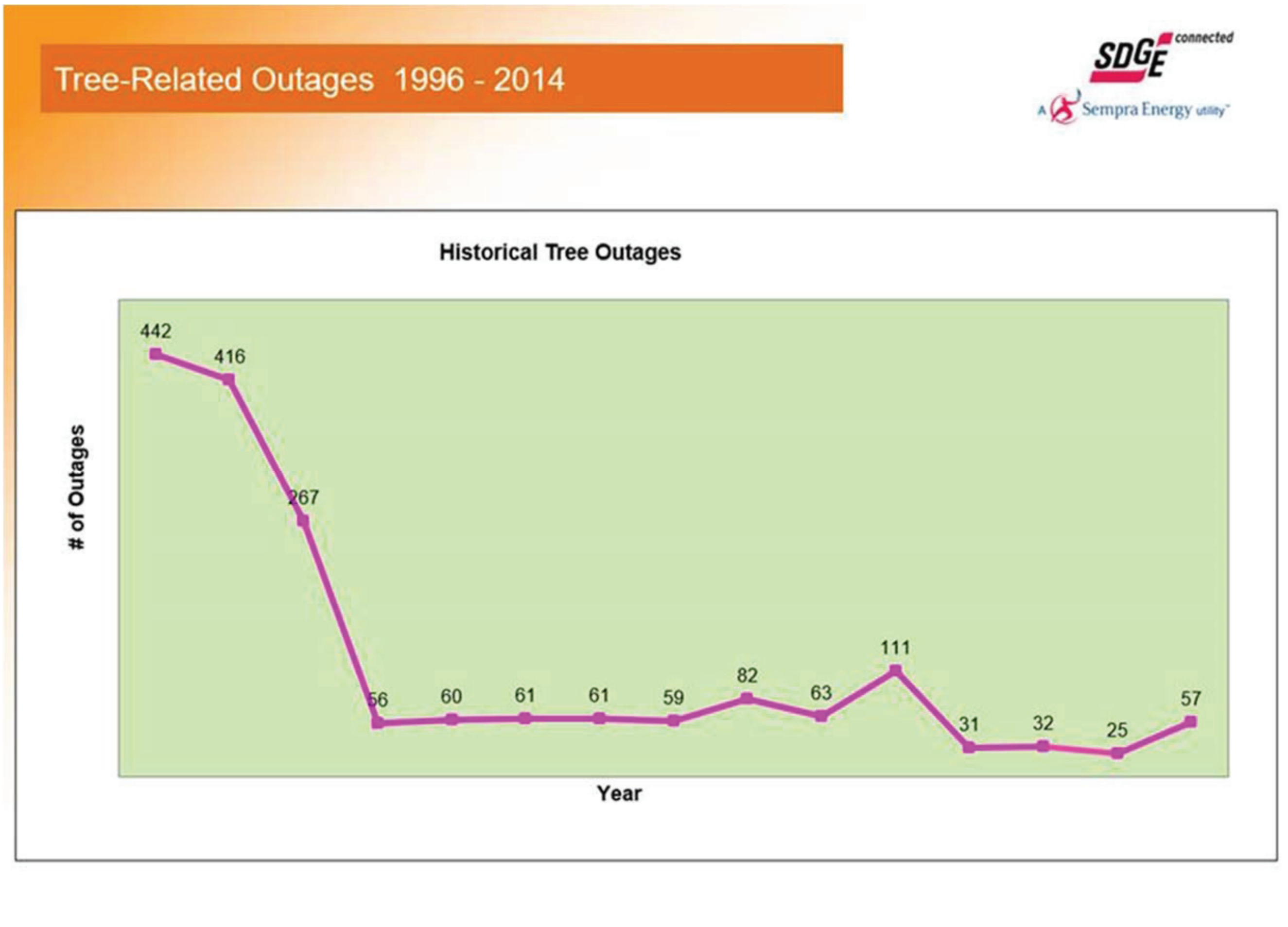
The time that fire has to grow before a responder intervenes is a major determinant in how large it becomes and how difficult it is to extinguish. Approximately 10% of fire events are intercepted by SDG&E teams before local and State first responders need to get involved, and all of these events are contained to less than a quarter acre. Of the fires that expand beyond a quarter acre, 20% progress beyond 10 acres, and one in fifteen of those expand beyond 100 acres. Without SDG&E's rapid response measures, three fires which would otherwise be contained to under 0.25 acres would run a one in 75 chance of developing into a wildfire of at least 100 acres. Approximately, one in twenty such fires would yield the consequences outlined in RAMP.

$$\frac{\text{Annual events caught by utility} \times \text{Fraction of uncaught events which develop beyond 0.25 acres} \times \text{Fraction of events over 0.25 acres that develop beyond 100 acres} \times \text{Fraction of events over 100 acres that yield the anticipated consequences}}{\text{Rate of serious wildfires anticipated under RAMP}}$$

This amounts to an increase in serious wildfires of 0.3% if the rapid response measures were abandoned.

- **Vegetation Management (current control)**

Approximately 15% of fire events are attributable to vegetation causes. In the mid-1990s, SDG&E experienced over 400 tree-caused outages per year. Following an enhancement to the tree pruning and vegetation management specification, tree-caused outages dropped precipitously, and have held between 25 and 57 in the 2011-2014 timeframe.



Analysts estimated that if the enhanced trimming were discontinued, tree outages would rebound from current levels (estimated at 40 per year) to pre-1998 levels (estimated at 420 per year). Of the outages avoided, about one in twenty are the type that could result in a ground-level ignition event.

$$\text{\% Fires due to Trees/Arcing} \times \frac{\text{Pre-1998 Tree Outage Rate} - \text{Current Tree Outage Rate}}{\text{Current Tree Outage Rate}} \times \begin{array}{c}\text{Proportion of avoided outages which}\\ \text{would result in ignition}\end{array}$$

This amounts to wildfire risk potentially increasing by approximately 7% if the current enhanced tree specification was abandoned.

- **System Hardening, Inspection & Repair Programs – Distribution (current control)**

The bulk of spending and benefits in this program are attributable to the Fire Risk Mitigation (FiRM) initiative to harden circuits through the replacement of poles and conductors. This mitigation would address wire-down incidents, which account for 25% of fires triggered by SDG&E's infrastructure. The Wildfire Risk Reduction Model combines GIS data with localized fire risk factors (fuel, dryness, wind, etc.) to quantify the risk reductions associated with changes to SDG&E's infrastructure.

WRRM places a unitless value of 12,857,000 points to the risk reduction which would be achieved by replacing all wire and poles with brand new overhead infrastructure. The FiRM team has modeled their Incremental projects for 2017, which have a unitless value of 1,214,000 points. It is assumed that the 2018 and 2019 projects will yield the same results. Finally, it is assumed that the overwhelming majority of wire down incidents are attributable to small wire and poles, but to be conservative that fraction has been set at 90%.

$$\text{\% Fires due to Wires Down} \times \frac{\text{WRRM Risk Reduction due to planned replacements}}{\text{WRRM Risk Reduction if all poles \& wire was replaced}} \times \text{\% Wires down due to poles and small conductor}$$

This amounts to a 6.4% reduction in the likelihood of triggering a wildfire.

- **Aviation Protection (current control]**

Aircraft hit wires approximately once per year in California. SDG&E serves about one-tenth of California's population, and it has been assumed that as a result there is one tenth of the infrastructure and aircraft passing through SDG&E's territory and running the risk of a collision. It is further assumed that marker balls reduce the likelihood of a collision by 50% and that SDG&E would be able to mark one tenth of potential locations in that time. If an aircraft were to collide with a wire and trigger a fire, it would increase the annual number of fire events by approximately 1%.

$$\text{Annual aircraft vs. wire events in CA} \times \text{Fraction of CA population in SDGE territory} \times \text{Estimated effectiveness of marker balls} \times \text{Percentage increase of fire events due to one aircraft event}$$

This amounts to a reduction in wildfire likelihood of 0.005%.

- **Advanced Detection (current control)**

As a situational awareness measure which enables other mitigations in this chapter, Advanced Detection has no direct and measureable benefits in and of itself. Either its cost may be loaded into an existing mitigation, or a portion of the benefit from an existing measure may be allocated back to this measure. In this case, SDG&E chose to allot 4% of the benefits accrued in the Hardening, Inspection and Repair mitigation back to the Advanced Detection measure, resulting in a 0.4% reduction in likelihood.

- **Advanced Protection (incremental mitigation)**

Advanced protection features a level of fault detection which enables SDG&E to become aware of wire-down events as the wires are falling and cut potential before the wires hit the ground. The technology requires sensors to be installed upstream and downstream of potential fault locations in order to recognize the fault signatures from both sides of the interruption. SDG&E must therefore make strategic decisions about where to install the devices, and can generally protect about 20% of each circuit upon which they install the technology. SDG&E expects to install on 10% of their circuits. The technology is assumed to be 80% effective, applies to about 70% of event types (Wire Down, Tree Contact, Vehicle, and a portion of the remaining causes), and because of redundancy with other mitigation measures, the effectiveness of the technology is discounted another 70%.

% Circuits to receive Advanced Protection × % of each circuit to be covered × % Estimated effectiveness of A.P. × % Applicable Causes × Redundancy Factor

This amounts to a reduction in wildfire likelihood of 0.34%

- **System Hardening, Inspection & Repair Programs – Distribution (incremental mitigation]**

The incremental distribution hardening spend is assumed to have a similar benefit ratio to the current WRRM-based distribution hardening spend. The projected risk reduction for the incremental distribution hardening efforts amounts to 5.3%.

- **System Hardening, Inspection & Repair Programs – Transmission (incremental mitigation)**

The transmission hardening spend has been assumed to be less efficient than the distribution spend on the basis that fewer fires are triggered by transmission systems than by distribution systems. As such the per-dollar benefit of the transmission programs was fixed to approximately 40% of the per-dollar distribution benefit. The projected risk reduction for the transmission hardening efforts amounts to 3.6%.

8.3 Risk Spend Efficiency Results

Based on the foregoing analysis SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

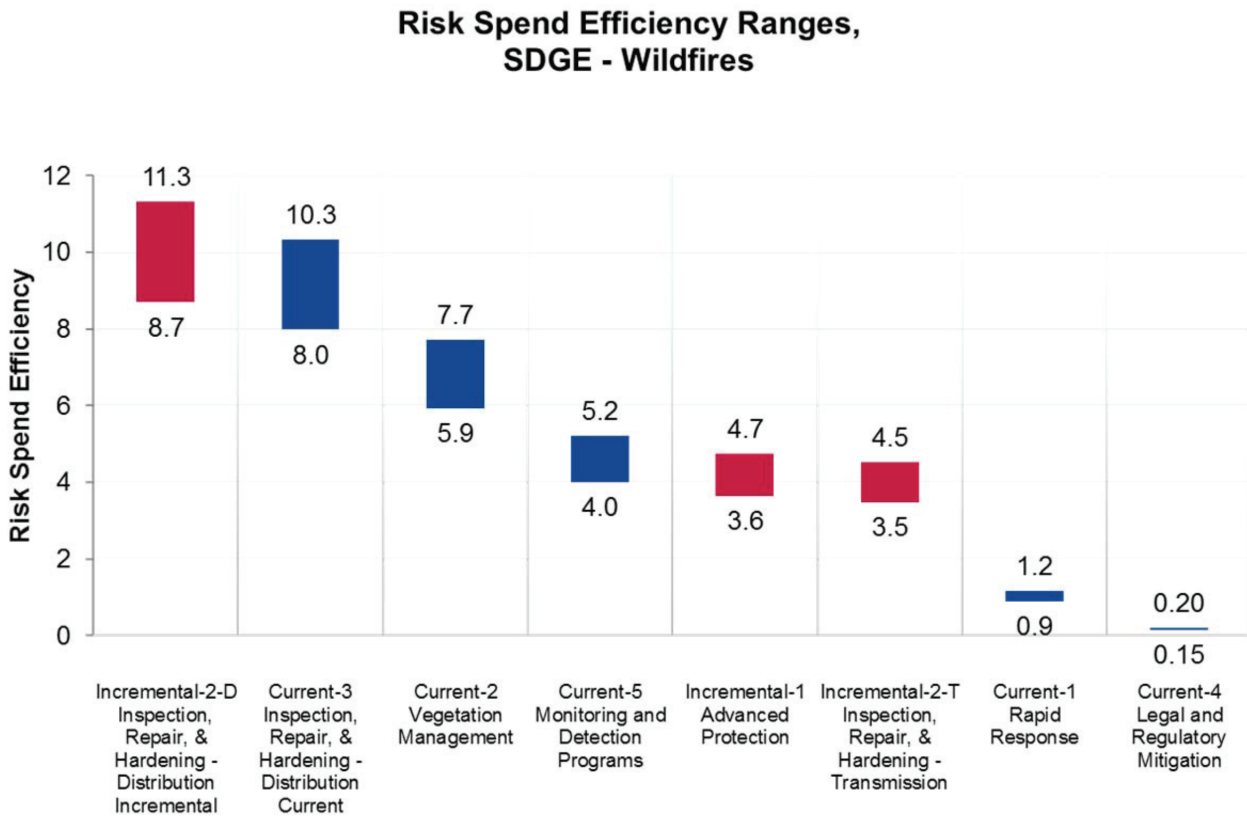
1. Inspection, Repair & Hardening – Distribution (incremental mitigations)
2. Inspection, Repair & Hardening – Distribution (current controls)
3. Vegetation Management (incremental mitigations)
4. Monitoring and Detection Programs (incremental mitigations)
5. Advanced Protection (incremental mitigations)
6. Inspection, Repair & Hardening – Transmission (incremental mitigations)
7. Rapid Response (current controls)
8. Legal and Regulatory Mitigation (current controls)

Figure 3displays the range[25] of RSEs for each of the SDG&E Wildfires risk mitigation groupings, arrayed in descending order.[26] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

[25] Based on the low and high cost ranges provided in Table 5 of this chapter.

[26] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 3: Risk Spend Efficiency



9 Alternative Analysis

SDG&E considered alternatives to the proposed mitigations as it developed the proposed mitigation plan for the Wildfires risk. Typically, alternatives analysis occurs during vendor selection and when implementing activities, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources.

9.1 Alternative 1 – Extensive Use of Falling Conductor Protection (FCP)

Currently, SDG&E uses a programmatic approach to fire prevention (as noted in its Fire Prevention Plan). For this alternative, SDG&E has considered replacing its programmatic program with the exclusive use of FCP. Depending on the physical configuration of the circuit, FCP may be faster to deploy; however, FCP is a new technology and has not yet been in place long enough to fully evaluate its effectiveness. In addition, long circuits with branches near or at the end of circuits are problematic due to their physical location in relation to monitors.

Currently, Engineering estimates the methods to be 70% effective when an FCP operates. Also, the dependency on circuit configuration, where a switch must be in communication with a reactive monitor device downstream in order for the coordination and algorithm to function, essentially would negate the use of FCP, especially on smaller, end of circuit branches. Further, the intent of FCP is to stop or decrease the likelihood of an ignition occurring due to a wire down event. Nonetheless, it does not address the issue of a wire coming down. System hardening would still need to be deployed. Accordingly, SDG&E dismissed this alternative in favor of its proposed plan to test FCP monitoring along with system hardening measures.

9.2 Alternative 2 – Undergrounding the FTZ

Consideration to underground the overhead electric system in the FTZ was considered as an alternative. If this alternative were pursued, the likelihood of the system serving as a source of ignition would be reduced. But, moving equipment underground does not fully remove the risk of fire due to some of the components being pad mounted (such as switches) that are a factor in events such as vehicular incidents. In addition, the cost of undergrounding electrical equipment would be very expensive (estimated in the billions of dollars) due to difficult terrain, unknown land and environmental issues, as well as the added cost of the facilities. Undergrounding also can increase restoration times due to underground fault location.

Risk Assessment Mitigation Phase
Risk Mitigation Plan

Catastrophic Damage Involving Third Party Dig-Ins (Chapter SDG&E-2)

November 30, 2016

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Executive Summary

The Catastrophic Damage Involving Third Party Dig-Ins (Dig-Ins) risk relates to the potential impacts from third party activities that result in a dig-in.

To assess this risk, San Diego Gas & Electric (SDG&E) first identified a reasonable worst case scenario, and scored the scenario against five residual impact categories (e.g., Health, Safety, Environmental; Operational & Reliability, etc., discussed in Section 4). Then, SDG&E considered as a baseline, the SDG&E mitigations in place for Dig-Ins in 2015 (mitigations are discussed in Section 5) and estimated the costs (costs are summarized in Section 7). SDG&E identified the following controls as of 2015: (1) Training; (2) Locate and Mark Activities; and, (3) Damage Prevention Public Awareness.

These controls focus on safety-related impacts (e.g., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability.

Based on the foregoing assessment, SDG&E proposed future mitigations. For Dig-Ins, SDG&E proposed to continue the four control categories from its 2015 baseline. In addition, SDG&E proposed enhancements within each category as well as incremental programs that aim in reducing frequency. The enhancements include, for example, increased resources to perform locate and mark activities in anticipation of increase demand due to new legislation; an additional resource to analyze the excavation reporting collection and data and to develop improvement action plans; and issuing smart devices to capture photographs of location marks.

Next, SDG&E developed the risk spend efficiency (sometimes referred to as RSE). The risk spend efficiency is a new tool that SDG&E developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The assessment was completed using three mitigation groupings. The following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. In-field dig-in prevention and improvements and current public awareness (current controls)
2. In-field dig-in prevention and improvements (incremental mitigations)
3. Admin-side analysis (incremental mitigations)

Finally, SDG&E considered two alternatives to the proposed mitigations, and in the final section of this chapter, SDG&E explains the reasons those alternatives were not included into its proposal.

Risk: Catastrophic Damage Involving Third Party Dig-Ins

1 Purpose

The purpose of this chapter is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of a dig-in, caused by third party activities, which results in catastrophic consequences (e.g., dig-ins on underground piping and facilities, referred to herein as Dig-Ins). In many cases, people or companies excavate in the vicinity of a buried utility infrastructure without realizing the infrastructure is there.[1] These third party excavation activities can vary based on project sizes. An example of small excavation activity is a homeowner performing landscaping work in their yard. Larger excavation activities include farmers grading/tilling their land, and construction companies digging in roadways or performing other underground infrastructure work.

This risk is focused on the more serious results of third party damage that lead to a release of natural gas with the possibility of hazard to life and property. The release of natural gas may not just occur at the time of the damage. A leak or rupture may also occur after the infrastructure has been damaged and reburied but becomes weakened over time. Typically, contractors and homeowners do not intentionally damage underground substructures. This risk is limited to those cases where there is no intent to damage the gas infrastructure.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the amount of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of the utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[2] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, the

[1] A discussion of potential dig-ins drivers is provided in Section 3.2.
[2] Commission Decision (D.) 14-12-025 at p. 31.

RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

2 Background

Across the spectrum, third-party damage to pipelines can range from minor scratches or dents, to ruptures with an uncontrolled release of natural gas. Serious consequences may be realized if an event occurs because of this risk. For example, if a leak or rupture occurs, an ignition of the released gas could cause an explosion and/or fire where people nearby could be seriously injured.

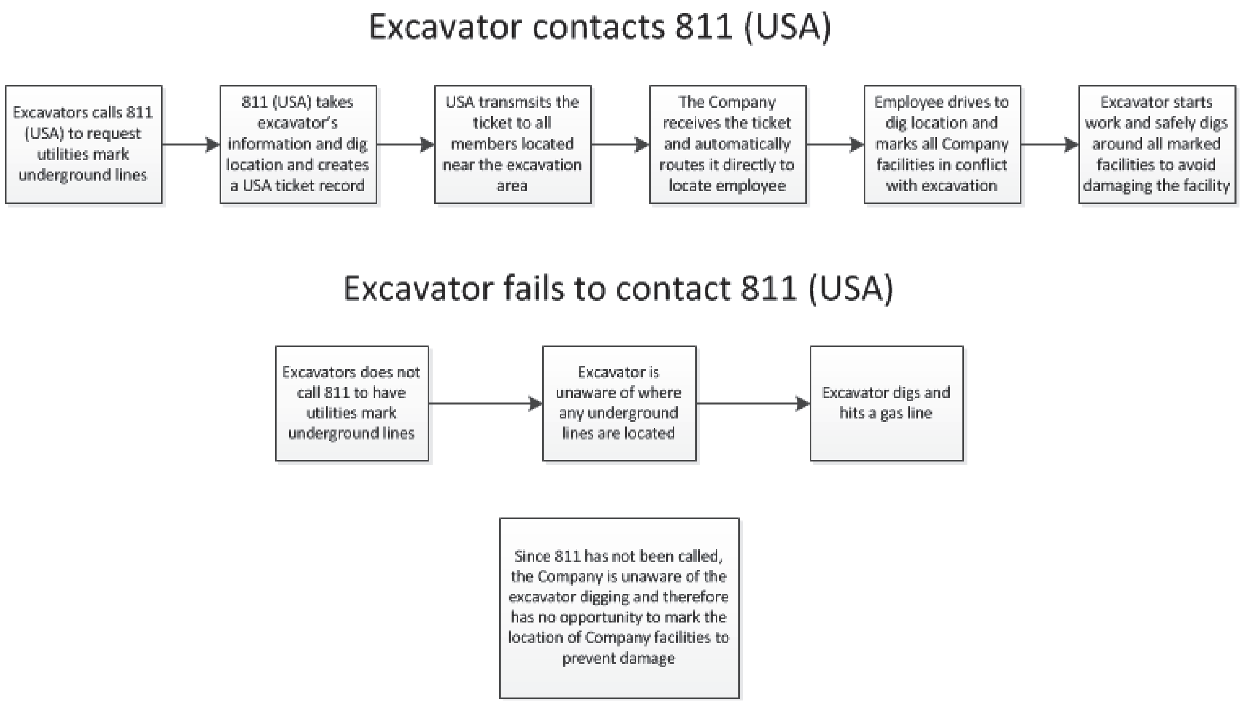
Past incidents substantiate these risks:

- In 2015 a Pacific Gas and Electric Company (PG&E) High Pressure Transmission line was ruptured when an excavator failed to schedule a standby for farm work near Bakersfield, California. The excavator proceeded to dig over the Transmission facility and struck the line, causing an explosion that killed the excavator, destroyed the excavation equipment, and damaged buildings miles away.
- In 2015 a PG&E High Pressure Transmission line was ruptured when an excavator failed to call 811 in Fresno, California. The excavator was grading over the Transmission facility and struck the line, causing an explosion that killed the excavator, and injured several others.

Under State Law, third parties planning excavation work have the responsibility of contacting the Regional Notification Center for their area, also known as 811, Underground Service Alert (USA), or DigAlert, at least two (2) full working days prior to start of their construction excavation activities. Once the third-party makes contact, the Regional Notification Center will then issue a USA Ticket notifying local utilities and other operators of the location and areas to be inspected for potential conflicts with the pending excavation work. Operators are required to mark their underground facilities via aboveground identifiers (e.g. Paint, chalk, flags, whiskers) to designate where underground utilities are positioned, thus enabling third-parties, like contractors and homeowners, to know where these structures are located. State law also requires third party excavators to use careful, manual (hand digging) methods to expose substructures prior to using mechanical excavation tools.

Figure 1 below illustrates the sequence of events when a third party calls 811 (USA) prior to conducting excavation work, and what can occur when they do not.

Figure 1: Excavation Contact Process Flow



As can be seen from the above flow charts, while there may be more steps when a third party calls 811 prior to commencing the excavation work, it is more likely to result in a positive outcome compared to when a call is not made. Having third-parties call 811 before digging is critical, and can significantly reduce the likelihood of a potential event if the correct processes are followed.

SDG&E operates and manages a natural gas system of over 14,000 miles of Distribution pipe and 228 miles of Transmission pipe within its 4,100 square mile service territory. This large piping network and large service territory exposes the Company to potential dig-in related issues.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand, analyze, and categorize risks."[3] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within

[3] A.15-05-002, filed May 1, 2015, at p. JMD-7.

its evaluation and prioritization of risks.[4] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Dig-Ins risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as a gas, operational risk as shown in Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	GAS	HIGH PRESSURE (>60 PSIG)
OPERATIONAL	GAS	MEDIUM PRESSURE (≤60 PSIG)

3.2 Potential Drivers[5]

When performing the risk assessment for Dig-Ins, SDG&E identified potential indicators of risk, referred to as drivers. These include but are not limited to the following:

1. **Third party contractors or homeowners/renters do not call a one-call center for locate and mark prior to their excavation.**

   Despite the creation of Regional Notification Centers to make it easy for the public to have underground infrastructure located and marked, and large advertising campaigns to alert the public of the need for doing so, incidents are still occurring where excavations are conducted without calling the one-call center for locating and marking underground utility infrastructure. Third party failure to contact the Regional Notification Center prior to excavating is the leading contributor of damage to Company pipelines. Third parties can damage or rupture underground pipelines and potentially cause property damage, injuries or even death, if gas lines are not marked; lines cannot be marked if the regional notification center is not contacted.

   This risk driver is the most frequent root cause of dig ins as it accounts for approximately 50% of dig-in damages to buried Company facilities. When an excavator chooses to dig without calling 811, the excavator assumes a risk that is out of the Company's control. Without receiving an 811 ticket, the Company has no opportunity to mark its facility within the area of excavation.

[4] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[5] An indication that a risk could occur. It does not reflect actual or threatened conditions.

2. **Company or Contractor employees performing locate and mark tasks do not mark the underground gas infrastructure correctly.**

   The Company or a Company Contractor, in some cases, inaccurately marks its facilities due to incorrect operations, such as mapping/data inaccuracies, equipment signal interference, and human error. When this happens, third parties are not provided accurate knowledge of underground substructures in the vicinity of their excavations, and the risk of damaging or rupturing gas pipelines increases.

3. **Excavator fails to comply with excavation laws or best practices in the vicinity of located underground gas infrastructure.**

   Damages often occur because the excavator fails to follow excavation legal requirements and best practices after calling USA. California State law (see Government Code Section 4216 et. seq.) requires excavators to perform several duties so that underground facilities are not damaged; for example:

   - Delineate the work location – The excavator is required to identify the excavation area with white markings so that the utility marks are provided in the correct area. If the excavator fails to delineate the work area, there is a risk that not all facilities may be marked.
   - Confirm all utilities have been marked – Before the excavation can start, the excavator must confirm all utilities listed on the USA ticket have marked, or have communicated that there is no conflict with the proposed excavation. If the excavator does not perform this duty, the excavator risks digging into a line that has not yet been marked.
   - Dig with care around marked facilities – Before using any power operated excavation or boring equipment, the excavator is required to hand expose, to the point of no conflict 24 inches on either side of the marked underground facilities, to determine the exact location of these structures. If excavators do not use care when digging near natural gas pipelines they put themselves and others at risk for injuries. The Company has an extensive public awareness program in place to educate contractors and homeowners about the dangers of not following safe excavation laws and best practices.
   - Call for re-marks if the marked facilities are no longer visible – When the excavator can no longer see the USA marks in the area of excavation, the excavator is required to call all utilities back to re-mark their facilities. If the excavator continues excavation work without requesting re-marks from the utilities, there is a risk that a previously marked facility could be damaged.

4. **Company does not respond to a one-call center request (e.g., USA) in the required timeframe.**

   The Company may not respond to USA requests within the required time frame (within two working days of notification, excluding weekends and holidays, or before the start of the excavation work, whichever is later, or at a later time mutually agreeable to the operator and the excavator). This may happen because of, e.g., human error, poor communication, or system failures.

In these cases, third parties may not know that the locate and mark activity was not performed. They, therefore, may wrongly assume that not seeing any markings at their excavation site indicates there is no gas infrastructure nearby. Without the marked gas infrastructure, third parties can damage or rupture the infrastructure if they are performing excavation activities near pipelines.

5. **Company does not perform "standby" duties when a third party is excavating in the vicinity of a high pressure (>60 psig) gas pipeline.**

Because high pressure pipelines (those that operate over 60 psig) pose a higher risk of hazard to life and property when damaged or ruptured, additional precautions are taken by the Company to observe excavation activities in the vicinity of these facilities. Qualified Company personnel are required to be present during excavation activities within 10 feet of any high pressure gas line (the presence commonly referred to as "stand-by"). The stand-by presence allows for redundancy via a Company representative should the third party not follow proper protocol during the excavation (e.g., not hand excavate near the pipeline), or the marks are determined to be inaccurate. Stand-by presence increases the excavator's awareness of all excavation requirements near the high pressure facility. These instances are given high priority since the impacts of an incident in these cases could be significant.

Table 2 below maps these five specific risk drivers to the larger driver categories in the taxonomy.

Table 2: Operational Risk Drivers

Driver Category	Dig-Ins Driver(s)
Asset Failure	Not applicable
Asset-Related Information Technology Failure	Not applicable
Employee Incident	• Company employees performing locate and mark tasks do not mark the underground gas infrastructure correctly • Company does not respond to a one-call center (e.g., USA) request in the required timeframe • Company does not have personnel perform "standby" duties when a third party is excavating in the vicinity of a high pressure (>60 psig) gas pipeline
Contractor Incident	• Excavator fails to comply with excavation laws or best practices in the vicinity of located underground gas infrastructure • Excavator does not call USA at least two working days before starting excavation work • Excavator begins work without notifying the Company, and as a result the Company does not perform "standby" duties during excavation near a high pressure (>60 psig) gas pipeline
Public Incident	• Third party contractors or homeowners/renters do not call a one-call center for locate and mark prior to their excavation • Excavator fails to comply with excavation laws or best practices in the vicinity of located underground gas infrastructure • Excavator begins work without notifying the Company, and as a result the Company does not perform "standby" duties during excavation near a high pressure (>60 psig) gas pipeline
Force of Nature	Not applicable

3.3 Potential Consequences

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

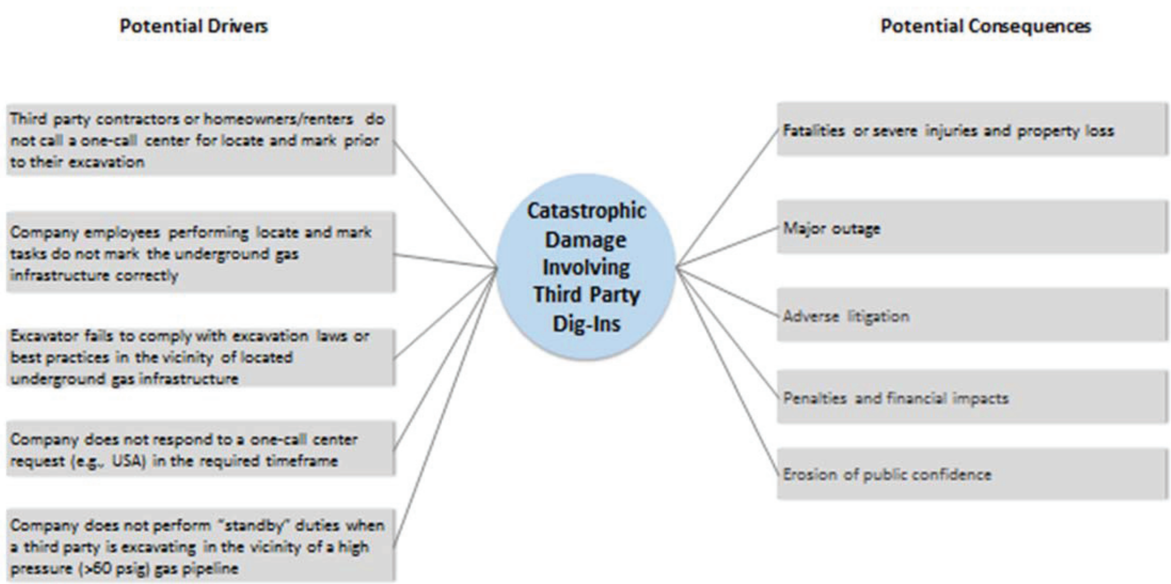
- Fatalities or severe injuries and property loss.
- Major outage.
- Adverse litigation.
- Penalties and financial impacts.
- Erosion of public confidence.

These potential consequences were used in the scoring of Dig-Ins that occurred during the SDG&E's 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown in Figure 2, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

Figure 2: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Dig-Ins as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many, possible ways in which a dig-in can occur. For purposes of scoring this risk, subject matter experts (SMEs) applied a reasonable worst case scenario to assess the impact and frequency. The hypothetical scenario represented a situation that could be expected to happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The SMEs selected a reasonable worst case scenario to develop a risk score for Dig-Ins and the scenario selected to assess the Dig-Ins risk is:

- A natural gas pipeline ruptures due to third-party excavation work in a populated business district during business hours, which results in fatalities, injuries, and substantial property damage.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, SMEs then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[6] Using the levels defined in the REF, the SMEs, applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3: Risk Score provides a summary of the Dig-Ins risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, SDG&E included this risk in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

[6] D.16-08-018 Ordering Paragraph 9.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	4	3	4	5	233,365

4.3 Explanation of Health, Safety, and Environmental Impact Score

Dig-ins have led to fatalities and injuries; for instance, consider the two instances in 2015 discussed in Section 2.[7] Accordingly, this risk was scored a 6 (severe) in the Health, Safety, and Environmental impact category.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, the following scores were assigned to the remaining residual risk categories.

- **Operational and Reliability:** Based on the scenario of a dig-in that results in a pipeline rupture, a score of 4 (major) was given in the Operational and Reliability impact category. This is due to past events that have resulted in major outages. Depending on the location of the damage, thousands of customers could lose service. The potential for one critical customer to lose service, especially in a business district, is far more likely to occur even in a less critical incident. Finally, loss of service over many days is not uncommon with these types of events, which may occur every 2-3 years.
- **Regulatory, Legal, and Compliance:** Next, a score of 3 (moderate) was given in the Regulatory, Legal and Compliance impact category because the controls and oversight SDG&E already has in place indicate current efforts to address this risk.
- **Financial:** Finally, a score of 4 (major) was given to the Financial impact category due to a potential costs associated with a catastrophic event, and the likelihood of multiple lawsuits and high value settlements.

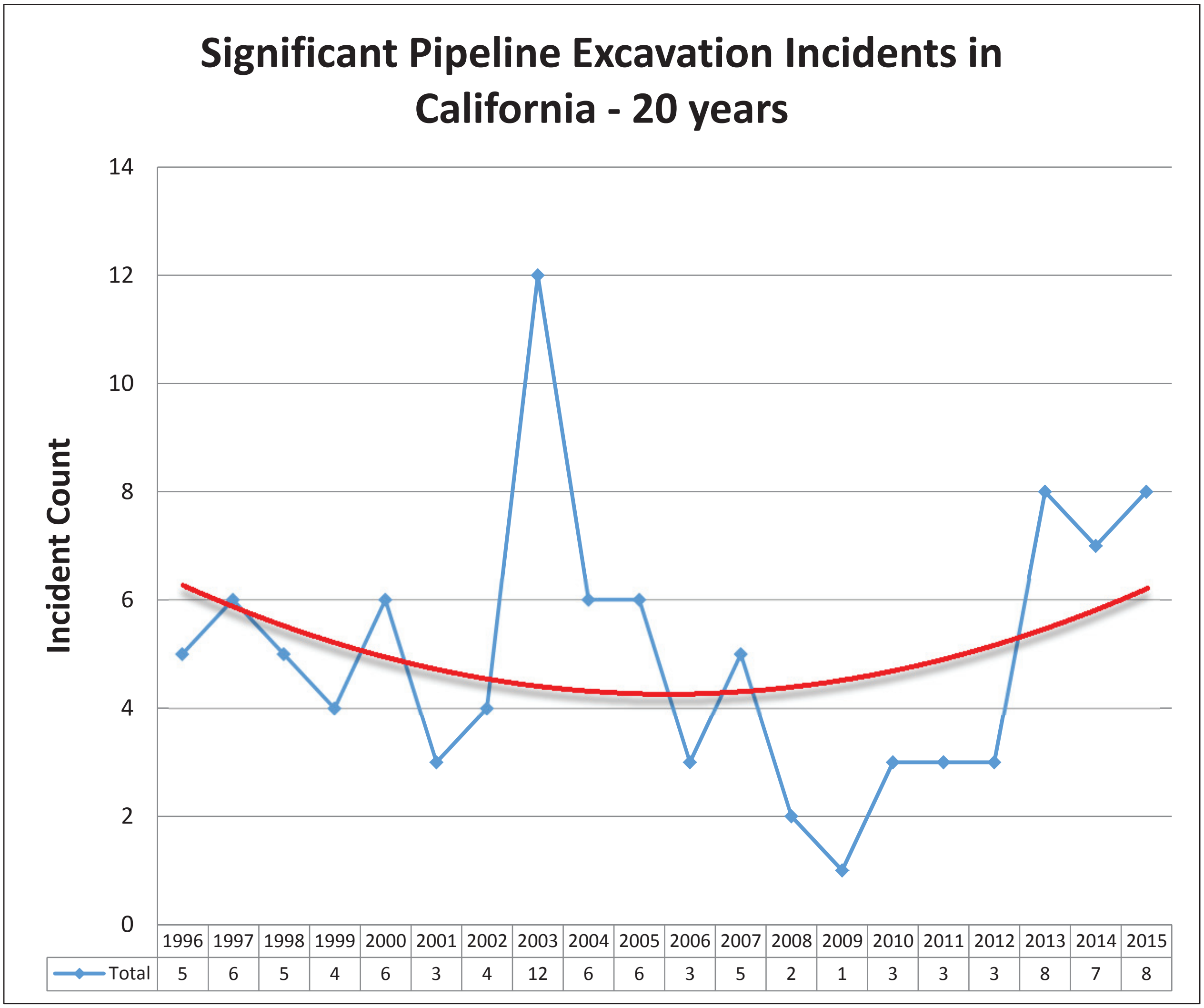
4.5 Explanation of Frequency Score

Based on the reasonable worst case scenario of a Dig-In, a score of 5 (extensive) was given for how likely this event is to occur. Although catastrophic dig-in related events have not recently occurred in SDG&E's service territory, the risk of a catastrophic dig-in related incident is very real because of the frequency with which dig-ins occur. Damage occurs in the Company's service territory almost once a day based on the 300 damage events in 2015. Approximately 50% of these damages did not have a USA Ticket.

[7] http://seuc.senate.ca.gov/sites/seuc.senate.ca.gov/files/12-17-15_background.pdf.

The graph provided below illustrates the number of significant gas pipeline excavation incidents in California over a 20-year period, from 1996-2015.[8]

Figure 3: Significant Pipeline Excavation Incidents in California



As shown above, the significant incidents involving gas pipelines in California are on the rise. Significant incidents are defined as:

1. Fatality or injury requiring in-patient hospitalization.

[8] The information is from the Pipeline and Hazardous Materials Safety Administration website: http://www.phmsa.dot.gov/pipeline/library/data-stats/pipelineincidenttrends .

2. $50,000 or more in total costs, measured in 1984 dollars.
3. Highly volatile liquid releases of 5 barrels or more, or other liquid releases of 50 barrels or more.
4. Liquid releases resulting in an unintentional fire or explosion.

Thus, the probability of this type of event occurring once every 1-3 years is reasonable, if further mitigations are not put in place.

5 Baseline Risk Mitigation Plan[9]

As stated above, the Dig-Ins risk involves impact to gas infrastructure arising from third party dig-ins. The 2015 baseline mitigations discussed below include the current evolution of the utilities' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include activities to comply with laws that were in effect at that time.

These controls focus on safety-related impacts[10] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[11] as well as controls and mitigations that may address reliability.[12] Accordingly, the controls and mitigations described in this section and in Section 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed risk mitigation plans are intended to address various events and is not limited to the reasonable worst case risk scenario used for the Risk Score (Section 4).

1. <u>Training</u>

This mitigation consists of two programs that provide employees the tools to perform activities associated with locate and mark: (1) Locate and Mark training and (2) Locate & Mark Operator Qualification. Adequately preparing employees, by offering educational opportunities and resources, gives them the knowledge to implement State and Company policies and procedures in a safe manner. This, in turn, helps SDG&E operate and maintain its system as well as protect employees, contractors and the public from the likelihood of an event attributable to this risk.

Locate and Mark training consists of approximately two weeks of classroom and hands-on training at the centralized training facility. This is a mandated activity in order to comply with Operator Qualification requirements, and to provide the basic knowledge to satisfactorily perform this critical task. Training schedule is dependent on annual demand.

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[9] As of 2015, which is the base year for purposes of this Report.
[10] The Current and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[11] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[12] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

Locate and Mark Operator Qualification training provides demonstrated knowledge and competency to perform locate and mark activities. It is mandated by the U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) in Title 49 CFR Part 192, Subpart N – Qualification of Pipeline Personnel (192.801 through 192.809). Specifically, this enhanced training "requires pipeline operators to document that certain employees have been adequately trained to recognize and react to abnormal operating conditions that may occur while performing specific tasks."[13] Employing resources that are formally trained to be aware and react to unusual pipeline conditions allows SDG&E to potentially protect against an adverse event before its occurrence. Locators are qualified at the end of training and then every five years. This certification is an industry standard qualification program.

2. Locate and Mark Activities

This control is comprised of three activities that are related to performing or supporting locate and mark work: (1) Locate and Mark, (2) Pipeline Observation (stand-by), and (3) Staff Support. Verifying that SDG&E is executing such tasks safely can reduce the potential of an event occurring.

The first activity is Locate and Mark, which is the actual work performed by SDG&E gas operations required to respond to over 150,000 USA notifications per year. To do this activity, SDG&E physically goes to the job site, locates any and all pipelines in the vicinity of the excavation, and marks its location appropriately. Knowing the location of the pipeline allows the third-party to avoid that area or carefully perform the excavation work to avoid contact with the pipeline. This activity is mandated by State Law (California Government Code Section 4216, and Federal law (the Code of Federal Regulation, (CFR) Title 49 part 192.614). This control activity also includes all locators, their Supervisor time, vehicles, tools, Mobile Data Terminals (MDTs), Geographical Information System (GIS)-related costs, Ticket routing systems, Dispatch support, locating materials, fees to Regional Notification Centers, and quality assurance.

The second Locate and Mark activity is Pipeline Observation (stand-by). In accordance with Title 49 CFR 192.935, Pipeline Observation (stand-by) is a mandated activity that requires a qualified Company representative to be present anytime excavation activities take place near a covered pipeline segment. Furthermore, the Company requires this activity for all pipelines operating at high pressure (pressure above 60psig), which is an industry best practice. This activity occurs daily in both Distribution and Transmission operations. The purpose of this function is to decrease the likelihood of an event occurring that otherwise could have been prevented by having another pair of qualified eyes observing the work being done. This is a best practice in the gas industry, and is critical to the safety of employees, contractors and the public.

The third activity is staff support. Support staff consists of one SDG&E employee who is responsible for developing and maintaining policies, processes and procedures that guide and direct locators in properly performing their assigned tasks in compliance with Federal and State regulations. Staff is

[13] http://www.phmsa.dot.gov/pipeline/tq/oq.

engaged daily in supporting operations by interpreting policies, tracking compliance, evaluating locate and mark tools and technologies, and providing refresher training as requested. This is a critical activity that allows the Company to meet or exceed State and Federal requirements, and align with industry best practices when applicable.

3. Damage Prevention Public Awareness

Public Awareness is mandated pursuant to Title 49 CFR 192.616. Its purpose is to develop and implement a continuing public education program focused on use of the one-call notification system; hazards associated with the unintended release of gas; physical indications that an unintended release of gas has occurred; steps that should be taken to protect public safety in the event of gas release; and procedures for reporting unintended releases of gas. SDG&E utilizes multiple channels for this communication such as billboards, bill inserts, radio announcements, bumper stickers, safety events, press releases, social media, and sponsorships to capture a vast audience.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. The Company's proposed mitigation plan consists of expanding some baseline activities as well as incremental programs that aim in reducing the frequency of a Dig-In.

1. Training

SDG&E is proposing to maintain this baseline activity with little to no changes. As discussed in Section 5, training is critical and aims to proactively reduce the potential of a dig-in based on factors that SDG&E can control (e.g., mismarks).

2. Locate and Mark Activities

As discussed in Section 5, this mitigation includes the work of performing Locate and Mark, Staff Support and Pipeline Observation (standby). SDG&E is proposing to increase the three activities.

a. Locate and Mark

Over the last 5 years, USA tickets have increased by 15%. This growth is forecast into the future as the current California excavation law gains additional enforcement, and existing public awareness efforts increase excavators' awareness of digging laws. In 2016, the California Governor signed Senate Bill (SB) 661 which established an enforcement Board that is authorized to take action against those parties who violate the excavation law. The amendments are expected to compel more excavators to call USA, which will add upward pressure to an already increasing ticket volume in the State. As a result, more employees will be needed to perform locate and mark activities in order for the Company to meet increasing USA ticket demands and prevent marking delays.

b. Support Staff

An additional management person is needed to analyze the excavation reporting collection and data to identify trends and develop continuous improvement action plans. This person will be specialized in targeting excavation trends needing the most attention, and will have a presence in the field to meet with excavators on the jobsite and provide safe digging education. This person will also work with internal stakeholders to improve internal locate and mark activities, and provide incident investigation support. One example of this person's activities will be to identify ways to prevent excavators from digging without a USA ticket, since 50% of the Company's damages are due to the excavator failing to call USA.

c. Pipeline Observation (standby)

As discussed in 2.a., above, with the rise in USA tickets, external focus and new laws, SDG&E is anticipating that there will be an increased need for pipeline observation. Pipeline observation helps to verify that employees and contractors are performing the work safely and following Company procedures. The proposed plan assumes that the Company's standby activities will grow in the year 2019.

3. Public Awareness

SDG&E is proposing to continue this baseline activity with little to no change. Current public awareness efforts involve a variety of methods for educating excavators and potential excavators about the excavation laws and best practices. These methods include bill inserts, media campaigns, damage prevention industry memberships, sponsorships, radio advertising, internet advertising, billboard advertising, safety meetings, and more.

4. Prevention and Improvements

SDG&E proposes to issue smart devices to locators. This new mitigation will allow SDG&E to proactively manage and mitigate the likelihood of Dig-Ins. Photographs are a common practice across the industry to protect companies from liability and enhance quality of locate and mark activities. Smart devices will give the Company the capability of capturing photographs of location marks at the USA ticket location. The photographs will provide additional documentation for each USA ticket thus offering quality assurance options not currently available. These additional quality audits will improve marking accuracy.

7 Summary of Mitigations

Table 4 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) addressed by a certain control activity, and the 2015 baseline costs for Dig-Ins. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables. SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

Table 4: Baseline Risk Mitigation Plan[14]
(Direct 2015 $000) [15]

ID	Control	Risk Drivers Addressed	Capital[16]	O&M	Control Total[17]	GRC Total[18]
1	Training*	• Company employees do not mark the underground gas infrastructure correctly • Company does not respond to a one-call center request in the required timeframe	n/a	$130	$130	$130
2	Locate and Mark Activities*	• Company employees do not mark the underground gas infrastructure correctly • Company does not have personnel perform "standby" duties	250	2,200	2,450	2,450
	Public Awareness*	• Third parties do not call prior to their excavation • Excavator fails to comply with excavation	n/a	20	20	20
	TOTAL COST		$250	$2,350	$2,600	$2,600

* Includes one or more mandated activities

The mitigations and costs presented in Table 4 and 5 mitigate the risk of dig-ins. Some of the activities also mitigate other risks presented in this RAMP Report; specifically, Records Management has

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[14] Recorded costs were rounded to the nearest $10,000.

[15] The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not escalated to 2016 amounts.

[16] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.

[17] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).

[18] The GRC Total column shows costs typically presented in a GRC.

included GIS-related costs. Employee, Contractor, Customer, and Public Safety, as well as Workforce Planning, also included costs for Operator Qualification and Locate and Mark Training. Additionally, Catastrophic Damage Involving a High-Pressure Gas Pipeline Failure and Catastrophic Damage Involving a Medium-Pressure Gas Pipeline Failure have costs associated with Operator Qualification for specific personnel. Because these activities benefit Dig-Ins as well as the other aforementioned risks, the costs and benefits are being included in all applicable RAMP chapters.

A description of the costs provided in Table 4 is as follows:

1. Training
   The costs represent the student or employee labor time of attending the training, as well as materials and instructor time. Given that SDG&E does not account for employees' time in a manner that explicitly provides details about the time spent per employee on training, high level cost estimates where used.

2. Locate and Mark Activities
   The costs associated with Pipeline Observation (stand-by) and Staff Support are primarily labor. The Locate and Mark mitigation costs, as described in Section 5, also include labor as well as locating equipment (such as warning mesh, chalk, copper wire, and marker balls) and supporting technology.

3. Public Awareness
   This mitigation includes estimated costs for excavator education, advertising and media expenses, promotional, instructional and educational materials, and labor associated with supporting these activities.

Table 5 summarizes SDG&E's proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan, and is not requesting funding approval. SDG&E will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 5 the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 5: Proposed Risk Mitigation Plan[19]

(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[20]	2019 O&M	Mitigation Total[21]	GRC Total[22]
1	Training*	• Company employees do not mark the underground gas infrastructure correctly • Company does not respond to a one-call center request in the required timeframe • Company does not have personnel perform "standby" duties	n/a	$120 - 140	$120 - 140	$120 - 140
2	Locate and Mark Activities*	• Company employees do not mark the underground gas infrastructure correctly • Company does not have personnel perform "standby" duties	740 - 820	2,600 - 2,870	3,340 - 3,690	3,340 - 3,690
3	Public Awareness*	• Third parties do not call a one-call center prior to their excavation • Excavator fails to comply with excavation laws	n/a	19 - 21	19 - 21	19 - 21
4	Prevention and Improvements	• Third parties do not call a one-call center prior to their excavation	n/a	20 - 30	20 - 30	20 - 30

[19] Ranges of costs were rounded to the nearest $10,000.
[20] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
[21] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[22] The GRC Total column shows costs typically represented in a GRC.

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[20]	2019 O&M	Mitigation Total[21]	GRC Total[22]
		• Excavator fails to comply with excavation laws • Company employees do not mark the underground gas infrastructure correctly • Company does not respond to a one-call center request in the required timeframe				
	TOTAL COST		$740 - 820	$2,760 - 3,060	$3,500 - 3,880	$3,500 - 3,880

☐	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

1. Training
   SDG&E does not expect a significant change in this activity when compared to the historical financial information. Therefore, the basis for the forecasted costs is the five-year historical average of 2011 to 2015. A range was then developed because the amount of Locate and Mark training and Operator Qualifications may vary on an annual basis.

2. Locate and Mark Activities
   The three projects/programs in this mitigation (Locate and Mark, Support Staff and Pipeline Observation) are being expanded in 2017-2019.

   - Locate and Mark - The increased costs are labor-related and are based on employee classification wages related to each additional employee. A range was identified to provide flexibility with respect to the employee classification.
   - Support Staff - The incremental costs are forecasted for a typical management salary for one employee. A range was identified to provide flexibility with respect to the level of employee and the desired expertise.
   - Pipeline Observation - The costs are based on the 2015 recorded costs, and a percentage increase in standby work based on the forecasted increase in USA tickets.

3. Public Awareness
   SDG&E does not expect a significant change in this activity from 2015. Accordingly, the basis for the forecasted costs is the five-year historical average of 2011 to 2015. A range was then developed because the amount of Public Awareness spending may vary on an annual basis.

4. Prevention and Improvements
   Costs were estimated using a zero-based forecast methodology because this is a new mitigation. The costs in Table 5 include estimates for the acquisition of the initial smart device and ongoing monthly telecommunications service contracts.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent.[23] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018. [24]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies

[23] D.16-08-018 Ordering Paragraph 8.
[24] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

(e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).

2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[25] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another.

Figure shows the RSE calculation.

Figure 4: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

[25] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 5 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Dig-Ins risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

The Proposed Risk Mitigation Plan in Section 7 identified five mitigations:

1. Training
2. Locate and Mark Activities
3. Public Awareness
4. Prevention and Improvements
5. Analysis

For purposes of calculating Risk Reduction, the Company further combined these four mitigations into three groups, based on their applicability to potential dig-in drivers, the inter-dependencies of their components, and whether they were current controls or incremental mitigations, as follows:

(a) In Field Activities and Public Awareness (current controls) – includes mitigations 1, 2, 3, and 4
(b) In Field Activities and Improvements (incremental mitigations) – includes mitigations 1, 2, and 4
(c) Admin-side Analysis (incremental mitigations) – includes mitigation 4

An important aspect of this risk is that the starting risk score for Catastrophic Damage Involving Third Party Dig-Ins was the same for both SoCalGas and SDG&E. However, as SDG&E has less than 1/6 the mileage of pipe, and thus less than 1/6 the exposure to this risk, the RSE calculations for SDG&E dig-ins include an adjustment that considers each company's relative miles of pipeline.

- Current In-field dig-in prevention and improvements, and Current Public Awareness (Group a)

This mitigation grouping combines current Public Awareness, Locate and Mark, and other Dig-In Prevention activities, as they are inter-dependent. For example, if public awareness activities were discontinued, there would be far fewer, if any, calls for locate and mark; conversely, if locate and mark activities were discontinued, public awareness alone would not be effective in reducing dig-ins. The Company's analysis addressed each activity separately to identify their respective contributions to risk reduction and then combined the results to determine the overall risk reduction from this mitigation grouping.

- Analysis of Public Awareness activities: According to information in "Reliability-based Prevention of Mechanical Damage to Pipelines (PR-244-9729)," 60% of the people who are very likely to call when they are aware of the option to call in are responsible for 40% of the dig-ins. With an implied 40% of the people responsible for 60% of the dig-ins, the people who don't call cause 2.25 times the dig-ins than those that do. In 2015 SDG&E incurred 137 dig-ins where there was a call and 175 incidents from failure to notify the one-call center. Multiplying the 137 by 2.25 resulted in an increase in the total number of dig-ins by approximately 55%. The risk assessment team used 54.9% for an estimate of the risk increase if funding for baseline public awareness were discontinued.

- Analysis of Dig-In Prevention activities: The assessment of the risk reduction contribution from current dig-in prevention activities was based on the analysis for incremental dig-in prevention, which is discussed below.

• Incremental In-field Activities and Improvements, and Incremental Admin-side Analysis (Groups b and c)

To assess the risk reduction contributions for the incremental mitigations in Groups b and c, SDG&E used its dig-in incident database, which categorizes dig-in damages by cause. First, for each of the mitigation categories (in-field work and admin-side analysis) the Company identified the share of each damage cause category associated with each mitigation category. Next, SDG&E then totaled the damages within each mitigation grouping. SMEs then estimated the effectiveness of each mitigation in reducing the likelihood of dig-ins in each respective mitigation group (e.g., the extent to which in-field work mitigations affected the in-field work share of the total dig-ins). Summing the resultant number of reduced dig-ins by category and dividing by the total dig-ins yielded that category's effectiveness:

- Incremental In-field dig-in prevention and improvements was determined to have a risk reduction effectiveness of 13%.
- Incremental Admin-side Analysis was determined to have a risk reduction effectiveness of 5%.

8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

4. In-field dig-in prevention and improvements and current public awareness (current controls)
5. In-field dig-in prevention and improvements (incremental mitigations)
6. Admin-side analysis (incremental mitigations)

Figure displays the range[26] of RSEs for each of the SDG&E Dig-In risk mitigation groupings, arrayed in descending order.[27] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart. As with most risks, the current mitigations provide the highest risk reduction per dollar, compared to the incremental mitigations.

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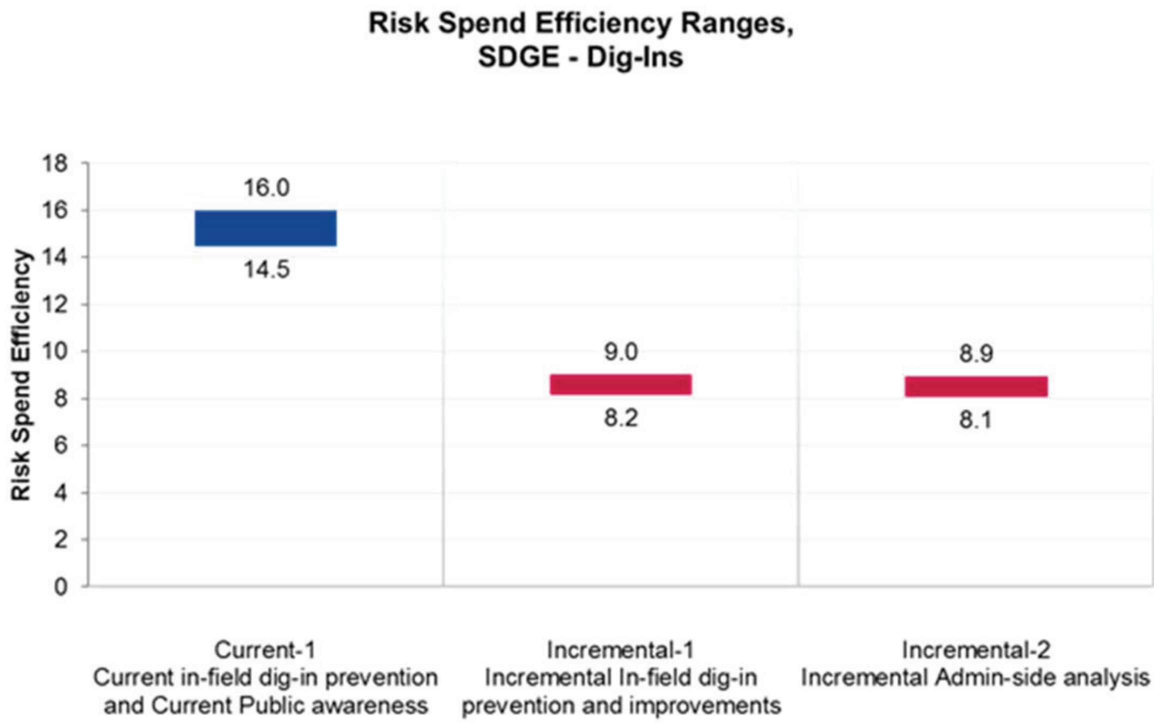
[26] Based on the low and high cost ranges provided in Table 5 of this chapter.

[27] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 5: Risk Spend Efficiency



9 Alternatives Analysis

SDG&E considered alternatives to the proposed mitigations as it developed the proposed mitigation plan for the Dig-Ins risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis also took into account modifications to the proposed plan and constraints, such as costs and likelihood of success.

9.1 Alternative 1 – Reduce Contract Locating Usage

SDG&E considered whether to reduce the level of its reliance on contractors. While contractors play a key role in the Company's operations, their performance in this area has not been as high as those of the Company's own locators. Selecting this alternative would require additional resources and, in turn, increase costs. Due to resource flexibility constraints, this alternative was not selected in favor of the proposed plan. Further, it should be noted that to address the issue of contractors' performance, SDG&E has proposed improvements to its Contractor Safety program (see RAMP chapter, Employee, Contractor and Public Safety).

9.2 Alternative 2 – Dedicated Standby Group

SoCalGas also considered whether to separate Locators, who perform standby activities, into their own functional group. This would allow for more focused staffing levels around these efforts, particularly high-pressure pipelines which could have incidents with significant impacts. This alternative was dismissed because a dedicated group performing standby activities would eliminate the flexibility to use these Locators for other tasks when needed. Thus, creating the need for additional resources. Accordingly, the proposed plan is preferred because this alternative could limit operational flexibility and add incremental costs for additional resources.

Risk Assessment Mitigation Phase

Risk Mitigation Plan

Employee, Contractor and Public Safety

(Chapter SDG&E-3)

November 30, 2016

310360

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Executive Summary

The Employee, Contractor and Public Safety risk is the risk of non-adherence to safety programs, policies and procedures, which may result in severe harm to employees, contractors and the general public. SDG&E's 2015 baseline mitigation plan for this risk consists of eight controls:

1. Comprehensive Health and Safety risk management framework and organization including an Environmental & Safety Compliance Management Program (ESCMP).
2. Mandatory employee training.
3. Field observations on employee and contractor safety behaviors including SDG&E's Behavior Based Safety (BBS) Program.
4. Regular safety meetings, such as routine safety meetings, safety tailgates, safety committee meetings, safety stand-downs, and Executive Safety Committee Meetings.
5. Ongoing maintenance programs.
6. Customer communications and First Responder training.
7. Contractor safety.
8. Customer orders related to public safety.

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability.

SDG&E will continue the 2015 baseline controls in the proposed plan as well as proposes to add incremental projects and programs as follows:

- Expansion of the Contractor Safety Program - SDG&E has added a Contractor Safety Program Manager and proposes implement a contractor safety system.
- Occupational Safety and Health Administration (OSHA) Voluntary Protection Program (VPP) Assessment - The VPP approach is a commitment by the Company to safety and health management. The objective of VPP is to implement programs that ultimately lead to incident reduction and/or prevention.
- Public Safety Awareness Campaign - SDG&E proposes to add a more robust public safety awareness campaign to address both gas and electric safety concerns, such as Wire Down situations.

The risk spend efficiency (RSE) was developed for Employee, Contractor, and Public Safety. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. To calculate the RSE, SDG&E used historical safety performance and incident trends in combination with subject matter expertise as the basis for the estimated benefits for current controls (i.e., 2015 baseline) and incremental mitigations (i.e., expansion of 2015 controls or new proposals).

One way in which SDG&E measures its performance with respect to safety is through its OSHA Recordable Incident rate. Another metric collected by SDG&E pertaining to safety is its Controllable Motor Vehicle Incident (CMVI) rate for its employees, which is the number of Controllable (or preventable) Motor Vehicle Incidents per million miles driven. SDG&E used these two metrics to determine the risk spend efficiency of the mitigations.

Finally, SDG&E considered two alternatives to the proposed mitigations for the Employee, Contractor and Public Safety risk, and summarizes the reasons that the two alternatives were not included into the proposed mitigations.

Risk: Employee, Contractor and Public Safety

1 Purpose

The purpose of this chapter is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the Risk Assessment Mitigation Phase (RAMP) risk of Employee, Contractor and Public Safety. The Employee, Contractor and Public Safety risk is the risk of non-adherence to safety programs, policies and procedures, which may result in severe harm to employees, contractors and the general public.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used as base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the numerous actions taken to mitigate each risk. This is the first time, however, that the utilities have presented this Risk Assessment Mitigation Phase (RAMP) submission, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities currently do not track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

2 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is

[1] Commission Decision (D.) 14-12-025 at p. 31.

to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[2] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks.[3] This includes identifying leading indicators of risk. Sections 2 – 8 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Employee, Contractor and Public Safety risk.

2.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as a cross-cutting risk because an incident could occur throughout different areas of the Company. The risk classification is provided in Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
CROSS-CUTTING	PEOPLE	EMPLOYEE CONDUCT

2.2 Potential Drivers[4]

When performing the risk assessment for Employee, Contractor and Public Safety, SDG&E identified potential leading indicators, referred to as drivers. These include, but are not limited to:

- **Deviation from policies or procedures –** SDG&E has many safety-related policies and procedures for employees and contractors to follow. Failure of someone to adhere to such Company safety policies and procedures could result in a safety-related event.
- **Non or improper use of personal protection and safety equipment –** Safety equipment serves to protect employees and contractors from avoidable injuries. Failure to wear personal protection and safety equipment can lead to a safety incident.
- **Not following motor vehicle safe driving practices –** If someone does not follow the law and or other applicable safety practices, it could result in a safety incident.
- **Damages to gas pipelines, electric infrastructure and facilities –** Damage to gas and electric infrastructure and facilities could cause an unpredictable environment and, thus, can lead to a safety incident.
- **Workplace hazards posed to employees –** Unsafe work environments, including work locations, roadways and parking places, customer premises, gas equipment condition, PCBs, lead from paint, asbestos, fumigation chemicals, etc. could lead to a safety event.

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[2] A.15-05-002, filed May 1, 2015, at p. JMD-7.
[3] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[4] An indication that a risk could occur. It does not reflect actual or threatened conditions.

2.3 Potential Consequences

If one of the drivers listed above were to occur resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

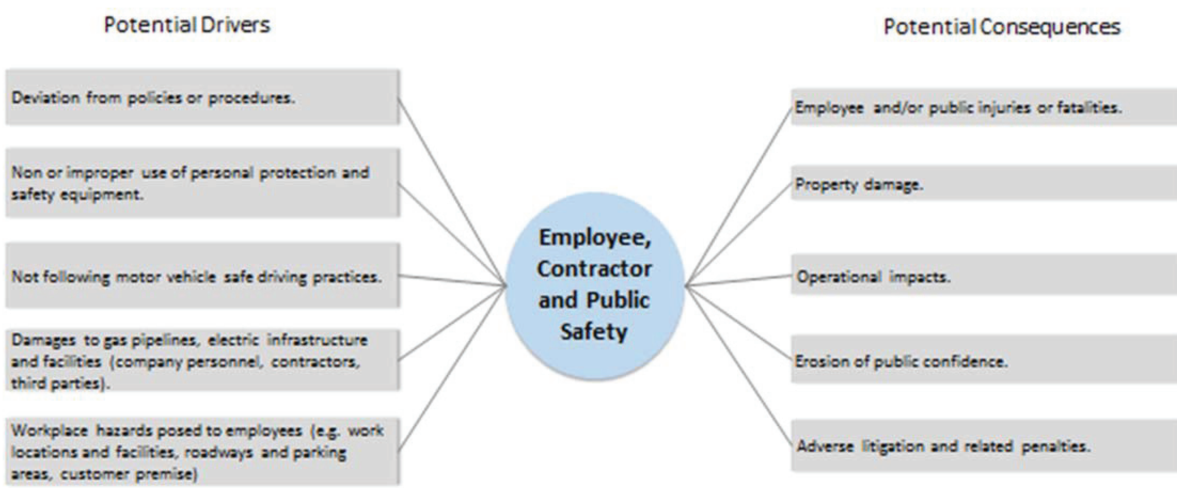
- Employee and/or public injuries or fatalities;
- Property damage;
- Disruption to operations;
- Erosion of public confidence; and
- Adverse litigation and related penalties.

These potential consequences were used in the scoring of Employee, Contractor and Public Safety that occurred during the development of SDG&E's 2015 risk registry process. See Section 3 for more detail.

2.4 Risk Bow Tie

The risk "bow tie" shown in Figure 1 is a commonly-used tool for risk analysis. The left side of the bow tie illustrates drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



3 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Employee, Contractor and Public Safety as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.[5]

3.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a public safety event can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Employee, Contractor and Public Safety:

- An employee or contractor not following a policy or procedure results in the fatality of one or more individuals – whether an employee, a contractor, or a member of the public.

[5] The "Employee, Contractor & Public Safety" risk from 2015 has been split into three distinct safety risks for 2016: "Customer Safety," "Employee Safety," and "Contractor Safety."

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if a risk occurs.

3.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[6] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 2 provides a summary of the Employee, Contractor, and Public Safety risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF and risk scoring methodology, please refer to RAMP Risk Management Framework discussion within this Report.

Table 2: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	4	4	3	4	73,796

3.3 Explanation of Health, Safety, and Environmental Impact Score

A score of 6 (severe) was given to this risk in the Health, Safety, and Environmental impact area. Failure to adhere to Company policies or procedures could result in fatalities or life threatening injuries. SDG&E strives to mitigate the drivers of this risk in an effort to avoid the realization of incidents occurring.

3.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SDG&E gave the other residual impact areas the following scores:

- **Operational and Reliability**: SDG&E rated this risk a 4 (major) because damage to Company assets and/or loss of service could be the result of an employee or contractor failing to follow a policy or procedure. For example, if failure to follow a policy or

[6] D.16-08-018 Ordering Paragraph 9.

procedure resulted in a gas pipeline explosion, the impact could be a service disruption to more than 10,000 customers; disrupt one critical location or customer; or disrupt service for one day, as defined in the 7X7 Risk Matrix.

- **Regulatory, Legal, and Compliance:** A violation that could result in financial-related penalties is considered a 4 (major) in SDG&E's 7X7 matrix. Lack of adherence to policy or procedures could result in regulatory investigations or litigation.
- **Financial:** Due to the potential for financial consequences and litigation, SDG&E rated Employee, Contractor and Public Safety a 3 (moderate) in the financial impact area. The estimated financial impacts were not expected to exceed $10 million.

3.5 Explanation of Frequency Score

Subject matter experts used empirical data to the extent available and/or their expertise to determine that the frequency of an event occurring due to the failure of an employee or contractor to follow policies or procedures is occasional or once every 3-10 years as defined in SDG&E's 7X7 matrix. This equates to a score of 4. The reasoning is that SDG&E has substantial controls in place to mitigate the realization of this risk.

4 Baseline Risk Mitigation Plan[7]

As stated above, Employee, Contractor and Public Safety risk is non-adherence to safety programs, policies and procedures, which may result in severe harm to employees, contractors and the general public. The 2015 baseline mitigations discussed below include the current evolution of the utilities' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time.

In general, most tasks performed by SDG&E employees and its contractors are related to safety. SDG&E employs both a Union and Non-Union workforce. Because the universe of potential mitigation activities related to safety is so extensive, SDG&E conducted a threshold assessment, to identify which ones to address within the scope of this risk, using the following questions:

1. Is the primary driver behind the policy, program or activity the safety of employees, contractors, customers or the public?
2. Does this policy, program or activity serve to identify the actions that should be taken to ensure the safety of employees, contractors, customers or the public?
3. Is this policy, program or activity driven by regulatory safety policy (OSHA, PHMSA, DOT, or CPUC)?
4. Does this policy, program or activity educate or alert employees, contractors or the public to potential safety hazards?

Activities and/or costs that are not included in the scope of this risk include:

- Activities performed to satisfy customer service requests (even though safety tasks are performed when completing the service request). Although work elements within some

[7] As of 2015, which is the base year for purposes of this Report.

service requests are performed for safety purposes, if the service request (work order) was not generated to specifically address safety, that service request was not included.

- Activities performed to maintain, repair or operate the gas pipeline infrastructure or Electric Infrastructure Integrity. These activities are captured in other RAMP risks.
- Computer systems (both hardware and software) used to support operations performed to mitigate safety hazards.
- Lease costs for motor vehicles used to support operations performed to mitigate safety hazards.
- The capital equipment used to mitigate safety hazards (and associated depreciation expenses).

SDG&E's baseline mitigation plan for this risk consists of eight controls: (1) Comprehensive Health & Safety risk management framework and organization, (2) Mandatory employee training, (3) Field observations on employee and contractor safety behaviors, (4) Regular safety meetings, (5) Ongoing maintenance programs, (6) Customer communications and First Responder training, (7) Contractor safety, and (8) Customer orders related to public safety. Subject matter experts collaborated to identify and document them. These controls focus on safety-related impacts[8] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[9] as well as controls and mitigations that may address reliability. Accordingly, the controls and mitigations described in Sections 4 and 5 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Employee, Contractor and Public Safety events, not just the scenario used for purposes of risk scoring. In addition, some of the activities mentioned also mitigate other risks, such as the Vegetation Management program is also a mitigation in the Wildfire risk.

Each of SDG&E's the baseline risk mitigations are described below.

1. <u>Comprehensive Health and Safety risk management framework, organization and assignment of responsibility</u>

A comprehensive health and safety risk management organization and framework is in place at SDG&E. Several organizations establish and carry out SDG&E's health and safety risk management policies, including SDG&E's Environmental & Safety Compliance Management Program (ESCMP). ESCMP is an environmental, health and safety management system to plan, set priorities, inspect, educate, train, and monitor the effectiveness of environmental, health and safety activities in accordance with the internationally accepted standard, ISO 14001. Brief descriptions of these groups follow.

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[8] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[9] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."

Safety Services

Safety Services encompasses SDG&E's Safety Operations, Safety Compliance and Wellness Programs branches. Safety Services is an organization dedicated to employee, contractor and public safety, which manages SDG&E's overall Health and Safety framework. The Safety Services department functions to:

- Reduce or eliminate incidents resulting in injury, property damage, or outages;
- Raise awareness of safety concerns and incidents through programs, regular safety campaigns and communications;
- Provide oversight and regulatory guidance to confirm adherence to policies and procedures; and
- Provide resources to integrate safety into everyday business decisions to promote the importance of safety to the overall organization's success.

Safety Services has developed policy and training programs including, but not limited to:

- Injury and Illness Prevention Program;
- Emergency Action Plan & Fire Prevention;
- Job observations;
- Incident investigation and analysis;
- Defensive driving;
- Body mechanics;
- Ergonomics;
- Contractor safety;
- Hazard communication;
- Confined spaces;
- Asbestos and lead;
- Hearing conservation, respiratory protection and personal protective equipment (PPE); and
- Public safety and substance abuse awareness and prevention programs.

Safety Operations

The Safety Operations branch of Safety Services provides field operations support including the use of Field Safety Advisors. Safety Operations supports field safety compliance audits, major safety programs, communications, management and statistical analysis. In an effort to reduce or eliminate incidents, the department provides safety training, conducts job observations, investigates and analyzes incidents, assists with the development of corrective actions, and promotes defensive driving, body mechanics, and ergonomically protective workplaces.

SDG&E monitors leading indicators to support injury prevention. One mechanism for capturing leading indicators is by conducting a bi-annual Safety Barometer Survey to assess the overall health of our safety climate and identify areas of opportunity that can help eliminate injuries and improve our focus and commitment to safety. The goal of this assessment is to increase employee participation in, and contribution to, SDG&E's ongoing efforts to continually improve its safety performance. The Safety

Operations department interprets and advises field operations regarding safety-related rules and regulations, and provides reviews of potential legislation that would impact field operations.

Field Safety advisors in the Safety Operations department serve a significant role and support all areas of the Company for:

- Support programs, initiatives and requirements for incident prevention;
- Incident investigation, including self-audits;
- Motor vehicle incident corrective action;
- Support of field operations safety committees, programs, training and compliance; and
- Technical safety support for projects to help develop plans for design/permitting and cost impacts to engineers, contractors, and other technical specialists.

Safety Compliance

The Safety Compliance branch is primarily responsible for compliance with safety regulations, establishing and managing programs, incident investigation training, policies and guidelines for the safety of SDG&E employees. This group interprets safety-related rules and regulations and provides reviews of potential legislation that would impact field operations, with the goal to maintain compliance with all federal, state and local regulations. This branch also monitors changes in employee safety and health regulations, develops internal safety policies and procedures to verify compliance with the applicable regulations, and manages company-wide implementation of key industrial hygiene programs, such as Hazard Communications, Hearing Conservation, Respiratory Protection, Asbestos and Lead Exposure Management. This area of Safety Services would also serve as a liaison during CPUC, Department of Transportation (DOT), California Highway Patrol (CHP), or Cal/OSHA audits or citations.

This branch also administers DOT-regulated and non-regulated drug and alcohol testing programs, including oversight of all pre-employment, random and other required testing of employees in safety sensitive positions at SDG&E under DOT regulations. In addition, this group addresses unique and highly complex employee issues which include but are not limited to:

- Administering the Substance Abuse Awareness and Drug & Alcohol Testing Program; and
- Rehabilitation case management.

Wellness Programs

Wellness Programs *are designed* to promote the physical and mental well-being of all company employees. These support the Company's commitment to providing quality health & wellness programs to motivate and promote safe and healthy lifestyles. Wellness Programs coordinates on-site employee assistance services for employees and work groups, including:

- Health & Education Seminars/Lectures (Stress Management, Weight Management, Nutrition, Heart Disease, High Blood Pressure, etc.)
- Fitness Subsidy Program (Company subsidy for gym membership)
- Annual Flu Immunizations

- Health Screenings (i.e., Body Fat, Cholesterol, Blood Pressure, Carotid Artery, Abdominal Aneurysm)
- Work-site programs, i.e., Weight Watchers, Yoga, Walking Class, Chair Massages, Reflexology
- Special Events (Health Fairs, Walk-a-thons, Blood Drives)
- Educational pamphlets/brochures on a variety of health & wellness topics
- Employee Assistance Programs
- Evaluation management of mental health behaviors affecting job performance, critical incidents and fitness for duty determination
- Safety stand-down support

Other examples of SDG&E safety and wellness programs include, but are not limited to:

- Facilities Maintenance Program – In addition to Facilities Capital projects designed to make workspaces safer, preventative, predictive and corrective maintenance are used to address deficiencies. Some examples include structural changes, asbestos inspection and abatement, and parking lot safety amenities.
- Traffic Control for employee and public safety at worksites.
- Vegetation Management – Tree Trim program includes inspecting and maintaining approximately 400,000 trees that have the potential to encroach within the minimum required compliance distance between vegetation and overhead power lines. Pole brushing for SDG&E involves the clearing of flammable brush and vegetation away from SDG&E distribution poles subject to California Public Resource Code (PRC), section 4292. PRC 4292 is intended to prevent energized electrical hardware from igniting a fire by keeping the area under subject poles clear of flammable vegetation at all times.
- Work Methods and Standards – Business functions related to developing and maintaining construction standards, standards practices, and system design for electric service, primary and secondary systems.
- Gas System Protection – Patrolling, Leakage Surveys, atmospheric corrosion control and odorization of gas. Mandated under Federal Regulations DOT/PHMSA Title 49.
- Occupational Health Nurse (OHN) Services – Occupational health nursing is a specialty practice that delivers health and safety programs and services to employees. The practice focuses on promotion and restoration of health, prevention of illnesses and injuries, and protection from work related and environmental hazards.
- Telemedicine – The practice of healthcare diagnosis and physician consultation using telecommunications technology. Telemedicine eliminates any wait time to see a provider by allowing quicker, real-time, on-demand evaluation for first aid and healthcare. It supports on-site first-aid injury care and injury care management.

2. <u>Mandatory employee training, retraining and refresher programs and standardized policies</u>[10]

[10] This section does not pertain to Contractors. Please see control number seven (7) regarding Contractors.

Training is a significant contributor to mitigating the Employee, Contractor and Public Safety risk. Both new (new hires, transfers or newly-assigned) and existing employees are required to complete mandatory safety and environmental training. Some training is one-time only, such as the Injury & Illness Prevention Program; other training is one-time with an annual refresher, such as driver training. Job Skills Training including Substation, Electric Regional Operations and Gas Operations job skills, Call Center Emergency Call Training, and the Apprentice Lineman Program. The Apprentice Lineman Program is a three-year (6,000 hours) apprenticeship consisting of formal training at Skills Training Center, on the job training and night school (San Diego Community College). Each step in the program is six months in length. There are three State approved apprentice programs. Apprentice program positions include lineman, electrician and meter tester. The program is a phased approach and the apprentice must pass each step of the program to advance to the next step. Also there is a variety of role-specific training including: SDG&E employees are required to take web-based training. For ESCMP, the year-end training certification process consists of:

Course Completion: Environmental & Safety (E&S) mandatory training is complete (and certifiable) only when the course has been taken by the employee AND is recorded as complete in the Company personnel records system (My Info).

Records: The use of a course code in My Info documenting that an employee completed Company specified mandatory training is only allowed when the actual course corresponding to the course code was taken by the employee (either instructor-led or e-learning). This is limited to courses available from the Safety and Environmental websites, with the exception of courses provided by outside vendors where prior approval of the correct subject matter expert has been given (*e.g.,* Remedy Ergonomics).

Calendar Year: Only E&S mandatory training that was completed during a calendar year applies to the annual ESCMP certification process for that year.

Timing for Training: The timing for mandatory employee training for Existing Employees, New Hires, Transfers, or Newly Assigned Employees is described below:

Existing Employees:

Safety and Environmental
Existing employees (*start date prior to 1/1 of current year*) must complete all applicable **mandatory** training by 12/31 of the current year.
Exception: Existing employees who are completely absent from 10/1-12/31 (and who did not complete all applicable mandatory training prior to absence).

New Hires, Transfers, or Newly Assigned Employees:

Safety
New hires, transfers, or newly assigned employees should complete **mandatory initial** training within 30 days of hire, transfer, or assignment, unless specified otherwise in the course code description.
Employer shall review with each employee upon initial assignment those parts of the Emergency Action Plan which the employee must know to protect the employee in the event of an emergency.

Environmental
New hires, transfers, or newly assigned employees must complete **mandatory initial** training within 90 days of hire, transfer, or assignment.
New hires, transfers, or newly assigned employees hired, transferred, or assigned after 10/1 should attempt to complete **mandatory initial** training by 12/31 but are still authorized up to 90 days to complete.

Initial, One-time Mandatory Training:

Where a mandatory E&S training course requires only an **initial** training, proof of that training must be recorded in My Info in order to certify that training is complete. If other written record exists, the information must be entered into My Info to establish a record of the training. If no other written record exists, employee must re-take training, and the information must be entered into My Info. Smith System® Driving records are not included in this requirement.

Examples of such training are:

Injury & Illness Prevention Program (IIPP)

Emergency Action Plan and Fire Prevention (EAP) for employees who are not located at Century Park, Lightwave and Sempra HQ.

Initial Mandatory Training with Annual Refresher:

Where a mandatory E&S training course requires an *initial* training session and an *annual* refresher, proof of the *initial* and *annual refresher* training must be recorded in My Info each calendar year. If there is no proof of initial training available, then the initial course must be re-taken and the completion recorded in My Info, with the following exceptions:

Smith System® Driving: For those employees required to complete the initial Smith System® Driving training and annual refreshers, and for whom there is no history of completing the initial training, we will accept (for ESCMP certification purposes) a history of taking an annual refresher.

Emergency Action Plan and Fire Prevention (EAP) for employees who are located at Century Park, Lightwave and Sempra Headquarters facilities.

3. Field observations of and feedback on employee and contractor activities and safety behaviors

SDG&E's Behavior Based Safety (BBS) Program is a proactive approach to safety and health management, focusing on principles that recognize at-risk behaviors as a frequent cause of both minor and serious injuries. The purpose is to reduce the occurrence of at-risk behaviors by modifying an individual's actions and/or behaviors through observation, feedback and positive interventions aimed at developing safe work habits. The BBS training process is observer training. It is peer-to-peer training which teaches the observers to identify and promote safe behaviors while providing feedback for potential exposure to risk. It empowers employees to not only control their own safe behaviors, but the company's as well.

4. Regular Safety Meetings

Safety meetings are scheduled to occur on a regular basis. Examples of safety meetings are:

- Routine safety meetings per Cal-OSHA
- Safety tailgates
- Safety committee meetings
- Safety stand-downs
- Executive Safety Committee Meetings

Routine safety meetings are attended by operational personnel. Agenda items include:

- Company-wide safety messages and updates;
- Discussion surrounding near miss/close call events;
- Business unit related materials;
- Updates to policies and standards; and
- Hazard identification.

Operational personnel also attend safety tailgates. Typically, these are held at the workplace or at the jobsite and facilitated by a Supervisor. Tailgates are designed to review the job prior to work starting, so that everyone understands the task at hand. The tailgate allows opportunity to discuss problems or issues at the site including hazard identification and protection plans. Work stop authority is also reiterated to employees including the importance of public safety. These are documented by tailgate sheets signed by attendees.

Safety Committee Meetings are held monthly in many departments at SDG&E. There are roughly 65 safety committees company-wide, which include over 500 employees. Safety Committee Meetings address district/location specific issues and plan Safety Stand-downs. Company-wide Safety Committee Chairpersons meet with the Safety Advisory Team (SAT) quarterly to disseminate company-wide safety information. The SAT team includes the Director and Manager of Safety, Field Safety Advisors and office Safety Advisors. SAT teams discuss current events regarding safety, with the intent that Safety Chairpersons will share the information with their individual workgroups. For example, if there is an influx of slips, trips and falls, the SAT team will discuss messaging and tips to take back to the groups to reduce these incidents and keep employees safer.

Safety Stand-downs are held annually or bi-annually, usually for a half-day, to:

- Bring in experienced speakers to discuss various safety topics;
- Provide employees with workshops to learn about safety in their area;
- Introduce grassroots ideas to the districts; and
- Solicit participation in safety related activities.

Executive Safety Council Meetings are led by the Chief Operating Officer (COO), comprise members from the Senior Management Team and are held quarterly at various locations. Agenda items include:

- Employee dialogue sessions – Employees of varying levels have the opportunity to speak directly with the executives about suggestions, concerns or issues relating to their job or location.

- Supervisor dialogue sessions – Supervisors are afforded a forum to provide ideas, discuss safety-related issues or concerns and receive updates from the executives on prior agenda items.
- Grassroots employee-led presentations – Employee-led safety teams help to create solutions the prevent injuries and result in safer worksites and enhanced culture of accountability. These teams demonstrate that passionate, engaged employees can work together to create effective safety solutions.
- Behavior Based Safety (BBS) updates, observations and data.
- Action item review.
- Roundtable discussions.

5. Ongoing maintenance programs

Properly maintaining SDG&E's assets and infrastructure contributes to the well-being and safety of employees, contractors and the public. The Corrective Maintenance Program (CMP), mandated under General Order 165, outlines the procedures for the inspection and maintenance of electrical distribution facilities. Qualified inspectors perform the inspections and generate follow-up repair orders that are completed by crews located at the various Construction and Operating Centers (Districts).

Transmission Line Maintenance Practices are mandated under CPUC code 348 and Western Electric Coordinating Council (WECC) Regional Reliability Standard FAC-501-WECC-1. The purpose of SDG&E's Transmission Inspection & Maintenance Program is to promote safety for the general public, SDG&E personnel and contractors by providing a safe operating and construction environment, while maintaining system reliability. This inspection and maintenance program helps SDG&E identify and repair component/conditions and clear the transmission system of defective equipment to minimize safety hazards and maintain system reliability.

Transmission Substation Maintenance Practices are mandated under General Order 174 and WECC Regional Reliability Standard PRC-005-2. The purpose of SDG&E's Substation Inspection & Maintenance Program is to promote safety for the general public, SDG&E personnel and contractors by providing a safe operating and construction environment, while maintaining system reliability. This inspection and maintenance program helps SDG&E identify and repair component/conditions and clear the substations of defective equipment to minimize safety hazards and maintain system reliability.

The activities included in this chapter are limited to the inspection and testing of Live Line tools mandated under OSHA rule 1910.269. The purpose of SDG&E's Live Line Tools Inspection & Testing Program is to confirm that SDG&E crews are provided with safe tools needed to carry out maintenance and construction responsibilities in the field, which in turn affect safety for the general public, SDG&E personnel and contractors. The costs and benefits related to the remaining programs described within this mitigation are addressed in the RAMP risk chapter for Electric Infrastructure Integrity.

6. Customer Communications and First Responder Training

Customer outreach, communication, and education are another way SDG&E mitigates this risk. The activities in this mitigation include:

- Communication campaign efforts regarding preparing for emergencies. These efforts are mainly concentrated in the high risk fire area.

- Public Safety campaigns focusing on informing and educating the public from the danger of downed power lines, pole contact from vehicles and the hazards associated with digging near gas lines. The campaign includes videos, TV and radio spots, newspaper ads, billboards and collateral geared toward a variety of scenarios used for different audiences.
- Safety-related messages delivered using multiple communication channels. Examples are bill inserts, print media, radio, web and social media. Messages include, but are not limited to, Carbon Monoxide Safety, fumigation and furnace safety.
- Pipeline safety campaign, which is mandated by federal pipeline safety regulations. SDG&E's campaign includes bill inserts, mailings to residential and business customers, mailings to excavators, businesses, land developers and farmers, and communications to schools and universities, public officials and emergency officials. Pipeline safety efforts provide customers with information about:
    - Natural gas pipeline locations
    - What to do if you sense a leak/smell gas
    - Messaging to direct customers to call 811 (DigAlert) and other actions to take prior to digging

Emergency Management/Fire Coordination provides safety and basic operational information about electricity and SDG&E's facilities as they relate to First Responder operations and activities. Events include training activities relative to substation safety, new hire fire academy sessions, Capstone crews, electric fire safety training to fire department personnel, and Wildland Simulation exercises. Emergency Operations Center (EOC) First Responder Training includes incident response training and exercises.

7. Contractor Safety

SDG&E relies heavily on contractors. Major Projects, Construction Services Construction Management, Construction Services Contracting, Aviation Services, and Fire Coordination and Prevention provide construction management and field oversight of all construction performed by contractors on electric distribution. This includes safeguarding that all contracted work is built to SDG&E design and safety standards and in accordance with GO 95 (Rules for Overhead Electric Line Construction) and GO 128 (Rules for Construction of Underground Electric Supply and Communications Systems).

Safeguards can include: administrative activities associated with construction services-managed construction work; oversight for construction, incident review and investigation, operations and maintenance activities that involve helicopter and fixed wing aircraft; and a wide range of highly skilled and experienced fire safety and fire preventative services, including design, operational, training and construction expertise, and coordination with fire departments and first responders during extreme fire weather events (such as red flag Santa Ana events).

Other Contractor Safety activities include:

- Annual Contractor Safety Summit – SDG&E sponsored contractor safety half-day event covering safety incidents, training and seminars.

- Contractor Quarterly Safety Council Meetings – SDG&E sponsored contractor safety two-hour event covering safety incidents, hazard identification, compliance, training and seminars.
- Southern California Utility Safety Alliance (SCUSA) monthly meetings – SCUSA meets monthly to review working methods, standards and regulations, and reviews safety incidents and injuries.
- Contractor Incident Database – an in house database designed to calculate metrics based on hours worked, incident and injury totals and incident descriptions for reporting, review and mitigation.

8. Customer orders relating to public safety

Customers call SDG&E's call center for many reasons. Some of those reasons are to inform SDG&E of safety-related items such as outages, emergencies, and detection of gas. Below are activities managed by SDG&E's call center with respect to safety:

- Call types relative to public safety include:
    - English/Spanish Emergency
    - English/Spanish Outage
    - English/Spanish Business Emergency
    - Fire and Police Calls
- Customer Service Field Emergency Orders
    - Carbon Monoxide
    - Fumigation
    - Hazardous and Non Hazardous gas leaks
    - NGAT or CO Testing is a safety-related program for Customer Assistance's ESA Program participants. The purpose is to test in-home equipment for carbon monoxide hazards. SDG&E conducts CO testing on homes weatherized through the Energy Savings Assistance (ESA) Program in accordance with the Statewide Energy Savings Assistance Program Installation Standards and the Statewide Energy Savings Assistance Program Policy and Procedures Manual. CPUC directives order SDG&E to charge the costs for the NGAT program to base rates rather than to the public purpose funds.
- Energy Diversion Investigation – Meter tampering and meter bypass investigation and remediation. Bypasses or unauthorized attachments create unsafe conditions for our crews as well as public safety officers and first responders. The unauthorized attachments are not standard and are a violation of the electric code and local building ordinances. These connections present the potential for fire, electrical shock or even the risk of electrocution to an SDG&E service technician, law enforcement, firefighters, city or county officials, occupants of the residence and/or community.

5 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 4 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. This plan is expected to leverage the current momentum of SDG&E's existing safety programs and policies, as well as incorporate a few, incremental activities for the years 2017-2019. These additions, along with any updates about other controls are described below.

1. <u>Expansion of the Contractor Safety Program</u>

SDG&E has added a Contractor Safety Program Manager and proposes implement a contractor safety system. The system is a database that collects health and safety, procurement, quality and regulatory information. This is needed to proactively review contractor safety performance consistently across all companies contracted by SDG&E, and to communicate SDG&E's expectations with regard to safety. The system will enhance SDG&E's ability to report, track and provide metrics with regard to its contractors.

2. <u>OSHA Voluntary Protection Program (VPP) Assessment</u>

The VPP approach is a commitment by the Company to safety and health management. The objective of VPP is to implement programs that ultimately lead to incident reduction and/or prevention. This would benefit SDG&E as VPP sites evolve into models of excellence and influence practices industry-wide. The VPP process includes four main elements:

- Leadership and employee involvement
- Worksite analysis
- Hazard Prevention and Control
- Safety and Health Training

3. <u>Public Safety Awareness Campaign</u>

SDG&E proposes to add a more robust public safety awareness campaign in the Customer Communications and First Responder Training mitigation to address both gas and electric safety concerns, such as Wire Down situations. This program aims to educate and provide a deeper level of understanding to the public with respect to safe practices around electric and gas infrastructure. The details of this incremental campaign will be addressed in SDG&E's Test Year 2019 General Rate Case (GRC) Application.

SDG&E is constantly evaluating new programs, technologies and ideas designed to reduce or eliminate incidents. Examples of such programs include:

- Job Hazard Analysis Enhancements
- Serious Injury and Fatality (SIF) program
- Safety Center of Readiness & Excellence (SCORE)
- IBEW Code of Excellence program
- Human Performance

6 Summary of Mitigations

Table 3 provides a summary of the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for this risk. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 3 were estimated using assumptions provided by SMEs and available accounting data.

Table 3: Baseline Risk Mitigation Plan Overview[11]
(Direct 2015 $000)[12]

ID	Control	Risk Drivers Addressed	Capital[13]	O&M	Control Total[14]	GRC Total[15]
1	Comprehensive Health & Safety risk management framework, organization and assignment of responsibility*	• Deviation from policies or procedures • Workplace hazards posed to employees • Non or improper use of personal protection and safety equipment	$5,010	$34,600	$39,610	$39,610
2	Mandatory employee training, retraining	• Deviation from policies or	n/a	16,670	16,670	16,670

[11] Recorded costs were rounded to the nearest $10,000.
[12] The figures provided in Tables 3 and 4 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[13] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[14] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[15] The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[13]	O&M	Control Total[14]	GRC Total[15]
	and refresher programs and standardized policies*	procedures				
3	Field observations of and feedback on employee and contractor activities and safety behaviors	• Deviation from policies or procedures • Workplace hazards posed to employees • Non or improper use of personal protection and safety equipment	n/a	650	650	650
4	Regular Safety Meetings*	• Deviation from policies or procedures • Workplace hazards posed to employees • Non or improper use of personal protection and safety equipment	n/a	3,520	3,520	3,520
5	Ongoing maintenance programs*	• Deviation from policies or procedures	n/a	2,660	2,660	2,660
6	Customer Communications and First Responder training*	• Failure of emergency preparedness and response	n/a	1,970	1,970	1,970
7	Contractor Safety Review	• Deviation from policies or procedures	38,160	740	38,900	38,900
8	Customer orders relative to public safety*	• Damages to gas pipelines and facilities	n/a	4,960	4,960	4,960

ID	Control	Risk Drivers Addressed	Capital[13]	O&M	Control Total[14]	GRC Total[15]
	TOTAL COST		$43,170	$65,770	$108,940	$108,940

* Includes one or more mandated activities

While all the controls and baseline costs presented in Tables 3 and 4 mitigate the Employee, Contractor and Public Safety risk, some of the controls also mitigate other risks presented in this Risk Assessment Mitigation Phase Report, including: Electric Infrastructure Integrity, Public Safety Events Electric, Wildfire, Catastrophic Damage Involving High-Pressure Pipeline Failure and Catastrophic Damage Involving Medium-Pressure Pipeline Failure.

Table 4 summarizes SDG&E's proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019 and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan and is not requesting funding approval. SDG&E will request approval of funding in the next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth on Table 4, the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 4: Proposed Risk Mitigation Plan Overview[16]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[17]	2019 O&M	Mitigation Total[18]	GRC Total[19]
1	Safety Policies & Programs*	• Deviation from policies or procedures • Workplace hazards posed to employees • Non or improper use of personal protection and safety equipment	$20,340 - $24,410	$33,220 - 39,870	$53,560 - 64,280	$53,560 - 64,280
2	Mandatory employee training, retraining and refresher programs*	• Deviation from policies or procedures	n/a	16,680 - 20,010	16,680 - 20,010	16,680 - 20,010
3	Field Observations and Behavior Based Safety Programs	• Deviation from policies or procedures • Workplace hazards posed to employees • Non or improper use of personal protection and safety equipment	n/a	900 - 1,080	900 - 1,080	900 - 1,080
4	Regular Safety Meetings, Safety Stand-downs and Tailgates*	• Deviation from policies or procedures • Workplace hazards posed to employees • Non or improper	n/a	3,520 - 4,230	3,520 - 4,230	3,520 - 4,230

[16] Ranges of costs were rounded to the nearest $10,000.
[17] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
[18] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[19] The GRC Total column shows costs typically represented in a GRC.

		use of personal protection and safety equipment				
5	Ongoing Maintenance Programs*	• Deviation from policies or procedures	n/a	2,810 - 3,370	2,810 - 3,370	2,810 - 3,370
6	Customer Communications and First Responder training*	• Failure of emergency preparedness and response	n/a	7,000 - 8,400	7,000 - 8,400	7,000 - 8,400
7	Contractor Safety Program	• Deviation from policies or procedures	115,370 - 138,440	740 - 890	116,110 - 139,330	116,110 - 139,330
8	Customer orders relative to public safety*	• Damages to gas pipelines and facilities	n/a	5,080 - 6,100	5,080 - 6,100	5,080 - 6,100
	TOTAL COST		$135,710 - 162,850	$69,950 - 83,950	$205,660 - 246,800	$205,660 - 246,800

☐	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

The forecasting methodologies used to develop the low range of the costs were primarily base year (2015) recorded amounts plus incremental and five-year average costs. These methodologies were deemed most accurate given the nature of the activities within the mitigations. The high range was derived to provide flexibility as SDG&E may expand or add incremental projects and programs as dictated by regulatory, legal or industry changes.

7 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[20] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[21]

[20] D.16-08-018 Ordering Paragraph 8.

[21] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 6). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

7.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

7.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 2 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what

the potential risk score would be) if that control was removed.[22] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

7.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 6. They multiplied the risk reduction developed in subsection 7.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another.

Figure 2 shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 4 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

7.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 7.1, above, in order to assess the RSE for the Employee, Contractor and Public Safety risk. The RAMP-A Overview and Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

The Company used two, standard metrics to estimate the potential risk reduction of the proposed mitigations: Occupational, Safety and Health Administration (OSHA) incident rates and controllable motor vehicle incident (CMVI) rates. OSHA incident rates reflect the rate of occupational injuries that occur while conducting work for the Company, while CMVI incident rates reflect the rate of avoidable motor vehicle incidents that occur during Company operations. Subject matter experts deemed these to be the best available to use for quantification. The OSHA Recordable Incident and CMVI data are commonly available – both internally and externally across utilities, which supports a data-driven and comparable assessment. Additionally, several of the mitigations are expected to yield qualitative benefits, particularly mitigations 6 and 7 on Table 3 and 4.

For purposes of quantifying the potential risk reduction, mitigations were split into two groups, as described in Table 5: ones that address work-related incidents that do not involve motor vehicles and one that addresses motor vehicle incidents.

[22] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

Table 5: Mitigation Groupings for Risk Reduction Analysis

	Mitigation	Description
1	Activities that address occupational incidents not involving motor vehicles	This mitigation includes activities that are focused on occupational safety. Activities in this mitigation group include safety standards and policies, skills training, and job observations.
2	Activities that address occupational incidents involving motor vehicles	This mitigation includes activities that are focused on safe driving practices. Activities in this mitigation group include driver training and telematics system.

- **Analysis of Mitigations that Address Occupational Incidents**

SDG&E estimated the potential increase in risk frequency if current controls were not in place. The assumption was that if these activities were not in place, SDG&E's OSHA incident rate would increase to the level of the worst OSHA incident rate in the industry. Based on 2015 data, SDG&E's OSHA incident rate was at 1.9 and the highest peer utility in that year had an OSHA incident rate of 5.2, which is 172% higher than SDG&E's rate. Additionally, SDG&E has seen a 3-year improvement rate of 3.1% since 2007. If the current controls were not in place, it was assumed that SDG&E would not have achieved that 3.1% improvement rate, along with experiencing a rate the same as the worst in the industry. The total estimated potential increase in risk frequency would be 174.9%.

- **Analysis of Mitigations that Address Motor Vehicle Incidents**

Similarly, an estimated percentage increase in risk frequency was calculated based on the assumption that current controls were not in place: SDG&E's CMVI rate would increase to the worst CMVI rate in the industry. Based on 2015 data, SDG&E's CMVI rate was at 2.9 and the highest peer utility in that year had a CMVI rate of 7.4, which is 259% higher than SDG&E's rate. Additionally, SDG&E has seen a 3-year improvement rate of 0.7% since 2007. If the baseline activities were not in place, then SDG&E would lose that 0.7% improvement rate along with experiencing a rate the same as the worst in the industry. The total estimated potential increase in risk frequency would be 260%.

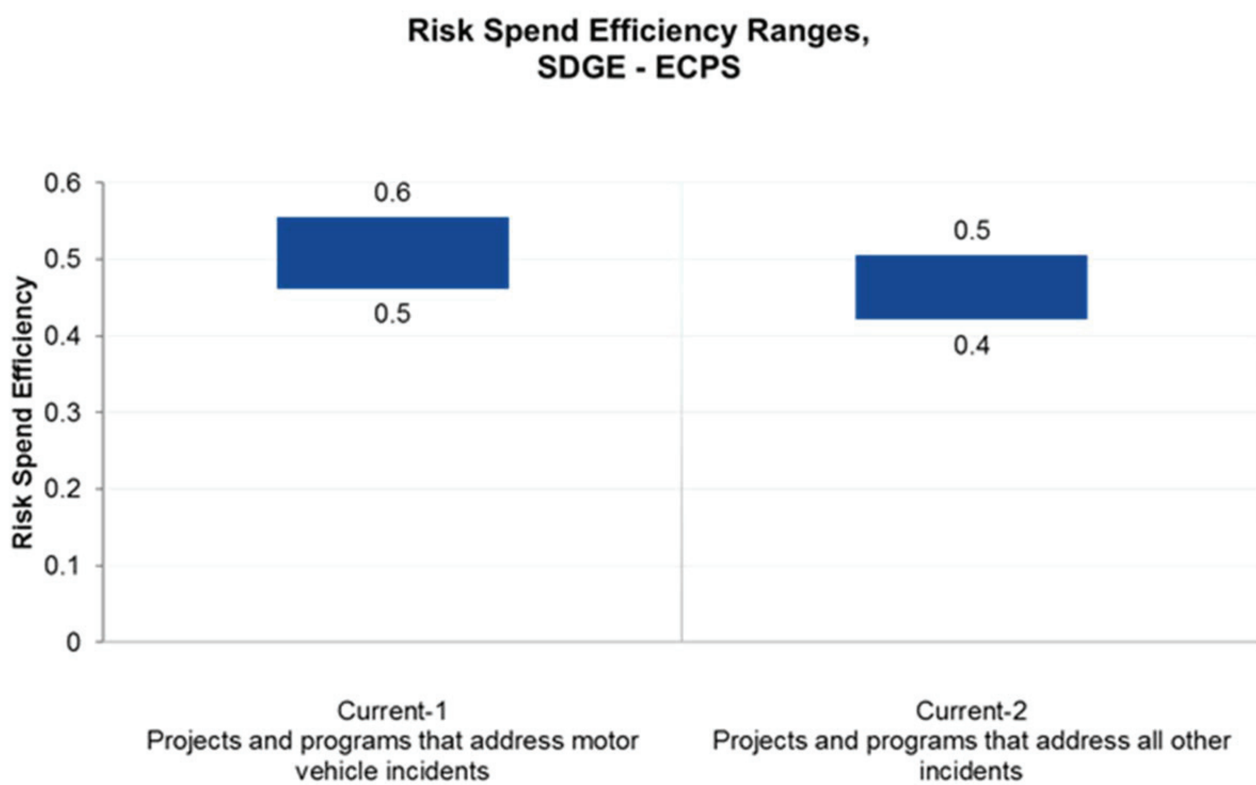
7.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Activities that address motor vehicle incidents (current controls)
2. Activities that address occupational incidents (current controls)

Figure 3 displays the range[23] of RSEs for each of the SDG&E Employee, Contractor, and Public Safety risk mitigation groupings, arrayed in descending order.[24] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

Figure 3: Risk Spend Efficiency



8 Alternatives Analysis

SDG&E considered alternatives to the proposed mitigations as it developed the incremental mitigation plan for the Employee, Contractor and Public Safety risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources.

[23] Based on the low and high cost ranges provided in Table 4 of this chapter.

[24] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

8.1 Alternative 1 – Training Modifications

As described in the sections above, education and training is a significant mitigation activity for this risk. Accordingly, SDG&E considered expanding the scope of training or increasing the frequency of training intervals. For example, SDG&E could add all employees to Smith System® driver training versus only those who drive 3,000 miles on Company business, or regularly drive a company vehicle. The Smith System ® training increases driver's safety awareness with principles based on the Five Keys to Space Cushion Driving: (1) aiming high in steering, (2) getting the big picture, (3) keeping your eyes moving, (4) leaving yourself an out, and (5) making sure others see you. Likewise, offering training more frequently could further reinforce the subject matter.

This alternative was dismissed in favor of the proposed plan because SDG&E has found that the current safety policies and programs have proven effective based on the gradual decline of SDG&E's OSHA rate. It was considered unlikely that the additional resources needed to expand training scope and increase training intervals would yield significant enough benefit.

8.2 Alternative 2 – Modernizing Training

SDG&E also considered modernizing its training techniques to include videos, computer simulations and computer-based training delivery channels. A majority of the current training is either online, on-the-job or in a classroom, face-to-face setting. SDG&E continues to consider new techniques and process improvements that may enhance the way in which it operates.

Similar to Alternative 1, SDG&E prefers its proposed plan over this alternative. All training is kept up-to-date to be current and comply with mandated regulations. There likely would be significant up-front costs to perform a large scale modernization of safety training which are not expected to produce significant enough benefits (e.g., fewer incidents and injuries).

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Distributed Energy Resources – Safety and Operational Concerns
(Chapter SDG&E-4)

November 30, 2016

309942

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Executive Summary

This chapter addresses the risk of safety and reliability events due to the high penetration of distributed energy resources (DERs) on SDG&E's system, which could potentially result in:

1. DERs to be energized and connected to the SDG&E system while SDG&E operators and field personnel have little to no visibility as to the DER's status;

2. SDG&E voltage regulating devices, such as load tap changers (LTCs), line regulators, and capacitors, to operate more frequently than they would on a circuit that is only managing the variations in load, potentially causing:
    a. swings in voltages caused by variable DER output may increase the number of operations of voltage regulating devices; and
    b. impaired outage restoration on circuits with high DER penetrations.
3. Prolonged outage restoration in high penetration areas, due to complications during outages caused by the increased load served by DERs at the point of service. Specifically, outage restoration could be delayed waiting for the projected load to drop low enough for operators to re-energize portions of the circuit.

These safety and operational concerns require a proactive approach to mitigating the impact of DERs to the SDG&E distribution system. SDG&E's 2015 baseline mitigation plan for this risk include a mixture of new tools, outreach, and monitoring, consisting of three controls:

1. **Voltage/Power Quality Studies of DER Interconnections –** Included in the study report will be mitigations that will reduce or eliminate impacts to the distribution system.

2. **Improved Modeling Tools –** SDG&E's improved studies will more accurately capture the impacts of DERs on the system and produce better mitigations than would otherwise be possible.

3. **Interconnection Compliance –** SDG&E's interconnection compliance program provides for UL-certified equipment installed to NEC specifications, marked with signage to inform regarding the electrical hazard.

These baseline mitigations focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability. The 2015 baseline mitigations are being maintained or expanded in the years 2017 through 2019, with the addition of two new mitigations:

1. **Increased Outreach Program**
    The proposed outreach program would add to SDG&E's existing outreach efforts regarding DERs, including any safety issues that may be encountered by the public and first responders.

2. **Anti-Islanding Testing Program**

   The anti-islanding testing program would "test" the anti-islanding function on a routine basis, using the customer's Smart Meter or through a technology solution, to reduce the possibility that a malfunctioning inverter could energize the distribution system during an outage.

The risk spend efficiency was developed for four proposed mitigations of the DER risk. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. Based on the risk spend efficiency assessment, the above mitigations for this risk can be prioritized as follows, from highest risk spend efficiency to lowest:

1. Interconnection Compliance
2. Anti-Islanding Testing Program
3. Increased Outreach Program
4. Interconnection Studies and Modeling

SDGE
A Sempra Energy utility

Risk: Distributed Energy Resources – Safety and Operational Concerns

1 Purpose

The purpose of this chapter is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of Distributed Energy Resources (DERs). DERs may include Solar Photovoltaic (PV), battery storage devices, electric vehicles, wind turbines, and other small devices that operate in parallel with SDG&E's distribution system.

DERs present two potential risks to SDG&E: safety and operational. The safety risks associated with DERs primarily deal with the potential for DERs to be energized and connected to the SDG&E system while SDG&E operators and field personnel have little to no visibility as to the DER's status. If an SDG&E employee or contractor is working on or near a distribution circuit with DER connected to it, they need to be assured that the DER is not energizing the system after the system is de-energized from the SDG&E substation. This protection is referred to as anti-islanding. The anti-islanding function in a DER inverter (utilized in most DER installations) immediately ceases operation upon the loss of a power signal from SDG&E. It is possible, however, that the anti-islanding protection fails and one or more DER continue energizing the circuit. In this instance, after touching an energized line that was supposed to be de-energized, a serious injury or fatality could occur to a SDG&E employee, contractor, first responder or member of the public.

The operational risk presented by DERs is two-fold. First, swings in voltages caused by variable DER output may increase the number of operations of voltage regulating devices. Second, outage restoration on circuits with high penetrations may be impaired. On a circuit with high DER penetration, the voltage of the circuit may move higher and lower based on the output of the DERs, which can be highly variable, especially solar PV. This can cause SDG&E voltage regulating devices, such as load tap changers (LTCs), line regulators, and capacitors, to operate more frequently than they would on a circuit that is only managing the variations in load. Because of this increased operation frequency, SDG&E would need to maintain these devices more often, and the devices would be more likely to suffer premature failure. In addition, customers who experience high and low voltages due to fluctuating DER may see damage to their appliances.

The other operational concern surrounding high DER penetration is outage restoration. Under a high DER penetration scenario, the DERs will be serving much of the load on a circuit at the point of service. After a forced outage, the inverters for each DER are required by their anti-islanding protection to wait up to 60 seconds before reconnecting to the grid, which causes a temporary increase in load. In this situation, outage restoration will take longer, and in some instances, customers may have to wait up to several hours before the projected load drops low enough for operators to re-energize portions of the circuit. In other words, SDG&E may not have the capacity available to serve load that previously was, in part or entirely, provided by DERs.

These safety and operational concerns require a proactive approach to mitigating the impact of DERs to the SDG&E distribution system. The assessment and analysis presented herein focuses on the risk of DERs owned by third parties who interconnect their system to SDG&E's grid. Those who choose to consume their generation on site and do not choose to interconnect (i.e., are not a SDG&E customer or supplier), are outside the scope of this risk.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP should focus on safety related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety, and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

2 Background

DER interconnections in SDG&E's service territory have increased exponentially over the past several years. SDG&E currently has over 100,000 DER systems connected to its distribution system, compared

[1] Commission Decision (D.) 14-12-025 at p. 31.

with only 11,732 in 2010. SDG&E expects that this number will continue to grow in the coming years, presenting increasing challenges in operating the distribution system safely and reliably.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[2] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks.[3] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the DER risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as an electric, operational risk as shown in Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	ELECTRIC	DISTRIBUTION

3.2 Potential Drivers[4]

When performing the risk assessment for DER, SDG&E identified potential indicators of risk, referred to as drivers. These include but are not limited to:

- **Failures of voltage control devices –** Failure of regulating equipment is typically caused by two factors: environment and overuse. DERs do not affect the environmental factors, but variations

[2] A.15-05-002, filed May 1, 2015, at p. JMD-7.
[3] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[4] An indication that a risk could occur. It does not reflect actual or threatened conditions.

in voltage will drive up operation count of regulating devices, resulting in wear and tear on their respective mechanisms.

- **Outages on high penetration circuits –** As mentioned above, under a high DER penetration scenario, the DERs will be serving much of the load on a circuit at the point of service. After an outage, the inverters for each DER are required to wait up to 60 seconds before reconnecting to the grid. During this time, SDG&E must serve the additional load on its distribution system, which may not be possible due to limited available capacity. The potential inability to serve additional load is a result of how SDG&E plans for load on its system. SDG&E's distribution planning is done on a net load basis, as opposed to gross load. Net load with respect to DER, Net Energy Metering (NEM) in particular, is the energy produced by the DER minus the energy consumed by the customer. Because the presence of a DER may mask gross load, SDG&E may not know the amount of load present when a DER fails. In this situation, outage restoration will take longer, and in some instances, customers may have to wait up to several hours before the projected load drops low enough for operators to re-energize portions of the circuit.

  Also, during the outages, a DER with failed anti-islanding protection may energize the circuit unbeknownst to utility personnel who may be working on that circuit to restore power to customers on the circuit.

- **Reverse power flow on distribution transformers –** For all DER installations, SDG&E requires each to submit an application and receive a permission to operate (PTO) letter from SDG&E before exporting to the grid. If a DER installer connects their system and exports to the grid without receiving PTO, SDG&E operators may not know that the distribution system is energized by individual DER installations during an outage.

- **Emergencies at DER premises –** A first responder such as a firefighter may not be familiar with DERs and how they operate, in order to properly and safely respond to a fire or other emergency at a premise where DER is installed. For instance, first responders may not know where to find the disconnect switch, or how to read the emergency signage, which may cause them not to enter the structure until they are certain the DER is de-energized.

- **Personnel working on a circuit with connected DER –** SDG&E or contractor personnel may not take the appropriate precautions when working on a circuit with a connected DER.

Table 2 maps the specific drivers of DER to SDG&E's risk taxonomy.

Table 2: Operational Risk Drivers

Driver Category	DER Driver(s)
Asset Failure	• Failures of voltage control devices • Reverse power flow in distribution circuits and transformers
Asset-Related Information Technology Failure	Not applicable
Employee Incident	• SDG&E personnel working on a DER circuit
Contractor Incident	• Contractor personnel working on a DER circuit
Public Incident	• Reverse power flow in distribution transformers • Outages on circuits with high DER penetration • Emergencies on circuits or premises with installed DER
Force of Nature	Not applicable

3.3 Potential Consequences

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences in a reasonable worst case scenario could include:

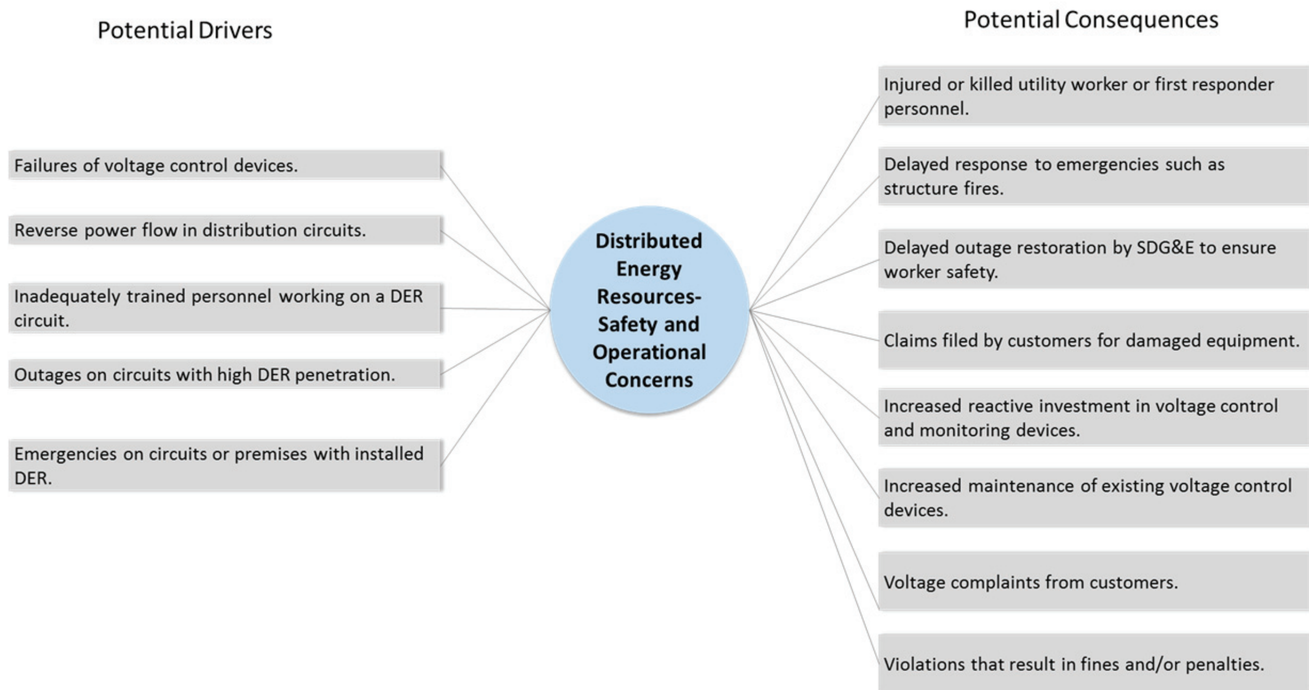
- Injured or killed utility worker or first responder personnel.
- Delayed response to emergencies such as structure fires.
- Delayed outage restoration by SDG&E.
- Damaged customer property.
- Damaged system equipment.
- Increased reactive investment in voltage control and monitoring devices.
- Increased maintenance of existing voltage control devices.
- Voltage complaints from customers.
- Financial consequences.

These potential consequences were used in the scoring of DER for the SDG&E's 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of DER as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a distributed energy resource incident can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for DER:

- First responders and/or Company employees respond to a circuit believed to be de-energized, DER isolation fails to work, and DER energizes/back-feeds the circuit, which could result in a life-threatening injury or fatality to a first responder/employee. This could also result in moderate affects to a critical location or customer (as well as potential customer privacy implications) and/or adverse financial consequences.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[5] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the DER risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	3	3	3	4	73,139

4.3 Explanation of Health, Safety, and Environmental Impact Score

During an outage on a distribution circuit, it is imperative to know that the circuit is de-energized so that utility personnel may safely work on the circuit to restore service to SDG&E customers. If a DER is energizing a circuit that utility operators and lineman believe is de-energized, a lineman or troubleshooter may unknowingly handle an energized conductor, causing injury and potentially resulting in a fatality. In addition, uncertainty regarding DER status could cause a first responder to delay action at a location where a DER is installed, potentially resulting in injury and possible fatality. Accordingly, SDG&E scored this risk a 6 (severe) in the Health, Safety, and Environmental impact category, as it has the potential to result in a few fatalities or life threatening injuries.

[5] D.16-08-018 Ordering Paragraph 9.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, the following scores were assigned to the remaining residual risk categories:

Higher DER penetration increases operational risk on the distribution system. As discussed above, risks include delayed outage restoration by SDG&E, damaged customer equipment, increased reactive investment in voltage control and monitoring devices, increased maintenance of existing voltage control devices, and voltage complaints from customers. Delayed outage restoration will affect SDG&E reliability metrics and result in longer outages for customers. If voltage is driven outside of the voltage requirements set forth in SDG&E's Electric Tariff Rule 2 limits by increased DER penetration, then it is likely that customers will experience damage to equipment caused by voltage that is beyond the limits that their equipment was designed for. These same voltage swings in SDG&E's distribution system will result in increased maintenance of existing voltage regulating equipment, as well as an increase in investment in new voltage/reactive power regulating devices and controls. Based on this, SDG&E rates this risk a 3 (moderate) in the Operational and Reliability impact category. While this has the potential to impact more than 1,000 customers or disrupt service for one day, the operational impacts may be limited to those with DERs or individual circuits.

A score of 3 (moderate) was given in the Regulatory, Legal, and Compliance and Financial impact areas. Due to the safety and operational concerns associated with this risk, regulatory and legal consequences could arise. Further, an event that occurs related to DERs could result in damaged equipment claims filed by customers. However, the financial outcome was estimated to be between $1 million and $10 million, which equates to a 3 on the 7X7 matrix.

4.5 Explanation of Frequency Scores

Due to SDG&E's comprehensive safety policies and protocols, SDG&E is able to mitigate some of its concerns. However, with increasing levels of DER penetration the potential for an injury or death to utility or first responder personnel will occur more frequently. It is likely, however, that high penetration of DERs will result in operational constraints. SDG&E has one 12kV circuit that already required new equipment to mitigate voltage concerns caused by a large DER installation. Therefore, SDG&E rated this risk a 4 (occasional) with a frequency of potential occurrence once every 3-10 years.

5 Baseline Risk Mitigation Plan[6]

As stated above, the safety risks associated with DERs primarily deal with the potential for DERs to be energized and connected to the SDG&E system while SDG&E operators and field personnel have little to no visibility as to the DER's status. The 2015 baseline mitigations discussed below include the

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[6] As of 2015, which is the base year for purposes of this Report.

current evolution of the utilities' management of this risk and the cost to comply with laws that were in effect at that time. The baseline mitigations have been developed over many years to address this risk.

These controls focus on safety-related impacts[7] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[8] as well as controls and mitigations that may address reliability.[9] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various DER scenarios, not just the scenario used for purposes of risk scoring.

The 2015 risk mitigation plan for DERs included a mixture of new tools, outreach, and monitoring. The new challenges presented by DERs require distribution planners to upgrade their modeling and forecasting tools, as well as to perform more precise interconnection studies to appropriately capture the effects of DER interconnections. Because DERs are relatively new to electric operations, outreach of both in-house and external stakeholders is necessary so that SDG&E employees and members of the public that may safely interact with DERs and/or the electric system. These three controls focus on the Health, Safety and Environmental impact area and/or the likelihood of an event occurring. In other words, the mitigations presented in Sections 5 and 6 are only safety-related.

1. Voltage/Power Quality Studies of DER Interconnections
   Performing voltage and power quality studies on DERs that request interconnection to SDG&E's system enable SDG&E to evaluate adverse operational impacts before the DER is connected to the system. Every project is required to be studied under Electric Rule 21, SDG&E's interconnection tariff for small generators, and projects are studied in the order they are received. Included in the study report will be mitigations that will reduce or eliminate impacts to the distribution system.

2. Improved Modeling Tools
   SDG&E over the past two years has updated its power flow software to enable modeling of DER in a time-series manner. The updated software can analyze the system over a 24-hour period, capturing the effect of variable DER on the voltage and thermal characteristics of the distribution system. SDG&E has also upgraded its forecasting software, purchasing a tool that will allow SDG&E to forecast the load of a circuit over a 24-hour period, rather than the peak load only forecasting approach that SDG&E has previously used. These improved modeling tools allow SDG&E to more accurately model and forecast DERs, increasing the accuracy of

[7] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[8] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[9] Measures taken to impact safety may also impact reliability.

interconnection studies as well as yearly planning studies. These improved studies will more accurately capture the impacts of DERs on the system, and produce better mitigations than would otherwise be possible.

3. Interconnection Compliance

   SDG&E's interconnection compliance program provides that DERs installed on the SGD&E system utilize equipment certified by UL. They are installed in connection with local authority inspections for compliance with National Electric Code (NEC) specifications. SDG&E checks for proper signage and safety placards so that anyone approaching the DER equipment is aware of the electrical hazard and can take appropriate steps to maintain their own safety.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. Baseline activities identified in the Section 5 are being maintained or expanded in the years 2017 through 2019. In addition, SDG&E's proposes to include the new mitigation of an Anti-Islanding Testing Program. The expanded and new mitigations are described in detail below.

1. Power Quality Studies of DER Interconnections

   SDG&E anticipates that this mitigation will be expanded during the 2017-2019 timeframe. Expansion of this activity includes the same activities identified above, but the number of interconnections is expected to increase due to increasing DER adoption rates and the availability of Integration Capacity Maps online resulting from the Distribution Resources Plan proceeding. This helps SDG&E maintain its safety levels by keeping up with the increasing number of requested interconnections.

2. Improved Modeling Tools

   SDG&E anticipates that this mitigation will be maintained during the 2017-2019 timeframe. SDG&E made a capital investment in 2015, as discussed in Section 5 and illustrated in Section 7, for improved modeling tools. There are on-going maintenance costs associated with software licensing for these modeling tools. Again, this mitigation aims to help SDG&E improve safety.

3. Increased Outreach Program

   SDG&E routinely works with first responders to educate them on how to respond to emergencies when dealing with electric system equipment. In fact, SDG&E currently conducts first responder training to effectively prepare those involved to collaboratively work together during emergency situations. SDG&E also works to inform the public on the hazards regarding electricity and gas through bill inserts, billboards, commercials, and other methods. Topics typically include what to do when a wire goes down, how to respond to a gas leak, and more.

The proposed outreach program would add to SDG&E's existing outreach efforts regarding DERs, including any safety issues that may be encountered by the public and first responders. The result of the outreach program would be increased awareness on the part of first responders and the public as to how to work with and around DERs.

4. Interconnection Compliance
   SDG&E anticipates that this mitigation will be expanded during the 2017-2019 timeframe. Expansion of this activity includes the same activities identified above, but the number of interconnections is expected to increase due to increasing DER adoption rates.

5. Anti-Islanding Testing Program
   As part of its interconnection process, SDG&E requires that all inverters be certified by the Underwriter's Laboratory (UL). This UL certification indicates that the inverter model has passed a series of tests, including a test of the anti-islanding functionality that is required to connect to the utility grid. During the course of receiving a PTO, SDG&E also checks that a disconnect switch is correctly installed when appropriate. SDG&E does not test the anti-islanding function, instead relying on the UL certification for compliance.

The anti-islanding testing program would "test" the anti-islanding function on a routine basis, using the customer's Smart Meter or through a technology solution, to reduce the possibility that a malfunctioning inverter could energize the distribution system during an outage. Because the anti-islanding protection is the primary mechanism to avoid potential safety events related to this risk, it is imperative that it is working properly. Further, the inverter is owned by a customer and located on a customer's premise making the working condition also unknown to SDG&E. Given these factors, SDG&E proposes to test the anti-islanding function on a customer's DER, or other program to address this issue. Additional details of the proposed testing program will be addressed in SDG&E's Test Year 2019 General Rate Case Application, which will be filed on September 1, 2017.

As mentioned, the equipment is generally on a customer's premise. Therefore, SDG&E plans to do the "test" using the customer's Smart Meter or through a technology solution. This may require a brief outage, approximately less than five minutes, to verify that the DER does indeed stop feeding electricity to the electric grid and the anti-islanding protection is working as intended.

7 Summary of Mitigation Benefits

Table 4 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for DER. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

Table 4: Baseline Risk Mitigation Plan[10]
(Direct 2015 $000)[11]

ID	Control	Risk Drivers Addressed	Capital[12]	O&M	Control Total[13]	GRC Total[14]
1	Power Quality Studies of DER Interconnections	• Failures of voltage control devices • Outage on high penetration circuits • Reverse power flow on distribution transformers	$40	n/a	$40	$40
2	Improved Modeling Tools	• Failures of voltage control devices • Outages on high penetration circuits • Reverse power flow in distribution transformers	1,640	n/a	1,640	1,640
3	Interconnection Compliance	• Inadequately trained personnel working on a circuit with connected DER • Emergencies at DER premises	n/a	1	1	1

[10] Recorded costs were rounded to the nearest $10,000.
[11] The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[12] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[13] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[14] The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[12]	O&M	Control Total[13]	GRC Total[14]
	TOTAL COST		$1,680	$0	$1,680	$1,680

SDG&E gathered the costs in Table 4 primarily using accounting information. However, because SDG&E does not track costs by activity, but rather by cost centers and capital budget codes, some assumptions by Subject Matter Experts were included to derive these costs. Accordingly, the costs provided herein are intended to be representative and not a comprehensive view of all costs related to DER.

Table 5 summarizes SDG&E's proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan, and is not requesting funding approval. SDG&E will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in table 5, the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 5: Proposed Risk Mitigation Plan[15]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[16]	2019 O&M	Mitigation Total[17]	GRC Total[18]
1	Power Quality Studies of DER Interconnections	• Failures of voltage control devices • Outage on high penetration circuits • Reverse power flow on distribution	$600 - 1,200	n/a	$600 - 1,200	$600 - 1,200

[15] Ranges of costs were rounded to the neared $10,000.
[16] The capital presented is the sum of the years 2017, 2018, and 2019 or a three year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
[17] The Mitigation Total column represents the total amount, which includes GRC items as well as any applicable non-GRC items.
[18] The GRC Total column is only presenting those costs which are typically represented in a GRC.

		transformers				
2	Improved Modeling Tools	• Failures of voltage control devices • Outages on high penetration circuits • Reverse power flow in distribution transformers	n/a	50 - 130	50 - 130	50 - 130
3	Increased Outreach Program	• Inadequately trained personnel working on a circuit with connected DER • Emergencies on DER premises	n/a	300 - 500	300 - 500	300 - 500
4	Interconnection Compliance	• Inadequately trained personnel working on a circuit with connected DER • Emergencies at DER premises	n/a	760 - 960	760 - 960	0
5	Anti-Islanding Testing Program	• Failures of voltage control devices • Inadequately trained personnel working on a circuit with connected DER • Emergencies at	n/a	200 - 300	200 - 300	200 - 300

		DER premises				
	TOTAL COST		$600 - 1,200	$1,310 - 1,890	$1,910 - 3,090	$1,150 - 2,130

	Status quo is maintained
	Expanded or new activity
*	Includes one or more mandated activities

The costs shown in Table 5 were forecasted using an average of the past three years for activities that are currently performed by SDG&E. For the Anti-Islanding Testing Program, the costs were forecasted using a method similar to how Corrective Maintenance Programs are performed. It was assumed that every current and future DER installation with an inverter would be tested once every five years by SDG&E personnel.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[19] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[20]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

[19] D.16-08-018 Ordering Paragraph 8.
[20] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[21] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure 2 shows the RSE calculation.

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[21] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 5 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the DER risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

SDG&E grouped the mitigations as follows:

(a) Interconnection studies and modeling (current controls)

- Conduct interconnection studies and incorporate DER into circuit modeling to ensure installed DER capacity does not exceed overnight load minima and backflow limiters are configured correctly.

(b) Baseline Placard Compliance Enforcement (current controls)

- SDG&E's Distribution Interconnection Information System (DIIS) Program, uses Smart Meter Data to identify unaccounted sources of power. Unknown back feed indicates a possible unregistered DER source that can be investigated and corrected through a multi-step process including auto-notification, formal letter, phone contact, field contact, and, finally, disconnection.

(c) Enhanced Training for first responders (incremental mitigations)

- Education and Awareness
  - Aggressive outreach program to educate first responders on DER
  - Virtual application process and approvals
- Safety placards

(d) Inspection program for inverters at DER installations (incremental mitigations)

- Inspect installations on a rotating five-year basis, addressing 20% of the installed base of 100,000+ installations annually and correcting any issues found.

For both current controls and incremental mitigations, residual risk was first determined by establishing the inherent likelihood of injury starting with the number of routine events per year, determining the proportion of events in which the hazard would be present, and the proportion of those which might result in serious injury. The anticipated risk reductions were then calculated by identifying the ways in which the mitigations would reduce either the number of hazardous locations, or the likelihood that an encounter with a hazardous situation would result in an injury.

Likelihood of Injury

- **First Responder Injury Due to Improperly Marked DER**

Two of the proposed mitigations, Baseline Placard Compliance Enforcement and Enhanced Training for First Responders, were evaluated in the context of this outcome. The residual risk for first responder injury is a function of three variables:

Factor A - Number of estimated annual fire calls in SDGE territory: 14,971 fire calls

Factor A was determined by extrapolating 5,639 annual SDFD fire responses[22] within the San Diego population of 1,356,000[23] to the full population of people served by SDGE of 3.6 million,[24] yielding a theoretical number of annual fire calls in the SDGE territory of 14,971.

Factor B - Number of unknown DER (solar) installation present at a fire location: 5.9 fire calls or 0.0229%

Factor B was determined by the number of unauthorized DER installations that would exist in the absence of the monitoring program. This number is a function of the back feed detection program in DIS which identifies approximately 80 unknown sources per week according to SDGE subject matter experts. Given that the process of converting this unknown DER installation into a properly registered installation that meets standards includes a set of deliberate notification and investigative steps over four to eight weeks, approximately 440 unregistered sites can exist at any one time. Relative to the 1.4M SDGE meters, this is 0.03% of the total meters; thus fire fighters encounter an unregistered DER site on 4.7 of the nearly 15,000 fire calls.

Factor C – Annual number of fire fighters receiving an electrical injury when encountering an unknown DER: 0.0036 fire calls annually or 0.076%

22 https://www.sandiego.gov/fire/about.

23 https://www.sandiego.gov/economic-development/sandiego/population.

24 http://www.sdge.com/aboutus.

Factor C was determined by the number of nationwide electrical injuries experienced by fire fighters (190 according to NFPA statistics[25]) relative to nearly 500,000 annual fire responses with the assumption that unregistered installation would double the nominal injury rate.

Based on these factors, the residual likelihood of an injury in this scenario is 0.004 incidents per year, or one every 279 years.

- **SDG&E Employee Injury Due to Islanding Because of Malfunctioning Inverters**

The Inspection Program for Inverters at DER Installations mitigation was evaluated in the context of this outcome. The residual risk for SDGE employee injury due to islanding as a function of malfunctioning inverters is similarly a function of three variables:

<u>Factor A – Annual number of outage events on the SDGE system</u>

A review of OMS data reveals SDGE experience approximately 1,900 outages per year, of about 500 customers each.

<u>Factor B – Rate of DER systems with malfunctioning relays across SDGE's installed base</u>

With over 100,000 DER installations across 1.4 million customers, every 500 customer outage affects an average of 36 DER customers. One in a thousand are assumed to have defective inverters.

<u>Factor C – Injury Rate when encountering islanding</u>

Due to procedures to test lines dead and ground before working, utilizing personal protective equipment, and working on all lines as though they were live, the injury rate is assumed to be 1 in 10,000.

Based on these factors, the residual likelihood of an injury in this scenario is 0.0068 incidents per year, or one every 147 years.

- **SDGE Employee Injury Due to Islanding Because of Excessive DER Capacity**

The Interconnect Studies and Modeling control was evaluated in the context of this outcome. The residual risk for SDGE employee injury due to islanding as a function of excessive DER capacity on a circuit is

<u>Factor A – Annual number of circuit lockout events on the SDGE system</u>

A review of OMS data reveals SDGE experience approximately 260 lockouts per year.

<u>Factor B – Rate of circuits with excessive DER-source power</u>

Because the existing interconnect studies and modeling, the assumed rate of over-capacity situations is assumed to be significantly low (0.1%)

<u>Factor C – Injury Rate when encountering islanding</u>

[25] http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/the-fire-service/fatalities-and-injuries/patterns-of-firefighter-fireground-injuries.

Due to procedures to test lines dead and ground before working, utilizing personal protective equipment, and working on all lines as though they were live, the injury rate is assumed to be 1 in 10,000.

Based on these factors, and because Factor B was set significantly low, the residual likelihood of an injury in this scenario is near zero at 0.00003 events per year. However, because Factor B is non-zero, rates of improvement can be measured.

Anticipated Risk Reduction

- Baseline Placard Compliance Enforcement

The detection algorithm identifies approximately 100 new rogue installations weekly, and it is estimated that with the time it takes to get rogue installations into compliance, there is a residual volume of 440 rogue installations across SDG&E's 1.4 million customers. It is estimated that by abandoning the program, that 5,200 rogue installations would accumulate by the end of a year, an increase of 845% from the residual level of 0.004 events per year.

- Interconnection Studies and Modeling

The number of feeders with excessive DER is set at an arbitrarily low 0.1%, but without interconnect studies and modeling it is estimated that 10% of circuits could host excessive DER load within three years, a one-hundred-fold increase to 0.003 events per year.

- Enhanced First Responder Training

It is estimated by enhancing first responder training to educate them about the emerging risks inherent in DER installations, the risk of injury when encountering rogue installations may be reduced by 40% of the 0.004 events per year.

- Anti-Islanding Inspection Program

By inspecting and addressing issues on 20% of installed DER systems per year, it is estimated that the prevalence of malfunctioning relays will be reduced by 20% of the 0.0068 events per year.

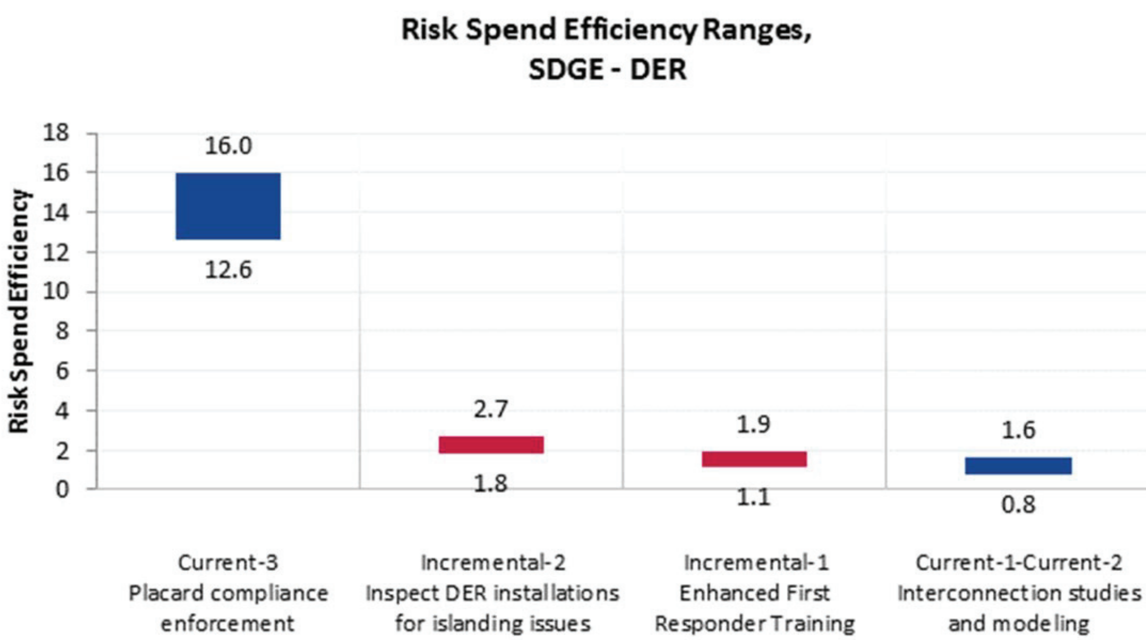
8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Placard Compliance Enforcement (current controls)
2. DER Inverter Inspection Program (incremental mitigations)
3. Enhanced First Responder Training (incremental mitigations)
4. Interconnection Studies and Modeling (current controls)

Figure 3 displays the range[26] of RSEs for each of the SDG&E DER risk mitigation groupings, arrayed in descending order.[27] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

Figure 3: Risk Spend Efficiency



9 Alternatives Analysis

SDG&E considered alternatives to the proposed mitigations as it developed the proposed mitigation plan for the DER risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints such as budget and resources.

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[26] Based on the low and high cost ranges provided in Table 5 of this chapter.

[27] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

9.1 Alternative 1 – First Responder Training

A simple training session with first responders was considered instead of a more comprehensive outreach program. This alternative would conduct twice yearly training sessions for first responders, providing them with information regarding DERs. A twice yearly training would be less costly compared to the proposed plan of outreach efforts to a wider audience who are interested, have, are impacted by and/or install DERs. However, this alternative would not provide the public with important information regarding DER equipment, and therefore was removed from consideration.

9.2 Alternative 2 – Rely on UL Certification for Anti-islanding

This alternative would rely on the status quo condition, whereby SDG&E accepts the UL certification as sufficient for verification of the anti-islanding functionality of inverters. Safety and reliability of DERs and by extension the distribution system could be at risk due to mistakes by UL and inverter manufacturers. Because of this, this alternative was dismissed from consideration.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Major Disturbance to Electrical Service (e.g., Blackout)
(Chapter SDG&E-5)

November 30, 2016

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Executive Summary

Major Disturbance to Electrical Service is the risk of a blackout or major loss of electric service throughout the SDG&E service territory. The loss of the electric power could occur in a large area, or across the entirety of the SDG&E service territory. The impact of a blackout can vary significantly depending on its extent and duration. SDG&E's 2015 baseline mitigation plan for this risk consists of two controls:

1. Advance Readiness
2. Monitoring and Control of the Bulk Electric System (BES)

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability. The 2015 baseline mitigation activities will continue to be performed in the proposed plan to, in most cases, maintain the current residual risk level. In addition, SDG&E's proposed risk mitigation plan includes the addition of new facilities and the implementation of new tools to further reduce human errors.

A risk spend efficiency was developed for Blackout. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The data used to determine the risk spend efficiency of the mitigations was based on industry research, information from adjacent utilities and inter-utility studies. The following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Monitoring and Control (current controls)
2. Advanced Readiness (current controls)
3. Ongoing Transmission Projects and Planning (current controls)
4. Modernization of Grid Control Centers (incremental mitigations)

Risk: Major Disturbance to Electrical Service (e.g., Blackout)

1 Purpose

The purpose of this chapter is to describe the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of Major Disturbance to Electrical Service. This is the risk of a blackout or major loss of electric service throughout the SDG&E service territory. The loss of the electric power could occur in a large area, or across the entirety of the SDG&E service territory. The impact of a blackout can vary significantly depending on its extent and duration. For example, the loss of the entire SDG&E system would have a greater impact than the loss of multiple power substations.

The risk addressed in this chapter deals with blackouts caused at the transmission-level, not at the distribution level. The Federal Energy Regulatory Commission (FERC) regulates Transmission, and so mitigation and costs are generally matters within FERC's oversight and authority.

Blackouts can be caused in various ways, including, but not exclusive to human errors, natural disasters, or asset failures. They can negatively impact critical sites where the environment and public safety can be at risk and have significant financial consequences. Even though electric power systems are planned and operated in accordance with established, strict reliability standards, unexpected events that fall outside these planning standards, make it difficult to fully eliminate the risk exposure of a blackout.

The risk assessment provided herein focuses on the factors or drivers and potential consequences for which SDG&E is aware. The mitigation activities and risk scores presented in this chapter captures what was known in 2015, which is the baseline year for the risk assessment. These activities help mitigate the blackout risk, but may not be solely performed for that purpose SDG&E has included FERC jurisdictional mitigations to demonstrate the completeness of its mitigation plan. However, these costs are for demonstration in the Risk Assessment Mitigation Phase (RAMP) only and will not be addressed or requested in the Test Year 2019 General Rate Case (GRC).

Mitigations related to the maintenance of existing electric transmission infrastructures, physical security, and cyber security, important for preventing a blackout, are covered in the RAMP risk chapters of: Electric Infrastructure Integrity, Public Safety Events – Electric and Cyber Security, respectively. Mitigations considered in this chapter improve and maintain safety by reducing the occurrence of system wide blackouts.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a RAMP Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015;

however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several GRC cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

2 Background

Mitigation activities to maintain system reliability and prevent the occurrence of blackouts are of paramount importance to SDG&E and society. Although the likelihood of a wide-spread, noteworthy blackout is small, there have been significant blackouts occurred throughout North America, Europe and other locations in recent history. For instance, the Northeast Blackout that occurred on August 14, 2003, impacted large portions of the Midwest and Northeast United States and Ontario, Canada. The outage affected an area with an estimated 50 million people and 61,800 megawatts (MW) of electric load in Ohio, Michigan, Pennsylvania, New York, Vermont, Massachusetts, Connecticut, New Jersey, and the Canadian province of Ontario. The blackout began a few minutes after 4:00 pm Eastern Daylight Time (16:00 EDT), and, in some parts of the United States, power was not restored for four days. Parts of Ontario suffered rolling blackouts for more than a week before full power was restored. Estimates of total costs in the United States range between $4 billion and $10 billion (U.S. dollars). In Canada, gross domestic product was down 0.7% in August, there was a net loss of 18.9 million work hours, and manufacturing shipments in Ontario were down $2.3 billion (Canadian dollars).[2]

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[1] Commission Decision (D.) 14-12-025 at p. 31.
[2] U.S.-Canada Power System Outage Task Force, "Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations", April 2004 http://www.nerc.com/pa/rrm/ea/2003%20Blackout%20Final%20Report/ch1-3.pdf.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[3] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks.[4] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Blackout risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as an electric, operational risk associated with generation and transmission as shown in Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	ELECTRIC	GENERATION AND TRANSMISSION

3.2 Potential Drivers[5]

When performing the risk assessment for Major Disturbance to Electric Services, SDG&E identified potential indicators of risk, referred to as drivers. The drivers identified were determined using historical data of blackouts in North America. These include, but are not limited to:

- **Generation Resource Constraints -** Electrical power systems rely on a continuous balance between load and generation to remain stable. Generation deficiencies related to energy market issues, lack of gas supply, lack of reserves, and lack of inertia or poor load forecast can lead to instability.

- **Grid Reliability Events -** Events, such as protection system mis-operations, can either initiate or increase the severity of an electrical disturbance.

[3] A.15-05-002, filed May 1, 2015, at p. JMD-7.
[4] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[5] An indication that a risk could occur. It does not reflect actual or threatened conditions.

- **Loss of Key Transmission Assets -** Forced or unplanned outages of major transmission lines (above 100 kV), if not studied properly or monitored, can lead to cascading, uncontrolled separation, or instability.

- **Software Bug in the Energy Management System -** A malfunction of the energy management system can prevent operators from responding to a disturbance.

- **Human Error -** Unintentional faults due to human operational oversight.

- **Natural Causes -** Unforeseen extreme natural events (i.e., lightning, wide area wildfires, or earthquake) can trigger the loss of several key transmission and generation assets that could lead to a blackout.

Table 2 maps the specific drivers of Major Disturbance to Electric Services to SDG&E's risk taxonomy.

Table 2: Operational Risk Drivers

Driver Category	Major Disturbance to Electric Services (e.g., Blackout) Driver(s)
Asset Failure	• Generation resource constraints • Grid reliability events • Loss of key transmission assets
Asset-Related Information Technology Failure	• Software bug in the energy management system
Employee Incident	• Human error
Contractor Incident	Not applicable
Public Incident	Not applicable
Force of Nature	• Natural causes (e.g. earthquakes, wildfires)

3.3 Potential Consequences

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

- Health and safety impacts, including life threatening injuries, to SDG&E customers and the public;
- Operational and reliability impacts;
- Exposure to compliance violations and penalties;
- Adverse litigation;

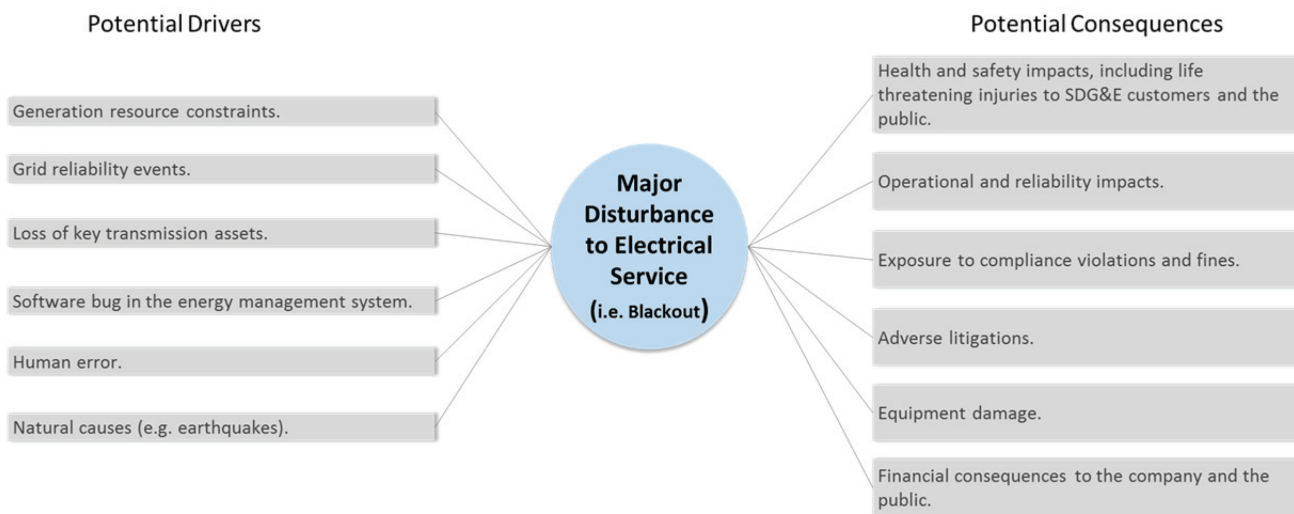
- Equipment damage; and/or
- Financial consequences to the Company and the public.

These potential consequences were used in the scoring of Major Disturbance to Electric Services that occurred during the SDG&E's 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown in Figure 1 is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Blackout as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a blackout can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Major Disturbance to Electric Services (e.g., Blackout):

- The loss of multiple transmission assets due to a significant event. Potential consequences include life threatening injuries or few fatalities. The operational impacts affect critical customers and entire metropolitan areas leading to severe and long-term consequences to the environment. Blackouts may involve regulatory compliance violations, litigation, and financial consequences. Specifically, a system-wide blackout, similar to the September 8, 2011, Pacific Southwest Blackout that affected the entire SDG&E system, was used as a baseline to score this risk.[6]

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[7] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the Blackout risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	7	5	5	2	44,458

4.3 Explanation of Health, Safety, and Environmental Impact Score

SDG&E scored this risk a 6 (severe) in the Health, Safety, and Environmental impact area due to its potential to result in life-threatening injuries or fatalities to employees or the public. For example,

[6] The 2011 Pacific Southwest Blackout occurred on September 8, 2011, when an 11-minute system disturbance occurred in the Pacific Southwest, leading to cascading outages and leaving approximately 2.7 million customers without power.
[7] D.16-08-018 Ordering Paragraph 9.

during the Northeast Blackout of August 2003, New York City officials reported a spike in emergency room treatments for diarrheal illnesses, presumably caused by eating spoiled food.[8] Fires caused by burning candles were reported across the city. Some of the deaths reported that day were attributed to carbon monoxide poisoning caused by fires or malfunction of home generators. Similar deaths were also reported during the 2012 Superstorm Sandy that caused significant power outages in the New Jersey area.[9] New research suggests that more deaths and injuries can be attributed to a blackout if accidents, cardiovascular conditions, respiratory problems, home medical device failures, and various other health conditions are considered.[10]

This is especially true given the loss of traffic signals which increases the likelihood of vehicle accidents. Also, critical facilities, such as hospitals with inadequate backup generators, run the risk of not to being able to care for patients.

With respect to environmental impacts, the Pacific Southwest outage resulted in some sewage pumping station failures that resulted in contaminated beaches and potentially unsafe water supplies in several areas.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, the following scores were assigned to the remaining residual risk categories.

- **Operational and Reliability:** A score of 7 (catastrophic) was given to this risk as a system-wide blackout, could affect the 3.6 million customers of SDG&E.
- **Regulatory, Legal, Compliance:** A score of 5 (extensive) was given as there are instances where blackout causes can be traced back to weak implementations of some of the North American Electric Reliability Corporation (NERC) standards by a Utility company, an Independent System Operator, or a Reliability Coordinator. During the Pacific Southwest Blackout, it was found that some of the entities involved violated one or more reliability standards. The alleged compliance violations resulted in penalties.[11]
- **Financial:** Financial consequences to the Company and the public may also result from a blackout. Blackouts may cause significant losses to local businesses (e.g., restaurants, grocery

[8] Shao Lin, Barbara A. Fletcher, Ming Luo, et al. "Health Impact in New York City During the Northeastern Blackout of 2003", Public Health Reports, 2011 May-Jun, http://www.publichealthreports.org/issueopen.cfm?articleID=2629.
[9] Centers for Disease Control and Prevention, "Deaths Associated with Hurricane Sandy – October –November 2012", https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6220a1.htm..
[10] G. Brooke Anderson and Michelle L. Bell, "Lights out: Impact of the August 2003 power outage on mortality in New York", Public Health Reports, Epidemiology. 2012 Mar; http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3276729/#R25.
[11] Federal Energy Regulatory Commission, "FERC Approves Final Settlement in 2011 Southwest Blackout Case", May 26,2015, Docket No IN14-11-000, http://www.ferc.gov/media/news-releases/2015/2015-2/05-26-15.asp#.V5aaIPkrJhE.

stores) and households. The business continuity of manufacturing plants and commercial businesses also may be impacted. Furthermore, blackouts can cause data loss and damage to assets such as computers and plant equipment. Lastly, possible lawsuits by individuals or businesses, coupled with regulatory penalties not covered under insurance policies, also can have financial impacts.[12] Subject matter experts considered this information when assigning a scoring of 5 (extensive) to this impact.

4.5 Explanation of Frequency Score

The 2011 Pacific Southwest Blackout is the only major system-wide blackout SDG&E has experienced since its creation. Other utilities in California have also had infrequent blackouts compared to utilities located in the northeastern and southeastern part of the United States. This can be explained in large part, by weather patterns in the eastern part of the United States (i.e., harsh winter and tropical storms). Accordingly, a low frequency of occurrence was selected because SDG&E has had only one major system-wide blackout. This corresponds to a score of 2 (rare), defined by the 7X7 matrix as an event that occurs once every 30-100 years.

The likelihood of a blackout in the SDG&E territory potentially could increase if major earthquakes or wild fires were to happen more often in San Diego County. Also, Blackouts may be driven by external entities. SDG&E's system depends on operational decisions made by the California Independent System Operator (CAISO), the Reliability Coordinator (Peak RC), and Western Electricity Coordinating Council (WECC), along with operational actions by neighboring utilities. A poor operational decision by an external entity can affect SDG&E's ability to serve its customers.

5 Baseline Risk Mitigation Plan[13]

As stated above, SDG&E defines Major Disturbance to Electrical Service risk as a blackout or major loss of electric service throughout the SDG&E service territory. The 2015 baseline mitigations discussed below include the current evolution of the utilities' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time.

SDG&E's 2015 risk mitigation plan includes a mix of two controls: (1) Advance readiness, and (2) Monitoring and Control of the Bulk Electric System (BES). Activities include: 24-hour real-time monitoring and control of all transmission assets; the development of short-term operating plans to prepare for potential system disturbances; seasonal studies; procedure coordination; personnel training; event reporting; and regulatory audits. These controls focus on safety-related impacts[14] (i.e., Health,

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[12] E. Mills and R. Jones, "An Insurance Perspective on U.S. Electric Grid Disruption Costs", Electricity Markets and Policy Group, Geneva Papers on Risk and Insurance Issues and Practice, Feb 2016; https://emp.lbl.gov/sites/all/files/lbnl-1004466.pdf.
[13] As of 2015, which is the base year for purposes of this Report.
[14] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.

Safety, and Environment) per guidance provided by the Commission in D.16-08-018[15] as well as controls and mitigations that may address reliability.[16] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various types of blackouts, not just the scenario used for purposes of risk scoring.

1. Advance Readiness

Advance readiness is of great importance in the avoidance of blackouts. It includes seasonal system impact studies of major known outage events, coordination of transmission protection schemes with neighboring utilities, and annual updates to the under-frequency load shedding program within the Western Electricity Coordinating Council (WECC) requirements. Participation in inter-utility regional studies and reliability standard development enables engineers to continuously share knowledge they acquire while operating their own system. Studies involve power flow, transient stability, post transient voltage stability, and other analyses. This knowledge is then used to establish parameters, guidelines, and standards that help maintain the reliability of the electric grid.

2. Monitoring and Control of the Bulk Electric System (BES)

The reliability of the SDG&E system depends on its continuous internal network connectivity and connectivity with its neighboring utilities. Events that unravel Interconnections, such as those in the August 2003 Northeast Blackout, may start out slowly, and then escalate to very fast (fractions of a second) cascading failures that cannot be manually stopped once they enter their dynamic phase.[17] While SDG&E cannot prevent events from happening on its system, it can monitor the Bulk Electric System (BES) and alert the CAISO to pending issues.

Real-time operation comprises all activities associated with the support and implementation of real-time actions to maintain the safe and reliable operation of the SDG&E electrical transmission grid and interconnections to prevent system collapse, separation, and overloads that might damage equipment and jeopardize the safety of personnel and the public. This activity provides the main point of contact with neighboring utilities, the California Independent System Operator (CAISO), and the Reliability Coordinator (Peak RC) and involves Real-time Operators, Outage Coordinators, Trainers, and the Energy Management System (EMS). Real-time operators conduct real-time assessments and establish Operating Limits so that the SDG&E's transmission system is continuously operated within acceptable reliability criteria. They monitor actual power flows on the system, control these flows, and coordinate with the CAISO and Peak RC.

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[15] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[16] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.
[17] North American Electric Reliability Corporation, "Reliability Concepts", Version 1.0.2, December 19, 2007 http://www.nerc.com/files/concepts_v1.0.2.pdf.

The outage coordination group manages and coordinates all transmission equipment outages and switching for scheduled maintenance, construction and modification or testing of all transmission equipment on 69, 138, 230 and 500 kV systems. The training team provides operators with the latest procedures, system changes, industry standards, and tools available.

One of the key findings of the September 8, 2011 Blackout, was that some of the entities' real-time tools were not adequate or operational to alert operators. SDG&E uses an EMS for situational awareness. In addition, the implementation of the Synchrophasor project will help improve real-time measurements needed to increase situational awareness, and aligns with the Company goal to move toward a smarter grid. The project began in 2010 and is expected to be fully implemented by December 2020. It is important to note that this is an evolving technology; the extensive testing, validation and continuous improvement SDG&E plans to do will continue beyond 2020. The Synchrophasor project consists of the installation and maintenance of Phasor Measurement Units (PMU) that take near real-time (sub-second) readings throughout the SDG&E system, and the acquisition of software tools needed for increased situational awareness, enhanced EMS models, Voltage Stability Analysis, Linear State Estimation, Oscillation and Disturbance detection, and to perform post-event analysis. Synchrophasors help provide a better indication of the electric grid stresses and could be used to trigger wide-area corrective actions to maintain grid reliability.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigation activities outlined in Section 5 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. In addition, SDG&E's proposed risk mitigation plan during the 2017-2019 timeframe includes the addition of new facilities and the implementation of new tools to further reduce human errors. These incremental mitigations are described in detail below.

1. Upgrades and Installation of New Transmission Facilities

SDG&E performs long-term Transmission Planning studies to identify transmission expansion projects to strengthen the electric grid. Those projects aim to upgrade and install additional facilities needed to prevent thermal overloads, transient instability, and voltage stability issues that could lead to a blackout. SDG&E proposed projects include the addition of dynamic reactive resources, new transmission lines, and upgrades to existing substations.

Reactive power resources are important in maintaining healthy power system voltages and facilitating power transfers. According to the U.S. – Canada Power System Task Force of the August 14, 2003, Blackout, inadequate reactive power resources are a common factor in most of the major blackouts that occurred in the past.[18] This means that under certain extreme system conditions, a major disturbance can cause a blackout in the SDG&E system if the amount of dynamic reactive power reserve is not sufficient. The addition of a Static Var Compensator at Suncrest, and the addition of synchronous condensers at San Luis Rey, Miguel, and San Onofre, will provide system operations with dynamic reactive power sources needed to quickly respond to major disturbances.

Another common factor in most of the major blackouts is the inability of a transmission system to maintain its integrity after sudden unexpected transmission line failures force power to flow onto other lines, causing severe thermal overloads. If adjacent transmission lines cannot handle those overloads, it can lead to additional cascading outages that might result in a blackout. Therefore, to have a reliable transmission system, a region requires backup transmission lines with adequate capacity. Furthermore, the rapid increase of renewable generation in the Imperial Valley area, combined with load growth in the SDG&E system, requires upgrades and the construction of new high voltage transmission lines to relieve congested lines which are already close to their maximum capacity. Among the multiple projects proposed to meet reliability standard requirements, SDG&E selected the following transmission capacity projects:

- New Sycamore Canyon to Penasquitos 230 kV transmission line;
- South Orange County Reliability project (Capistrano substation upgrade and addition of 230 kV transmission lines);
- New Imperial Valley flow control device project (Phase Shifting Transformer);
- New second 230 kV transmission line from Miguel to Bay Boulevard; and
- New Mission to Penasquitos 230 kV transmission line.

Those 230 kV projects were determined, based on subject matter experts' experience with the SDG&E system, to have the greatest impact on reducing the likelihood of a major blackout compared to lower voltage projects (below 230 kV) that usually help solve localized reliability issues. This assumption is considered reasonable when observing the type of facility failures that triggered previous major blackouts such as the 1965 Northeast Blackout, the 1977 New York City Blackout, the 1982 and 1996 West Coast Blackouts, the 1998 Upper Midwest Blackout, the 2003 Northeast Blackout, and the 2011 Pacific Southwest Blackout. Although construction associated with those projects is estimated to start during the 2017-2019 period, their in-service dates are estimated to extend to 2021.

[18] U.S.-Canada Power System Outage Task Force, "Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations", April 2004 http://www.nerc.com/pa/rrm/ea/2003%20Blackout%20Final%20Report/ch1-3.pdf.

2. Modernization of Grid Control Centers

The Transmission Energy Management System Modernization Project will upgrade SDG&E's current mimic board and control room. The upgrades will help improve situational awareness and prevent potential human errors. Upgrades would include replacing the static mosaic tile board with a dynamic video wall, upgrading the peripheral devices/applications that support such systems, and maximizing the utilization of control room space while maintaining an ergonomic work environment consistent with the Company's policies. The result of the Transmission EMS Modernization Project will be enhanced safety and reliability by expediting the identification of critical system conditions through means of dynamic visual content.

3. Advance Readiness

Advanced Readiness is a baseline mitigation that SDG&E is proposing to continue. For a description of this activity, please refer to Section 5 above.

4. Monitoring and Control of the Bulk Electric System

Monitoring and Control of the BES is an ongoing mitigation and is described in detail in Section 5 above.

7 Summary of Mitigations

Table 4 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for Major Disturbance to Electrical Service. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

Table 4: Baseline Risk Mitigation Plan[19]
(Direct 2015 $000)[20]

ID	Control	Risk Drivers Addressed	Capital[21]	O&M	Control Total[22]	GRC Total[23]
1	Advance Readiness*	• Generation resource constraints • Loss of key transmission assets • Grid reliability events • Natural causes (e.g. earthquakes, wildfires, etc.)	n/a	$1,030	$1,000	$0
2	Monitoring and Control of the Bulk Electric System*	• Generation resource constraints • Loss of key transmission assets • Natural causes (e.g. earthquakes, wildfires, etc.) • Human error • Public incident (e.g. car contact with poles) • Software bug in the energy management system	4,920	1,580	6,500	0

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19 Recorded costs were rounded to the nearest $10,000.
20 The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
21 Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
22 The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
23 The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[21]	O&M	Control Total[22]	GRC Total[23]
	TOTAL COST		$4,920	$2,610	$7,500	$0

* Includes one or more mandated activities

1. <u>Advance Readiness</u>

Costs for the Advanced Readiness mitigation of $1 million represent the total 2015 annual salaries of the Electric Grid Operations Support cost center. One hundred percent of these costs have been identified as FERC jurisdictional based on the group's labor allocation to Transmission O&M. Therefore, the costs associated with Advance Readiness have been deducted from the GRC Total column of Table 4.

2. <u>Monitoring and Control of the Bulk Electric System</u>

The costs for the Monitoring and Control of the BES mitigation, shown in Table 4, for both Capital and O&M consist of both labor and capital plant expenditures. The labor identified with this activity comprises: 11 Transmission System Operators (TSO), nine Operations Shift Supervisors (OSS), two NERC Certified Trainers, and two NERC Certified Outage Coordinators in the Electric Grid Operations center. Labor costs were estimated by using the average annual salary pay for each job description, multiplied by the number of full-time equivalents (FTEs) and allocating the amounts equally between transmission capital engineering and transmission O&M. The capital costs reflect the 2015 expenditures associated with Synchrophasor installations. Capital costs associated with the EMS are needed in order to be compliant with NERC Critical Infrastructure Protection (CIP) standards. All costs associated with the Monitoring and Control of the BES have are non-GRC (FERC jurisdictional) based on the allocation of labor and identification of capital plant as transmission and have been deducted from the GRC Total amount.

Table 5 summarizes SDG&E's proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan, and is not requesting funding approval. SDG&E will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 5, the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 5: Proposed Risk Mitigation Plan[24]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[25]	2019 O&M	Mitigation Total[26]	GRC Total[27]
1	Upgrades and Installation of New Transmission Facilities*	• Generation resource constraints • Loss of key transmission assets • Natural causes (e.g. earthquakes, wildfires, etc.)	$382,560 - 467,570	n/a	$382,560 - 467,570	$0
2	Modernization of Grid Control Centers	• Human error	13,900 - 15,360	n/a	13,900 - 15,360	11,810 - 13,060
3	Advance Readiness*	• Generation resource constraints • Loss of key transmission assets • Grid reliability events • Natural causes (e.g. earthquakes, wildfires, etc.)	n/a	980 - 1,080	980 - 1,080	0
4	Monitoring and Control of the Bulk Electric System*	• Generation resource constraints • Loss of key transmission assets	12,140 - 13,420	1,500 - 1,650	13,640 - 15,070	0

[24] Ranges of costs were rounded to the nearest $10,000.
[25] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
[26] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[27] The GRC Total column shows costs typically represented in a GRC.

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[25]	2019 O&M	Mitigation Total[26]	GRC Total[27]
		• Natural causes (e.g. earthquakes, wildfires, etc.) • Human error • Public incident (e.g. car contact with poles) • Software bug in the energy management system				
	TOTAL COST		$408,600 - 496,350	$2,480 - 2,730	$411,080 - 499,080	$11,810 - 13,060

(white box)	Status quo is maintained
(shaded box)	Expanded or new activity
*	Includes one or more mandated activities

While all the mitigations and costs presented in Table 5 mitigate the Blackout risk, some of the controls also mitigate other risks presented in this RAMP. Specifically, the Modernization of Grid Control Centers mitigation is also included in the Fail to Blackstart risk. Because the Modernization of Grid Control Centers project mitigates the risks of Blackout and Fail to Blackstart, the costs and risk reduction benefits are included in both chapters.

1. Upgrades and Installation of New Transmission Facilities

Preliminary costs shown in Table 5 for the Upgrades and Installation of New Transmission Facilities mitigation consist of both labor and capital plant additions. The labor associated with this activity represents the development of the 10-year transmission plan studies in cooperation with the CAISO. This task is performed by the Transmission Planning group, which attributes 50% of its labor to the development of the 10-year transmission plan studies. The labor costs included above reflect 50% of 2015 labor costs. In other words, for O&M labor expenses, SDG&E used a base year (2015). forecast methodology to project future costs. The dollars associated with addition of capital plant are based on estimated costs provided on accounting documents such as capital budget documents (CBD's) and/or work order forms. While these capital costs were zero-based, they were informed by reviewing previous capital projects and SDG&E experience. The ranges of costs provided for this activity were developed due to uncertainty of the exact capital plant amounts and variability of labor costs.

2. Modernization of Grid Control Centers

Modernization of Grid Control Center costs reflect estimates developed by the Electric Grid Operations organization for SDG&E's internal capital approval process. The $14 million - $15.4 million includes a portion identified as FERC jurisdictional, non-GRC dollars. $2.1 million - $2.3 million has been identified as non-GRC based on an 85/15 split between CPUC/FERC, respectively, for the Electric Grid Operations departmental accounting allocation.

3. Advanced Readiness

The forecasted range of costs associated with this item is consistent with those recorded in 2015 because, at this time, SDG&E believes the future scope will closely resemble 2015.

4. Monitoring and Control of the Bulk Electric System

Like the Advanced Readiness mitigation, the projected costs for this mitigation are similar to the costs incurred in 2015. The range provided in Table 5 is reasonable as SDG&E anticipates that this activity will not dramatically change in the years 2017-2019.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[28] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018. [29]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of

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[28] D.16-08-018 Ordering Paragraph 8.
[29] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[30] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure 2 shows the RSE calculation.

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[30] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 5 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Blackout risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

The risk assessment team analyzed four mitigation groupings. The first consists of three current operation planning controls; the second is two, ongoing monitoring and control measures; the third is an assortment of ongoing transmission projects; and the fourth is a proposed system modernization project. The analysis of these mitigations used a combination of industry research and risk team estimates, based on SME input.

The mitigations groupings included:

(a) Advance Readiness

- System Impact Studies of Major Outage Events
- Coordination of transmission protection schemes with neighboring utilities - updates to the under-frequency load shedding program within WECC requirements.
- Participate in Inter-Utility Regional Studies and Reliability Councils & Standard Development

(b) Monitoring and Control

- Real-time operation
- Synchrophasor Project

(c) Ongoing Transmission Projects and Planning

- 10-year transmission plan Studies
- San Luis Rey Synchronous Condensers
- San Onofre Synchronous Condenser
- Miguel Synchronous Condensers
- Suncrest Static VAr Compensator
- TL23071: Sycamore Canyon - Penasquitos 230 kV Line
- South Orange County Reliability Project
- Imperial Valley Flow Control Device
- 2nd Miguel to Bay Blvd 230 kV line
- New Mission - Penasquitos 230 kV Line

(d) System modernization (Modernization of Grid Control Centers)

- Transmission Energy Management System Modernization Project

- Current: Advanced Readiness

This mitigation analysis drew on the development of short-term operating plans, coordination with other neighboring utilities, and participation in inter-utility studies. Because the controls in this grouping focus on industry-wide efforts, the team sought to quantify the effectiveness of this mitigation in terms of determining where SDG&E would be positioned in comparison to other utilities if it did not engage in the activities for this mitigation. To do this, the analysis team compiled the electric disturbance event data from the U.S. Energy Information Administration (EIA). The data includes information on incidents by region or state, including the date of the incident, and the number of customers. Because the data was provided by state, states where a utility operates were used as a proxy for the utilities themselves.

Other researchers who have used this data identified a threshold for a blackout to be 50,000 customers.[31,32] The team counted the number of events per state that affected more than 50,000 customers, over 2002-2013 (all years for which data were available) and normalized each state by its population. The results were ordered and sorted into quartiles. SDG&E is a California utility and California ranked near the top of the 2nd quartile, in terms of number of major disturbance events affecting 50,000 customers per state, per population. With input from SMEs, the team determined that if SDG&E were not engaged in this mitigation, it would fall to the bottom of the 2nd quartile, a fall of over 110% from its current position.

Based on this proxy estimate using industry-wide blackout data, the risk team SMEs estimated that if these mitigations were discontinued, the likelihood of an incident would increase by over 110%.

- Current: Monitoring and Control

This risk consists of the maintenance of the energy management system, real time operation, monitoring, and control of the electrical system, as well as the installation of synchrophasors, which provide a better indication of the electric grid stresses and could be used to trigger wide area corrective actions to maintain grid reliability. For the analysis of the effectiveness of this mitigation, the team relied on SME input to estimate the likelihood of a blackout in the absence of these projects. SMEs indicated that without this mitigation, SDG&E could have a blackout once every 1 to 3 years, compared to its current likelihood of once every 30 to 100 years. Determining the risk reduction based on SME input is

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[31] P. Hines, J. Apt, and S. Talukdar. "Trends in the History of Large Blackouts in the United States." IEEE Power and Energy Society General Meeting, 2008.
[32] P. Hines, J. Apt, and S. Talukdar. Large Blackouts in North America: Historical Trends and Policy Implications. Energy Policy, v. 37, pp. 5249-5259, 2009.

SDG&E's best estimate at this time, especially given that there is no industry data available for validation.

- Current: Ongoing Transmission Projects and Planning

This mitigation consists of various transmission planning studies and their associated proposed equipment upgrades and additions. Transmission planning studies ensure projects are proposed to enable the transmission system to withstand the loss of one or two simultaneous transmission facilities. It was assumed that as long as an event/disturbance causes the loss of one or two transmission facilities, a blackout will not occur. Meaning, if three major facilities were lost, the risk of having a blackout increases. Assuming losing three facilities instead of losing two facilities occurs at a 1-10% rate, these efforts reduce the risk by a factor of 10-100. That is, losing two transmission facilities is 10-100 times more likely than losing three transmission facilities. Without these measures, the likelihood score would, conservatively, be 10x its current score.

- Incremental: Modernization of Grid Control Centers

This mitigation upgrades an antiquated EMS visualization tool and control room. This tool will help improve situational awareness and prevent potential human errors. SDG&E estimated that this improvement will reduce the likelihood of a blackout by 10%. SDG&E's SMEs consider this to be the best estimate at this time since there is no industry data available for validation.

8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

5. Monitoring and Control (current controls)
6. Advanced Readiness (current controls)
7. Ongoing Transmission Projects and Planning (current controls)
8. Modernization of Grid Control Centers (incremental mitigations)

Figure 3 displays the range[33] of RSEs for each of the SDG&E Blackout risk mitigation groupings, arrayed in descending order.[34] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

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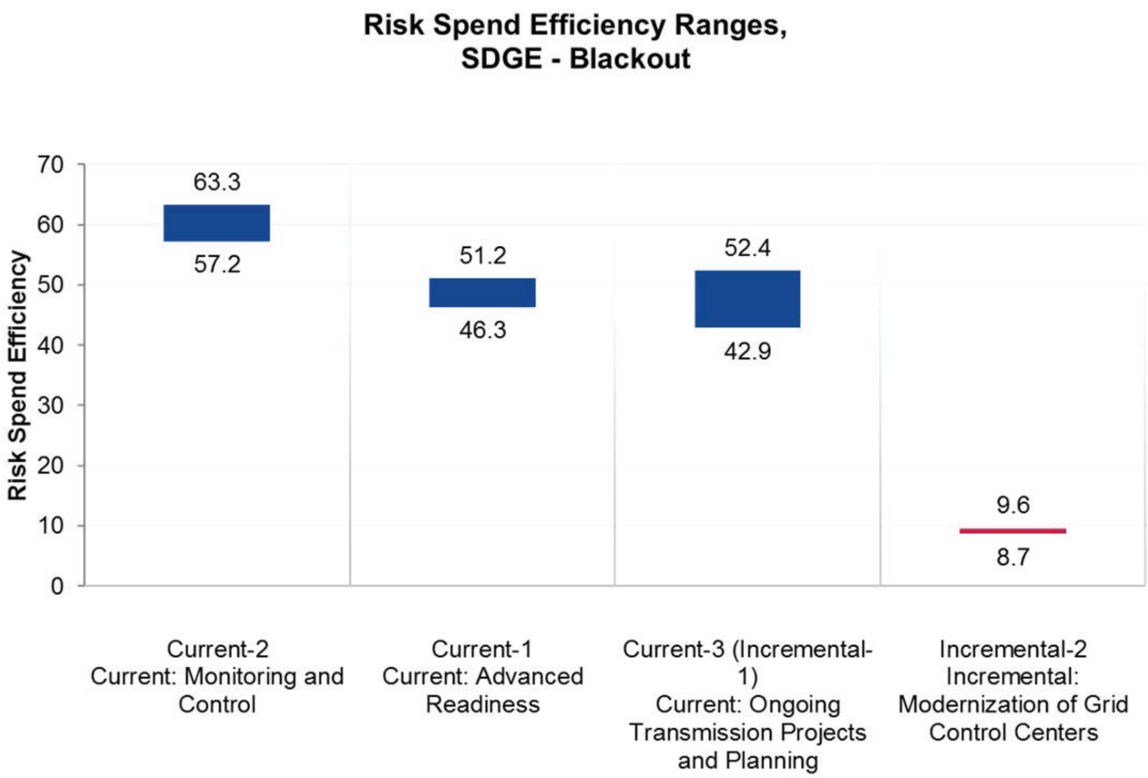
[33] Based on the low and high cost ranges provided in Table 5 of this chapter.
[34] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 3: Risk Spend Efficiency



9 Alternatives Analysis

SDG&E considered alternatives to the proposed mitigations as it developed the proposed mitigation plan for the Major Disturbance to Electrical Service (Blackout) risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources. Due to the serious safety concerns of a blackout, maintaining the status quo was not considered as a plausible alternative. Instead, adjustment of project scopes and addition of new activities were selected to derive alternatives during the selection process.

9.1 Alternative 1 – Modernization of Grid Control Centers

Modernization of both the primary and back-up control centers was considered as an alternative. Modernization for purposes of this alternative included remodeling of control rooms, installation of Direct View LED video walls, construction of a production development lab, and integration of a new cross-site collaborative software solution. The modernization of the primary Grid Control Center alone was instead selected in SDG&E's proposed plan in anticipation of future plans of an all-encompassing control center, yielding the existing primary Control Center as a sustainable back-up in the future. The existing back-up control center is close to an earthquake fault line, which does not make it an optimal location. The selected alternative project improves public safety by augmenting situational awareness within the control room, which will yield expedient responses to critical system conditions that jeopardize public safety, and by laying the groundwork for a more reliable back-up control center in the future.

9.2 Alternative 2 – Imperial Valley Flow Control Device

The installation of a back-to-back HVDC Converter technology at Imperial Valley was considered as one of the alternatives to control the power flowing from the Imperial Valley substation into Mexico's Centro Nacional de Control de Energia (CENACE) system. The back-to-back HVDC Converter technology was not selected and viewed as infeasible because it was more expensive and required more space at the substation than available. The Phase Shifting Transformer technology was selected instead and proved to have a more adequate cost, footprint, and flow control capability.

Risk Assessment Mitigation Phase

Risk Mitigation Plan

Fail to Blackstart (Chapter SDG&E-6)

November 30, 2016

310286

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Executive Summary

The Fail to Blackstart risk is the inability to restore electric services to customers in the SDG&E service territory following a disturbance or an event in which the SDG&E service territory suffers a complete blackout or shut down condition. An essential part of having the ability to restore electric services from a blackout is to have access to adequate Blackstart facilities and Cranking Paths[1] when restoration from an interconnection with a neighboring utility is not an available option.

SDG&E's 2015 risk mitigation plan includes two controls: (1) Maintenance, certification, and testing of existing Blackstart facilities, and (2) Annual Blackstart plan review and training. These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision16-08-018 as well as controls and mitigations that may address reliability.

The 2015 baseline mitigations will continue to be performed in the proposed plan to, in most cases, maintain the current residual risk level. SDG&E's proposed risk mitigation plan includes the addition of Blackstart facilities, the modernization of SDG&E control centers, and enhancements to substation backup power.

A risk spend efficiency was developed for Fail to Blackstart. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Maintenance, certification, testing, and training (current controls)
2. The South Grid Black Start Project (incremental mitigations)
3. Substation backup power enhancements (fuel cells) (incremental mitigations)
4. Modernization of Grid Control Centers (incremental mitigations)

[1] A portion of the electric system that can be isolated and then energized to deliver electric power from a generation source to enable the startup of one or more other generating units. Source: North American Electric Reliability Corporation, Glossary of Terms Used in Reliability Standards (http://www.eia.gov/electricity/data/eia411/nerc_glossary_2009.pdf).

SDGE

A Sempra Energy utility

Risk: Fail to Blackstart

1 Purpose

The purpose of this chapter is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of Fail to Blackstart. A Fail to Blackstart is the inability to restore electric services to customers in the SDG&E service territory following a disturbance or an event in which the SDG&E service territory suffers a complete blackout or shut down condition. An essential part of having the ability to restore electric services from a blackout is to have access to adequate Blackstart facilities and Cranking Paths[2] when restoration from an interconnection with a neighboring utility is not an available option.

To more fully understand the nature of risk, one must recognize the distinction between an isolated blackout and a complete system blackout. An isolated blackout is the loss of the electrical service in neighborhoods or regions of the SDG&E territory while the electric grid, overall, continues to operate. A complete system blackout happens when the entire SDG&E electric power grid has been de-energized as a result of a disturbance or unforeseen event. Fail to Blackstart relates to the latter situation when there is an assumption that restoration through an interconnection with a neighboring utility is not available; that the only viable restoration option is through a generation Blackstart Resource instead of using an interconnection.

Blackstart facilities are small generators that have the ability to start without support from the external electric transmission system. Those units are used during blackouts to energize designated transmission lines and larger generators which, in turn, are used to restore loads, maintain frequency and voltages, until the isolated system reestablishes connections with neighboring transmission systems. The designated transmission lines used to route power from the Blackstart facilities to the larger generators is called the Cranking Path.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based

[2] A portion of the electric system that can be isolated and then energized to deliver electric power from a generation source to enable the startup of one or more other generating units. Source: North American Electric Reliability Corporation, Glossary of Terms Used in Reliability Standards. (http://www.eia.gov/electricity/data/eia411/nerc_glossary_2009.pdf).

on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[3] Mitigations considered in this chapter improve and maintain safety by reducing the duration of system wide blackouts. In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

The mitigation activities and risk scores presented in this chapter captures what was known in 2015. These activities presented herein help mitigate the risk Fail to Blackstart, but may not be performed solely for that purpose. Nonetheless, these mitigations are presented in this chapter and the entire cost of the activity is included. It should be noted that a large portion of this risk is under the jurisdiction of the Federal Energy Regulatory Commission (FERC). SDG&E has included FERC jurisdictional mitigations to demonstrate the completeness of its mitigation plan. However, these costs are for demonstration in the RAMP only and will not be addressed or requested in the Test Year 2019 GRC.

Mitigations related to the maintenance of existing transmission infrastructures, such as the Cranking Paths, although important for preventing a failure to blackstart, are not covered in this chapter because they are already included in the Electric Infrastructure Integrity risk chapter within this Report.

2 Background

On September 8, 2011, SDG&E experienced a total system blackout during the Pacific Southwest Blackout. Both major interconnections to the SDG&E system remained energized at the Southern California Edison and Arizona Public Service facilities. This allowed for the preferred method of restoration using the Interconnection. SDG&E Blackstart facilities were not used to restart the SDG&E system[4]. However, in different circumstances, when adjacent systems are also blacked out and the

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[3] Commission Decision (D.) 14-12-025 at p. 31.
[4] SDG&E's Blackstart resource at its Miramar facility was operated in case it was needed.

SDG&E system must be re-energized internally, then the need for a Blackstart facility as well as its Cranking Path becomes extremely critical.

In 2015, several Blackstart facilities were available. The legacy units originally owned by SDG&E, but divested in the late 1990s to NRG, have blackstart capability that allows a V8 reciprocating engine to start every other Cabrillo II peaking generator (4 V8 units at Kearny, 1 V8 unit at Miramar)[5]. SDG&E currently has two Blackstart facilities. The first, owned and maintained by SDG&E, is located at the Miramar Energy Facility (MEF) where a gas-fired reciprocating engine generator has the ability to start either of the MEF gas turbines. The other is located at the Orange Grove Energy facility at the Pala substation. A Power Purchase Agreement (PPA) between SDG&E and Orange Grove requires a reciprocating engine generator to start either of the Pala gas turbine units to serve as Blackstart facilities. Both Blackstart facilities are reciprocating engines that will start co-located combustion (gas) turbine generators, which would then start the large Palomar Energy Center (PEC) generators required to restore the SDG&E system.

A failure to be able to restore the SDG&E system would have costly impacts. For example, a lack of ability to restore electric service not only has the obvious impacts of endangering life and property, but access to water and sewage services may be impaired as well. The presence of many military installations in the San Diego area also underscores the importance of being able to restore the power system in the event of a major blackout. Furthermore, portions of neighboring systems that are also blacked out could need help from the SDG&E system to speed up their restoration process.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[6] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within

[5] These units were contracted to the California Department of Water Resources through 2011. All attributes, including blackstart, was considered to be under contract. The CAISO did not separately contract for blackstart. SDG&E does not consider the Kearny units a Blackstart Resource because the units do not currently qualify under NERC Standard EOP-005-2 R13. After 2011, various contractual obligations existed between Cabrillo II and SDG&E or the CAISO. Three of the five units will retire at the end of 2016, with the other two expected to retire after 2017.
[6] A.15-05-002, filed May 1, 2015, at p. JMD-7.

its evaluation and prioritization of risks.[7] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Fail to Blackstart risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as an electric, operational risk associated with generation and transmission assets as shown in Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	ELECTRIC	GENERATION AND TRANSMISSION

3.2 Potential Drivers[8]

When performing the risk assessment for Fail to Blackstart, SDG&E identified potential indicators of risk, referred to as drivers. These include, but are not limited to:

- **Combustion turbines of Palomar Energy Center (PEC) not available -** Scheduled outage for maintenance work or unplanned "forced" outage.
- **Lack of flexibility if the current resources are not available during a Blackstart situation -** NRG, Pala and MEF units not available.
- **Lack of availability of equipment on the Cranking Path -** Scheduled out-of-work for Transmission lines or transformers (i.e., for maintenance or upgrade).
- **Inadequately maintained Blackstart equipment -** Improper testing and maintenance of small diesel generators used to start Pala or MEF units.
- **Inadequately maintained Cranking Path -** Degraded equipment (i.e. transformers, breakers, relays, overhead conductors) is not replaced in a timely manner.
- **Inadequately studied Blackstart Cranking Path and target unit starting requirements -** Simulations performed do not identify protection scheme changes needed when energizing a Cranking Path, or potential damage to equipment due to transformer inrush currents.

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[7] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[8] An indication that a risk could occur. It does not reflect actual or threatened conditions.

- **Inadequate Blackstart training -** Blackstart drills do not provide operators the opportunity to acquire hands-on experience on how to restore the transmission system; or, drills are not performed at a frequency so that operators knowhow to restore the transmission system.

- **Human error -** Unintentional faults due to human mistakes.

- **Force of Nature Events and Acts of Terror** - Unforeseen weather events, fires, sabotage, or earthquake (particularly if occur in the northern portion of the system) isolate the PEC unit or render the cranking paths inoperable.

Table 2 maps the specific drivers of Fail to Blackstart to SDG&E's risk taxonomy.

Table 2: Operational Risk Drivers

Driver Category	Fail to Blackstart Driver(s)
Asset Failure	• Combustion turbines of Palomar Energy Center (PEC) not available • Lack of flexibility if one of the current resources is not available during a Blackstart situation • Lack of availability of equipment on the Cranking Path • Inadequately maintained Blackstart equipment • Inadequately maintained Cranking Path
Asset-Related Information Technology Failure	Not applicable
Employee Incident	• Inadequately studied Blackstart Cranking Path and target unit starting requirements • Inadequate Blackstart training • Human error
Contractor Incident	Not applicable
Public Incident	Not applicable
Force of Nature	• Force of nature events and acts of terror

Subject matter experts from SDG&E Electric Grid Operations determined the risk drives using historical data of restoration issues encountered during past Blackouts around the world:

- New York State Department of Public Service review of the August 2003 Northeast Blackout shows that only one of the designated Blackstart generators was ready and able to start. Two other Blackstart generator locations failed to start until start-up power was provided to them from the transmission grid. This prevented several larger generators in New York City to come online during the early hours of the Blackout that could have hastened the overall restoration process and minimized the impact of the blackout[9]. Furthermore, analysis of the conversations between transmission and generation operators during the event showed a lot of confusion as to what had happened and the exact status of the transmission and generation facilities, resulting in restoration decisions being delayed. Finally, the synchronization of a small part of the electric system in the Gilboa area to the rest of grid was delayed due to the inability to close a 345 kV transmission line. It was later determined by the New York Power Authority (NYPA) that the line could not be closed due to an erratically operating switch yard synchroscope, until an operator was able to switch over to a backup synchroscope.

- EURELECTRIC's investigation of the blackout that affected Sweden and Denmark on September 23, 2003, found that restoration in Denmark was slower than in Sweden, because the Blackstart facilities in the central power plants in Zeeland failed to operate. Similar issues were also found during a blackout in Italy on September 28, 2003.

3.3 Potential Consequences

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

- Serious injuries or fatalities;
- Prolonged delays to restart SDG&E's system after a complete system-wide blackout;
- Exposure to compliance violations and penalties; and
- Adverse litigation and resulting financial impacts.

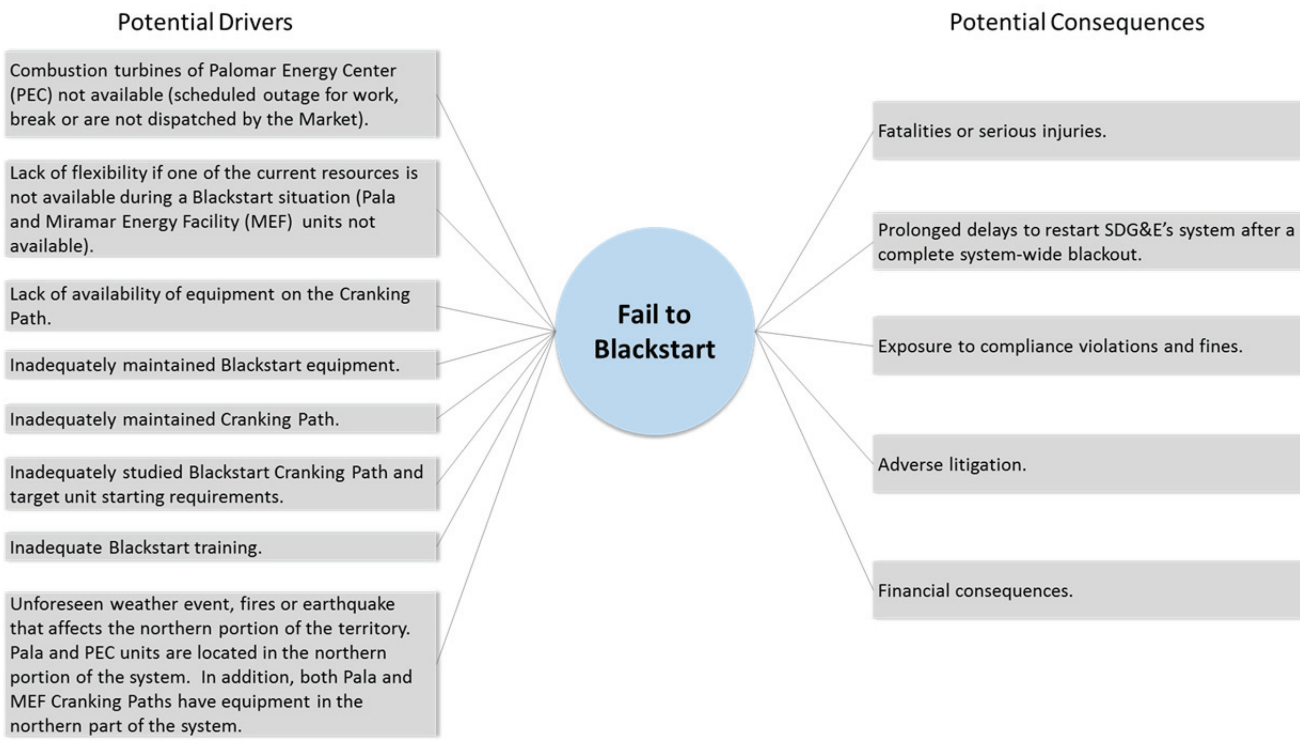
These potential consequences were used in the scoring of the Fail to Blackstart risk that occurred during the SDG&E's 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

[9] New York State Department of Public Service, Second Report on the August 14, 2003 Blackout.

Figure 1: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Fail to Blackstart as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a fail to blackstart can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Fail to Blackstart:

- Following a complete blackout, which affects more than a million customers in San Diego and south Orange County, the Palomar Energy Center units are unavailable for any reason. Under this scenario, the restoration process from a generation Blackstart facility will likely fail. Due to the prolonged effects of the Blackout, consequences including life threatening injuries or possible, a few fatalities, as well as long term impacts to the environment, become more likely. An investigation or enforcement action may lead to financial consequences.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[10] Using the levels defined in the REF, the subject matter experts, applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the Fail to Blackstart risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	7	5	5	2	44,548

4.3 Explanation of Health, Safety, and Environmental Score

SDG&E scored this risk a 6 (severe) in the Health, Safety, and Environmental impact area due to its potential to result in a few fatalities or life-threatening injuries to employees or the public. This is reasonable because failing to restore the electric system from a system-wide blackout essentially means prolonging all the negative effects of a blackout. For example, during the Northeast Blackout of August 2003, many New York City beaches remained closed after several millions of gallons of raw sewage overflowed into the waters around the city, sending bacteria counts soaring. Back-up generators at two sewage treatment plants failed, emptying waste into the Hudson River and into New York harbor. City officials reported a spike in emergency room treatments for diarrheal illnesses, presumably caused by

[10] D.16-08-018 Ordering Paragraph 9.

eating spoiled food.[11] Fires caused by burning candles were reported across the city. Some of the deaths reported that day were attributed to carbon monoxide poisoning caused by fires or malfunction of home generators. Similar deaths were also reported during the 2012 Superstorm Sandy that caused extensive power outages in the New Jersey area.[12] New research suggests that more deaths and injuries can be attributed to a blackout if accidents, cardiovascular conditions, respiratory problems, home medical device failures, and various other health conditions are considered.[13]

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SDG&E subject matter experts assigned the following scores to the remaining residual risk impact categories.

- **Operational and Reliability:** A 7 (catastrophic) was given to this impact, drawing on Company experience in the September 8, 2011, Pacific Southwest Blackout. A similar system-wide blackout, could affect SDG&E's the 3.6 million electric customers. Failing to restore the system could leave all those customers without power for prolonged periods of time. The ability to quickly restore electric power to those millions of customers in a safe and reliable manner becomes critical in order to minimize the impacts of a blackout. Substation equipment and control centers, needed to restore the system, depend on backup power and batteries. Failing to restore the system before substation batteries run out would prevent conditions that would further exacerbate the restoration process.
- **Regulatory, Legal, and Compliance:** A 5 (extensive) was given to this impact. Often, blackouts and failure to blackstart causes can be traced back to weak implementations of some of the North American Electric Reliability Corporation (NERC) standards by a utility company, an Independent System Operator (ISO), or a Reliability Coordinator (RC). For example, during the Pacific Southwest blackout, it was found that some of the entities involved violated one or more reliability standards. The alleged compliance violations resulted in penalties.[14]
- **Financial:** Financial consequences to the Company and the public resulting from a blackout will be worse if the restoration process takes too long. In addition to potential direct losses of sales revenue by a utility company during a blackout, indirect losses to local businesses (e.g., restaurants, grocery stores) and households, which may be forced to discard quantities of spoiled food, can be significant. Business continuity of manufacturing plants and commercial businesses

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[11] Shao Lin, Barbara A. Fletcher, Ming Luo, et al. "Health Impact in New York City During the Northeastern Blackout of 2003", Public Health Reports, 2011 May-Jun, http://www.publichealthreports.org/issueopen.cfm?articleID=2629

[12] Centers for Disease Control and Prevention, "Deaths Associated with Hurricane Sandy – October – November 2012", https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6220a1.htm. SDG&E was not penalized.

[13] G. Brooke Anderson and Michelle L. Bell, "Lights out: Impact of the August 2003 power outage on mortality in New York", Public Health Reports, Epidemiology. 2012 Mar; http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3276729/#R25.

[14] Federal Energy Regulatory Commission, "FERC Approves Final Settlement in 2011 Southwest Blackout Case", May 26,2015, Docket No IN14-11-000, http://www.ferc.gov/media/news-releases/2015/2015-2/05-26-15.asp#.V5aaIPkrJhE.

also may be impaired during a long lasting blackout. Furthermore, a blackout can cause data loss or corruption and damage to assets such as computers and plant equipment. Lastly, possible lawsuits by individuals or businesses, coupled with regulatory penalties, may also negatively affect the Company.[15] Considering these inputs, SMEs scoring this risk a 5 (extensive) in the financial impact category.

4.5 Explanation of Frequency Score

The frequency of failing to restore the SDG&E System depends on the frequency of occurrence of a regional blackout. During the Pacific Southwest Blackout, which is the only system-wide blackout that has affected SDG&E, power was restored using the Interconnection. This essentially means that SDG&E did not need to use its Blackstart facilities to restore its system. Analysis of other utilities shows that despite preparation and testing, failing to restore a system using Blackstart facilities is common due to unforeseen problems that cannot be identified in studies and simulations. They only can be identified during an actual Blackout situation. The SDG&E power grid is such that part of its system cannot be shutdown to comprehensively test Blackstart facilities, along with their Cranking Paths, without affecting customers. Accordingly, SDG&E scored this risk a 2 (rare), defined by the 7X7 matrix as an event that occurs once every 30-100 years. This score ties directly to the Blackout risk frequency score because in order to fail to blackstart the SDG&E system, a regional blackout will first need to occur.

5 Baseline Risk Mitigation Plan[16]

As stated above, a Fail to Blackstart risk is the inability to restore electric services to customers in the SDG&E service territory following a disturbance or an event in which the SDG&E service territory suffers a complete blackout or shut down condition. The 2015 baseline mitigations discussed below include the current evolution of the utilities' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time.

SDG&E's 2015 risk mitigation plan includes two controls: (1) Maintenance, certification, and testing of existing Blackstart facilities, and (2) Annual Blackstart plan review and training. Subject matter experts from Electric Grid Operations, which is part of the Electric Transmission and System Engineering department, collaborated to identify and document them.

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[15] E. Mills and R. Jones, "An Insurance Perspective on U.S. Electric Grid Disruption Costs", Electricity Markets and Policy Group, Geneva Papers on Risk and Insurance Issues and Practice, Feb 2016; https://emp.lbl.gov/sites/all/files/lbnl-1004466.pdf.

[16] As of 2015, which is the base year for purposes of this Report.

These controls focus on safety-related impacts[17] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[18] as well as controls and mitigations that may address reliability.[19] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Fail to Blackstart events, not just the scenario used for purposes of risk scoring.

1. <u>Maintenance, certification, and testing of existing Blackstart facilities</u>

NERC standard EOP-005-2 mandates Transmission Operators to have Blackstart facilities that are tested at least once every three years. The MEF units are owned and maintained by SDG&E, while the Pala units are maintained by Orange Grove through the PPA agreement they have with SDG&E. The continuous maintenance of those existing Blackstart facilities is necessary so that Blackstart facilities are able to properly operate when they are needed. California ISO oversees the testing and certification of Blackstart facilities.

2. <u>Annual Blackstart plan review and training</u>

On average, regional blackouts happen once every 25 years;[20] hence, Transmission Operators generally can only get experience restoring systems through other methods, such as simulations. SDG&E conducts annual Blackstart training, which is a week-long session that gives operators the opportunity to respond to Blackstart scenarios with involvement of generation operators within SDG&E's footprint, and distribution operators. The training teaches the concepts of voltage control and generation control when a system has experienced a wide-scale shutdown. The training is based on Blackstart plans that are reviewed and coordinated every year with California ISO, Peak Regional Coordinator, and neighboring utilities. This activity is mandated by NERC standard EOP-005-2 and helps reduce the likelihood of human errors when restoring a system.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan to, in most cases, maintain the current residual risk level. This section provides an overview of the

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[17] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[18] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[19] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.
[20] JR Minkel, "The 2003 Northeast Blackout – Five Years Later", Scientific American, August 13, 2008 http://www.scientificamerican.com/article/2003-blackout-five-years-later/.

proposed risk mitigation plans for the years 2017, 2018 and 2019. SDG&E's proposed risk mitigation plan during the 2017-2019 timeframe, as explained below, includes the addition of Blackstart facilities, the modernization of SDG&E control centers, and enhancements to substation backup power. The proposed plan also assumes that the Pio Pico Energy Center (PPEC) achieves its expected commercial operation date.[21]

1. South Grid Blackstart Project

NERC Emergency Preparedness and Operations Reliability Standard EOP-005 states: "*Ensure plans, Facilities, and personnel are prepared to enable System restoration from Blackstart Resources to assure reliability is maintained during restoration and priority is placed on restoring the Interconnection*". The South Grid Blackstart project is proposed to provide Blackstart capability to the southern part of the SDG&E electric grid and to address the dependence on the Palomar Energy Center (PEC) units. These are the only Blackstart facilities remaining in this area since the retirement of the Southbay Power plant in 2010. The PEC units are the only reachable units through a Cranking Path from the current Blackstart facilities that have isochronous mode.[22]

This project is required to Blackstart the southern portion of the transmission grid in case of a Blackout and it provides an alternative to restore the system when the PEC units are out of service for maintenance or if they fail. A smaller-sized engine generator will be installed at SDG&E's El Cajon facility, enabling emergency starting of the Cuyamaca unit that will then start the Pio Pico Energy Center units. Once the PPEC units are energized by the Cuyamaca unit through a selected Cranking Path, the PPEC units will be used to maintain frequency and voltages to reenergize the transmission backbone and restore loads, as well as facilitate the interconnection with neighboring transmission systems.

2. Modernization of grid control centers

During the September 8, 2011, Pacific Southwest Blackout, the use of the existing static control room mimic board proved to be confusing to operators. It was difficult for operators to determine if lines were out of service or if circuit breakers were opened. This made the static mimic board inadequate to portray the "big picture" of the system needed to make timely decisions. Operators had to use their workstation EMS displays instead, and dispatch personnel to sites to prevent errors from happening. This led to delays in the restoration process. The Transmission Energy Management System Modernization Project will upgrade SDG&E current mimic board and control room. Similar projects have already been implemented at SCE and PG&E.

[21] Pio Pico Energy Center is a 318 MW simple-cycle electrical generating facility.
[22] Isochronous mode allows generators to maintain the frequency of an electrical system constant.

Moreover, he upgrades will help improve situational awareness, manage the new challenges faced by electric transmission systems due to the recent penetration of renewable resources, and their inherent intermittent nature, and prevent potential human errors. SDG&E expects that the Transmission EMS Modernization Project will enhance safety and reliability by expediting the identification of critical system conditions through means of dynamic visual content. Upgrades would include the replacement of the static mosaic tile board to a dynamic video wall, upgrading the peripheral devices/applications that support such systems, and maximizing the utilization of control room space while maintaining an ergonomic work environment consistent with the Company's policies.

3. Substation backup power enhancements (fuel cells)

Part of the restoration process following a blackout is to energize the Cranking Path which comprises several transmission lines and circuit breakers. It is imperative that operators can energize the Cranking Path during a blackout. If a blackout lasts more than eight hours, as experienced during the Pacific Southwest Blackout, it is highly likely that the batteries at the substations on the Cranking Path will be depleted. If this happens, personnel would be deployed to set portable diesel generators to recharge batteries for the duration of the outages. This manual deployment likely would further delay the restoration. Without the ability to quickly charge batteries, the reliability of the Cranking path could be degraded to the point of failure. The purpose of the substation backup power enhancement project is to purchase 30-GenCell 5kW fuel cells to be installed, at major substations throughout the SDG&E service territory, as an auxiliary power system for control shelters. SDG&E anticipates that these fuel cells increase battery charge life to over a day ensuring power is continuously available during outages for switching, control, protection, and communication equipment. In addition, the use of fuel cells will decrease the potential for environmental hazards caused by spills of portable diesel generators, which have also occurred in the past.

4. Maintenance, certification, and testing of existing Blackstart facilities

SDG&E is proposing to maintain this baseline activity with little to no changes. Please refer to Section 5 for details about this mitigation.

5. Annual Blackstart plan review and training

This mitigation also is a continuation of the baseline control. Please refer to Section 5 for details about this mitigation.

7 Summary of Mitigations

Table 4 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for Fail to Blackstart. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

Table 4: Baseline Risk Mitigation Plan[23]
(Direct 2015 $000)[24]

ID	Control	Risk Drivers Addressed	Capital[25]	O&M	Control Total[26]	GRC Total[27]
1	Maintenance, Certification and Testing of Existing Blackstart Facilities*	• Inadequately maintained Blackstart equipment • Lack of flexibility if one of the current resources is not available during a Blackstart situation	n/a	$20	$20	$20
2	Annual Blackstart Plan Review and Training*	• Inadequate Blackstart training • Inadequately studied Blackstart Cranking Path and target unit starting requirements • Human error	n/a	60	60	0

[23] Recorded costs were rounded to the nearest $10,000.
[24] The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[25] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[26] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[27] The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[25]	O&M	Control Total[26]	GRC Total[27]
	TOTAL COST		n/a	$80	$80	$20

* Includes one or more mandated activities

1. Maintenance certification and testing of existing Blackstart facilities

The cost estimates for this control are for the labor hours of 17 operation technicians at Palomar associated with weekly 1-hour unloaded testing, monthly 2-hour loaded testing, and annual training. Average annual salary rates were used to forecast the costs. Only the costs of maintaining and testing the MEF Blackstart equipment (i.e., small diesel generator) were considered. Costs associated with the maintenance of the MEF gas turbine generators, and for maintaining the grid and Palomar were excluded. This mitigation requires eight hours of training, annually, for all operation technicians and, again, average salary rates were utilized.

2. Annual Blackstart plan review and training

The cost estimates for this control are for the labor hours from Grid Operations Support group and the Mission Control Training Section. The Grid Operations Support group estimates that eight weeks of an engineer's time is used for this mitigation. The derivation of engineer's labor entailed calculating the average pay rate for engineers and average number of hours in a month multiplied by two months. The costs associated with Mission Control Training Section reflects labor associated with the development and implementation of on-going Blackstart training of transmission system operators (TSO) and Operation Shift Supervisors (OSS) on an annual basis as mandated by NERC Standard EOP-005-2.

These costs are FERC jurisdictional and, therefore, are not included in the GRC Total column shown in Table 4.

Table 5 summarizes SDG&E's proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan, and is not requesting funding approval. SDG&E will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 5 the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 5: Proposed Risk Mitigation Plan[28]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[29]	2019 O&M	Mitigation Total[30]	GRC Total[31]
1	South Grid Blackstart Project	• Combustion turbines of Palomar Energy Center (PEC) not available • Lack of flexibility if one of the current resources is not available during a Blackstart situation • Lack of availability of equipment on the Cranking Path • Inadequately maintained Blackstart equipment • Inadequately maintained Cranking Path • Force of nature (e.g., earthquakes, wildfires)	$1,170 - 1,300	n/a	$1,170 - 1,300	$820 - 910
2	Modernization of Grid Control Centers	• Human error	13,900 - 15,360	n/a	13,900 - 15,360	11,810 - 13,060

28 Ranges of costs were rounded to the nearest $10,000.
29 The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
30 The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
31 The GRC Total column shows costs typically represented in a GRC.

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[29]	2019 O&M	Mitigation Total[30]	GRC Total[31]
3	Substation Backup Power Enhancements (Fuel Cells)	• Inadequately maintained Cranking Path	4,210 - 5,700	n/a	4,210 - 5,700	0
4	Maintenance, Certification, and Testing of Existing Blackstart Facilities*	• Inadequately maintained Blackstart equipment • Lack of flexibility if one of the current resources is not available during a Blackstart situation	n/a	19- 21	19- 21	19- 21
5	Blackstart Training and Procedure Development*	• Inadequate Blackstart training • Inadequately studied Blackstart Cranking Path and target unit starting requirements • Human error	n/a	57 - 63	57 - 63	0
	TOTAL COST		\$19,280 - 22,360	\$76 - 84	\$19,360 - 22,440	\$12,650 - 13,990

☐	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

While all the mitigations and costs presented in Table 5 mitigate the Blackout risk, some of the controls also mitigate other risks presented in this RAMP. Specifically, the Modernization of Grid Control Centers mitigation is also included in the Major Disturbance to Electrical Service (e.g. Blackout) risk. Because the Modernization of Grid Control Centers project mitigates the risks of Fail to Blackstart and Blackout the costs and risk reduction benefits are included in both chapters.

1. South Grid Blackstart Project

The costs shown in Table 5 represent capital plant expenditures and SDG&E labor. The dollars associated with the addition of capital plant and labor are based on estimated costs provided in accounting documents such as Capital Budget Documentation (CBD) and/or Work Order Authorization forms (WOA). While these capital costs were zero-based, subject matter experts reviewed the costs of previous capital projects and used their experience when developing estimates. Costs are presented as ranges to account for potential variability in capital and labor costs over the time period..

Thirty percent (30%) of the South Grid Blackstart costs have been identified as FERC jurisdictional. Therefore, 70% of the capital costs associated with South Grid Blackstart are presented in the GRC Total column of Table 5, while the remaining 30% are omitted from the GRC total.

2. Modernization of Grid Control Centers

These costs reflect estimates provided in CBD and WOA internal accounting documents. While these capital costs were zero-based, subject matter experts reviewed the costs of previous capital projects and used their experience when developing estimates. Costs are presented as ranges to account for potential variability in capital and labor costs over the time period. The Capital cost ($13.9 million - $15.3 million)includes a portion identified as FERC jurisdictional, non-GRC dollars. Following SDG&E's Capitalization Policy, 15% of the range ($2.1 million - $2.3 million) has been identified as non-GRC dollars. Accordingly these FERC jurisdictional costs are not included in the GRC Total column in Table 5.

3. Substation Back Up Power Enhancements

The substation backup power enhancement (fuel cells) costs reflect estimates provided in the CBD and WOA internal accounting documents. While these capital costs were zero-based, subject matter experts reviewed the costs of previous capital projects and used their experience when developing estimates. Costs are presented as ranges to account for potential variability in capital and labor costs over the time period.

All of the capital costs associated with Substation backup power enhancement have been identified as FERC jurisdictional, non-GRC costs. Therefore, these costs are not included in the GRC Total column in Table 5.

4. & 5. Maintenance, Certification, and Testing of Existing Blackstart Facilities; & Annual Blackstart Plan Review

SDG&E proposes to maintain two of the baseline controls in 2017-2019: (1) Maintenance, certification, and testing of existing Blackstart facilities, and (2) Annual Blackstart plan review and training. SDG&E does not expect a significant change in these activities as compared to 2015. A range of costs for each is provided to account for potential variation in annual spend over the time period.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[32] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[33]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.

[32] D.16-08-018 Ordering Paragraph 8.
[33] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[34] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure 2 shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 5 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Fail to Black Start risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

[34] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

This risk is dependent on SDG&E being in a blackout. The probability of being in a blackout was given to be 0.0183 in the Blackout risk. The residual risk score for the likelihood of a failure to black start did not account for this probability and all RSE scores were thus adjusted to account for this dependency.

The risk assessment team analyzed four mitigation groupings. The first is the only current, ongoing control and consists of several projects related to maintenance, certification, and testing of the existing black start resources. The remaining mitigations are incremental: adding black start capabilities to the southern part of the system, upgrading a visualization tool, and adding fuel cells to provide backup power in the event of a blackout. The analysis for these mitigations consisted of a combination of industry research and risk team estimates, based on SME input.

The mitigation groupings include:

(a) Maintenance, Certification, and testing of existing Black start Resources & Black start training and procedure development
- MEF I and II black start generators maintenance and testing programs
- Bicertification of MEF I and II as black start units
- Maintenance of Orange Grove as a black start resource through current Power Purchase Agreement (PPA) (SDG&E does not incur any cost specific to this mitigation)
- SDG&E black start/system restoration training and drill
- Development and coordination of Black start plans with CAISO, Peak RC, and neighboring utilities through SDG&E EOP5005 procedure update

(b) South Grid Black-Start Project
- Add black start capabilities to the southern part of the SDG&E electric system

(c) Transmission Energy Management System Modernization Project
- Upgrade antiquated EMS visualization tool and control room

(d) Substation Auxiliary Power System (fuel cells)
- Use fuel cells to provide backup power at major substations and substations on the Black start Cranking Paths.

- <u>Current Controls: Maintenance, Certification, Testing, and Training</u>

Industry research performed in fields other than the electric power field since the 1800s shows the importance of repetitive training, and that forgetting depends on many factors, such as the type of material being learned, learners' prior knowledge and motivation to learn, and training format. In some experiments, learners forgot 51% of what they learn after three years. This phenomenon has been extensively documented as the "forgetting curve," and is usually characterized by an exponential or a power function that decays. [35,36] Additionally, not maintaining blackstart equipment will further increase the decay rate of the forgetting curve, augmenting the likelihood of failing to black start.

The analysis team estimated that after three years, the likelihood of failure to black start, without maintenance and training, will go to approximately 30%. This estimate was based on the following: the likelihood of being able to black start, after one year of no training or maintenance, was assumed to be around 80-90%; after two years, 70-80%; after three years, 40-60%. This is an average of 70% success over the three years. The average likelihood of failing to black start, after three years, was therefore assumed to be approximately 30%.

- Incremental: South Grid Black Start Project

This mitigation provides a redundancy to the PEC units. To determine the new likelihood of a failure to black start after implementing this mitigation, the team developed a fault/decision tree that compared the original likelihood to black start and the new likelihood after implementing this mitigation. Factors considered included neighboring utilities in blackout, availability of PEC units, duration of event, availability of redundant path, and battery failure.

  - Original probability of failure to black start, given SDG&E is in blackout: neighbors in blackout * PEC units unavailable * event lasts less than eight hours + neighbors in blackout * (PEC units unavailable or PEC units available but batteries fail) * event lasts longer than eight hours
  - New Probability = neighbors in blackout * [event lasts less than eight hours * PEC units unavailable * Redundant Path Unavailable + event lasts longer than eight hours * ((PEC units unavailable * Redundant Path unavailable or Redundant Path available but batteries fail) + PEC units available but batteries fail * Redundant Path unavailable or Redundant Path available but batteries fail)]

The original probability of failure to black start, given SDG&E is in blackout is 0.0183, based on the likelihood score assigned to this risk. The new probability from the South Grid Black Start Project was calculated to be 0.00622, a 65.9% risk reduction.

- Incremental: Modernization of Grid Control Centers

This mitigation upgrades an antiquated EMS visualization tool and control room. This tool will help improve situational awareness and prevent potential human errors. SMEs estimate that this improvement

[35] Thalheimer, W., "How Much Do People Forget?" April 2010, http://www.work-learning.com/catalog.html.
[36] Murre JMJ, Dros J., "Replication and Analysis of Ebbinghaus' Forgetting Curve", PLOS ONE, July 2015 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4492928/.

will reduce the likelihood of a blackout by 10%. SDG&E's SMEs consider this to be the best estimate at this time since there is no industry data available for validation.

- Incremental: Substation Backup Power Enhancements (fuel cells)

The scope of this project is to purchase 30-GenCell 5kW Fuel Cells, to be installed in electric substations throughout the SDG&E service territory, as an auxiliary power system for control shelters. To determine the new likelihood of a failure to black start after implementing this mitigation, the team developed a fault/decision tree that compared the original likelihood to black start and the new likelihood after implementing this mitigation. Factors considered included neighboring utilities in blackout, availability of PEC units, and duration of event.

- o Original probability of failure to black start, given SDG&E is in blackout: neighbors in blackout * PEC units unavailable * event lasts less than eight hours + neighbors in blackout * (PEC units unavailable or PEC units available but batteries fail) * event lasts longer than eight hours
- o With this mitigation, events lasting longer than eight hours can still be black started 100% of the time, if PEC units are available. New Probability = neighbors in blackout * 100% * PEC units unavailable

The original probability of failure to black start, given SDG&E is in blackout is 0.0183, based on the likelihood score assigned to this risk. The new probability from Substation Backup Power Enhancements (fuel cells) was calculated to be 0.01462, a 19.9% risk reduction.

8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

5. Maintenance, certification, testing, and training (current controls)
6. The South Grid Black Start Project (incremental mitigations)
7. Substation backup power enhancements (fuel cells) (incremental mitigations)
8. Modernization of Grid Control Centers (incremental mitigations)

Figure 3 displays the range[37] of RSEs for each of the SDG&E Fail to Black Start risk mitigation groupings, arrayed in descending order.[38] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

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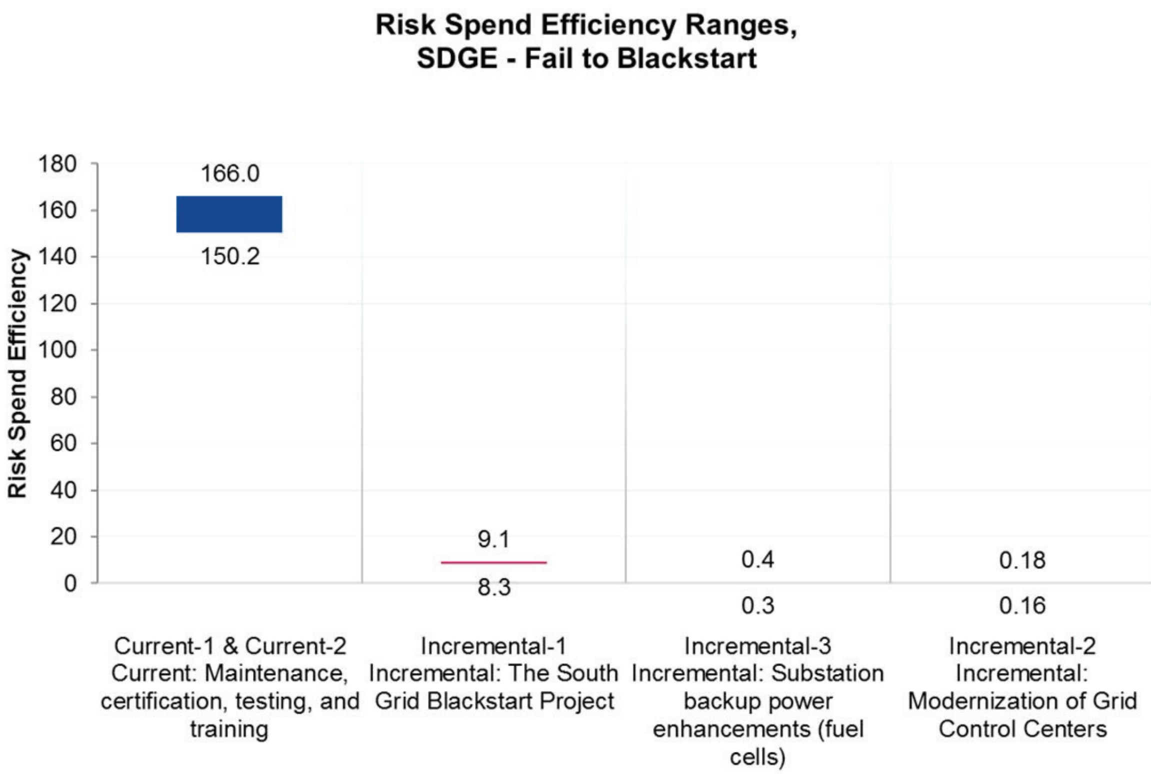
[37] Based on the low and high cost ranges provided in Table 5 of this chapter.
[38] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 3: Risk Spend Efficiency



9 Alternatives Analysis

SDG&E considered alternatives to the proposed mitigations as it developed the proposed mitigation plan for the Fail to Blackstart risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources. Due to the serious safety concerns of a failure to blackstart, an effort was made not to consider the status quo as a plausible alternative.

9.1 Alternative 1 – Modernization of Grid Control Centers

Modernization of both the primary and back-up control centers was considered as an alternative. Modernization for purposes of this alternative included remodeling of control rooms, installation of Direct View LED video walls, construction of a production development lab, and integration of a new cross-site collaborative software solution. The modernization of the primary Grid Control Center alone was instead selected in SDG&E's proposed plan. This selection anticipates future plans for an all-encompassing control center that would shift the existing primary Control Center to be the a sustainable back-up in the future. The existing back-up control center is close to an earthquake fault line, which does not make it an optimal location. The selected alternative project improves public safety by augmenting situational awareness within the control room, which should hasten responses to critical system conditions that jeopardize public safety, and by laying the groundwork for a more reliable back-up control center in the future.

9.2 Alternative 2 – Substation backup power

The installation of diesel generators at major substations was considered as one of the alternatives to the deployment of fuel cells to enhance substation backup power at SDG&E. Diesel generators were not selected and were viewed as infeasible because they are costlier to run and maintain, as well as require additional environmental permitting. The deployment of fuel cell technology was selected instead because it is more cost-effective and environmentally friendly.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Cyber Security
(Chapter SDG&E-7/SCG-3)

November 30, 2016

310314

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Executive Summary

The purpose of this chapter is to present the mitigation plan of the San Diego Gas & Electric Company (SDG&E) and Southern California Gas Company (SoCalGas) (collectively, the Companies) for the risk of Cyber Security. The Cyber Security risk involves a major cyber security incident that causes disruptions to electric or gas operations (e.g., SCADA system) or results in damage or disruption to company operations, reputation, or disclosure of sensitive data. The Companies' 2015 baseline mitigation plan for this risk consists of five controls aligned with the control functions in the National Institute of Standards and Technology (NIST) Cyber Security Framework:

1. Identify;
2. Protect;
3. Detect;
4. Respond; and
5. Recover.

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the California Public Utilities Commission (Commission or CPUC) in Decision (D.) 16-08-018, as well as controls and mitigations that may address reliability. The Companies' proposed mitigation plan comprises both baseline and new mitigation activities.

Based on the foregoing assessment, the Companies proposed future mitigations. For Cyber Security, the Companies proposed to continue the five control categories, identified above, but included enhancements within each category. The enhancements include:

1. Identify
   - Compliance Records Management – implement a system of recordkeeping dedicated to compliance records to better support regulatory auditing.
   - Enterprise Threat Intelligence – automate distribution of threat intelligence to business and system owners to improve Cyber Security risk awareness and engagement.

2. Protect
   - Web Applications and Database Firewalls – improve protective capabilities for web applications and databases to reduce the likelihood and impact of an incident.
   - Host-Based Protection – improve host-based protections for direct attacks and to prevent attackers from pivoting to a host from a neighboring host.

3. Detect
   - Insider Threat Detection/Prevention – leverage emerging technologies to improve the detection of insider threat activities and the related risk impacts.

  - Perimeter Tap Infrastructure Redesign – improve the performance and visibility into network traffic to limit impacts of incidents.

4. Respond
   - Incident Response Secure Collaboration – implement a secure, out-of-band communication capability to coordinate and support incident response activity.
   - Security Orchestration – automate and support enhancements to the workflow related to responding to and analyzing escalated events to better manage and learn from cyber events.

5. Recover
   - Information Security technology backup and recovery – refresh backup and recovery for sensitive information security systems so as to return to a safe and secure risk posture.

The risk spend efficiency (RSE) was developed for Cyber Security. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The set of corporate measures that are in place is assumed to reduce the likelihood of experiencing such an event from what the likelihood would be otherwise. The risk reduction calculation is based on internal self-assessment results, and these results are further based on the judgment of subject matter experts (SMEs).

The benefits assessment for this risk was completed at a risk portfolio level, where the migration activities (within the five functional control areas) were combined and assessed as one aggregated mitigation. Because cyber threats are in a constant evolutionary state, corporate countermeasures also evolve over time and are generally lagging. Since countermeasures are designed to match known threats, all of them are categorized as baseline, so only one set of security measures was analyzed.

The benefits assessment addresses the mitigations at both Companies, collectively.

Risk: Cyber Security

1 Purpose

The purpose of this chapter (or plan) is to present the combined mitigation plans of the Companies for the risk of Cyber Security. This risk is a major cyber security incident that causes disruptions to electric or gas operations (e.g., SCADA system) or results in damage or disruption to company operations, reputation, or disclosure of sensitive data.

This risk is a product of the Companies' September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Companies. The Companies take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the Companies have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the Companies do not currently track expenditures in this way, so the baseline amounts are the best effort of the company to benchmark both capital and operations and management (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the Commission and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that the Risk Assessment Mitigation Phase (RAMP) be focused on safety-related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the Companies take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the Companies have made efforts to identify those costs.

Electric and gas operations, safety systems, information processing, and other utility functions are increasingly reliant on technology, automation and integration with other systems. The complex interoperation of these systems and the rapid changes that occur in the industry in response to climate,

[1] D.14-12-025 at p. 31.

cost and other drivers create a risk situation where inadvertent actions or maliciously motivated events can potentially disrupt core operations or disclose sensitive data, among other serious consequences. In addition, the functioning of society relies on safe and reliable energy delivery. The magnitude and likelihood of the Cyber Security risk is a documented concern at the national level, exemplified by Executive Order 13636 of February 21, 2013, titled "Improving Critical Infrastructure Cybersecurity."

This risk assessment focuses on responding to, and mitigating potential drivers and the potential resulting events of which the company is aware. However, the Companies strive to implement mitigations to address those instances (drivers and/or events) that may be unknown to the company. The mitigation approach is to leverage a framework of cyber security controls across the enterprise, with emphasis on key systems and data in order to address evolving threats and vulnerabilities. This approach considers all systems as potential weak points, which may provide an attacker a foothold within the enterprise or, through an error, create a situation to disrupt energy delivery, expose sensitive information, or cause other potential adverse events.

The assessment does not address Cyber Security risk mitigations performed by other groups within the business and Information Technology organizations. In particular, recovering and restoring energy delivery is addressed by other risks areas and departments.

The internal organization responsible for managing this risk is primarily the Information Security (IS) department, which resides in the Information Technology organization. The mitigations discussed in this chapter focus on those activities performed or supported directly by the department as a shared service for SDG&E, SoCalGas, and Sempra Energy, the parent company of SDG&E and SoCalGas. The Information Security department addresses cyber security risks potentially impacting the energy distribution information technology infrastructure and customer and business information systems.

As mentioned above, Cyber Security is a shared service since it supports SDG&E, SoCalGas and Sempra Energy. Generally, for accounting purposes, enterprise capital-funded solutions are booked to SoCalGas, while the bulk of the staffing resources and non-labor O&M costs are booked in SDG&E. Activities specific to electric appear in the SDG&E mitigation plan and activities attributed to the gas systems are addressed in SoCalGas' mitigation plan.

2 Background

In general, the Companies' Information Security Cyber Security program addresses Cyber Security at the enterprise level, using the industry standard NIST Cyber Security Framework[2] as a guide for best security risk management practices. Cyber security programs addressing this risk are not mandated; however, a cyber security program based on best practices, like the NIST framework, also should be in compliance with any forthcoming mandates. Should requirements or mandates change, the best practices followed by the program would be reviewed and updated to assess compliance.

In response to Executive Order 13636, the NIST Cyber Security Framework was developed through collaboration between the Federal government and the private sector, to address and manage Cyber Security risk cost-effectively based on business needs. The Framework supports the application of Cyber Security risk controls and best practices to reduce and manage Cyber Security risks, in order to improve the security and resilience of critical infrastructure. Effective industry practices from multiple resources have been grouped into five functional areas: (1) Identity; (2) Protect; (3) Detect; (4) Respond; and (5) Recover.

The Cyber Security risk mitigation plan is based on these functional areas. The definitions and descriptions of the functional areas are from the NIST Cyber Security Framework 1.0, pages 8-9.

1. Identify

Identify refers to developing organizational understanding to manage Cyber Security risk to systems, assets, data, and capabilities. The activities in the Identify Function are foundational for effective use of the NIST Framework. Understanding the business context, the resources that support critical functions, and the related cyber security risks, enables an organization to focus and prioritize its efforts, consistent with its risk management strategy and business needs. Examples of control Categories within this Function include: Asset Management; Business Environment; Governance; Risk Assessment; and Risk Management Strategy.

2. Protect

Protect refers to developing and implementing the appropriate safeguards so that the company can provide safe and reliable delivery of critical infrastructure services. The Protect Function supports the ability to limit or contain the impact of a potential cyber security event. Examples of control Categories within this Function include: Access Control; Awareness and Training; Data Security; Information Protection Processes and Procedures; Maintenance; and Protective Technology.

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[2] https://www.nist.gov/cyberframework.

3. Detect

Detect refers to developing and implementing the appropriate activities to identify the occurrence of a Cyber Security event. The Detect Function enables timely discovery of Cyber Security events. Examples of control Categories within this Function include: Anomalies and Events; Security Continuous Monitoring; and Detection Processes.

4. Respond

Respond refers to developing and implementing the appropriate activities to take action regarding a detected Cyber Security event. The Respond Function supports the ability to contain the impact of a potential Cyber Security event. Examples of control Categories within this Function include: Response Planning; Communications; Analysis; Mitigation; and Improvements.

5. Recover

Recover refers to developing and implementing the appropriate activities to maintain plans for resilience and to restore any capabilities or services that were impaired due to a cyber security event. The Recover Function supports timely recovery to normal operations to reduce the impact from a Cyber Security event. Examples of control Categories within this Function include: Recovery Planning; Improvements; and Communications.

2.1 Safety Model Assessment Proceeding

SDG&E presented how it manages Cyber Security risk in the Safety Model Assessment Proceeding (S-MAP). On May 1, 2015, SDG&E submitted its Application (A.) 15-05-002, which was accompanied by the supporting testimony of Scott King. Mr. King described the Information Security Program and the Cyber Security risk management process. The Information Security Program governs risk management activities via the application of best practices, acceptable use policies, security standards, and technology requirements for managing and maintaining technology systems.

The Cyber Security risk management process describes the methodology used to prioritize resources to address identified risks. Risks are identified using multiple sources of information and assessments of both practices and critical cyber security controls. The risk mitigation practices and controls described in the S-MAP testimony are mapped to the NIST Cyber Security Framework to provide a programmatic summary. Efforts to manage risk are prioritized based on the risk scoring, benefits of the control activity, and evolving threats to the safety and reliability of critical systems.

Managing Cyber Security risk is a key business practice at the Companies that continually evolves to keep pace with threats, technology innovations, and advances in cyber security best practices to efficiently and cost-effectively manage cyber-related risks. The NIST cyber security framework is used to group these activities and projects into the five functional areas described above.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in A.15-05-002/004 "SDG&E [/SoCalGas] is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[3] The Enterprise Risk Management (ERM) process and lexicon that the Companies have put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Companies are committed to increasing the use of quantification within its evaluation and prioritization of risks.[4] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers, and potential consequences of the Cyber Security risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, the Companies classify this risk as a cross-cutting risk that affects business and Information Technology (IT) systems as shown in 1. Cyber Security is a cross-cutting risk because an incident could potentially impact many areas throughout the Companies.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
CROSS-CUTTING	BUSINESS/IT SYSTEMS	TECHNOLOGY ASSETS AND INFORMATION

The threats related to this risk are dynamic. New adversarial techniques may evade current Cyber Security controls. Technology innovations and adoption continually increase the exposure of infrastructure and business services to a risk impact.

3.2 Potential Drivers[5]

When performing the risk assessment for Cyber Security risk the Companies identified potential indicators of risk, referred to as drivers. These include, but are not limited to:

- **Technology Failure** – The malfunction or failure of a technological device.

[3] A.15-05-002/004, filed May 1, 2015, at p. JMD-7.
[4] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[5] An indication that a risk could occur. It does not reflect actual or threatened conditions.

- **Human Threats** – These can be unintentional or deliberate. An unintentional threat is an error that occurs due to someone not doing something correctly. A deliberate threat includes potentially criminal activity that is likely motivated by profit, political agenda, or other illegal activity. Deliberate human threats are the most challenging threat to mitigate because tactics, methods, and capabilities evolve quickly to leverage unknown or unanticipated weaknesses.
- **Public Incident** – An incident, such as a long-term power outage, pollution, or chemical spill, motivating a threat agent to attempt to affect the risk.
- **Force of Nature** – An environmental event such as a flood, earthquake, or fire, that can cause a combination of asset, human, or process failures to circumvent controls designed to prevent the risk from occurring.

Human threat sources can be further grouped based on motivations and associated drivers. Human threat sources, motivations, and actions are described in Table from NIST SP 800-30.

Table 2: NIST SP 800-30 Threat Descriptions

Threat-Source	Motivation	Threat Actions
Hacker, cracker	Challenge Ego Rebellion	• Hacking • Social engineering • System intrusion, break-ins • Unauthorized system access
Computer criminal	Destruction of information Illegal information disclosure Monetary gain Unauthorized data alteration	• Computer crime (e.g., cyber stalking) • Fraudulent act (e.g., replay, impersonation, interception) • Information bribery • Spoofing • System intrusion
Terrorist	Blackmail Destruction Exploitation Revenge	• Bomb/Terrorism • Information warfare • System attack (e.g., distributed denial of service) • System penetration • System tampering
Industrial espionage (companies, foreign governments, other government interests)	Competitive advantage Economic espionage	• Economic exploitation • Information theft • Intrusion on personal privacy • Social engineering • System penetration • Unauthorized system access (access to classified, proprietary, and/or technology-related information)
Insiders (poorly trained, disgruntled, malicious, negligent, dishonest, or terminated employees)	Curiosity Ego Intelligence Monetary gain Revenge Unintentional errors and omissions (e.g., data entry error, programming error)	• Assault on an employee • Blackmail • Browsing of proprietary information • Computer abuse • Fraud and theft • Information bribery • Input of falsified, corrupted data • Interception • Malicious code (e.g., virus, logic bomb, Trojan horse) • Sale of personal information • System bugs • System intrusion • System sabotage • Unauthorized system access

The threats identified above are an expansion of human deliberate actions that may result in the realization of a cyber event. Worldwide access to the Internet and the pervasiveness of technology leveraging networking capabilities potentially expose information and operational technology and information assets to all human threat agents. The Companies monitor such potential threats and implement mitigation efforts, as described in Sections 5 and 6, to protect the employees, contractors, customers, the public, and the Companies.

3.3 Potential Consequences

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

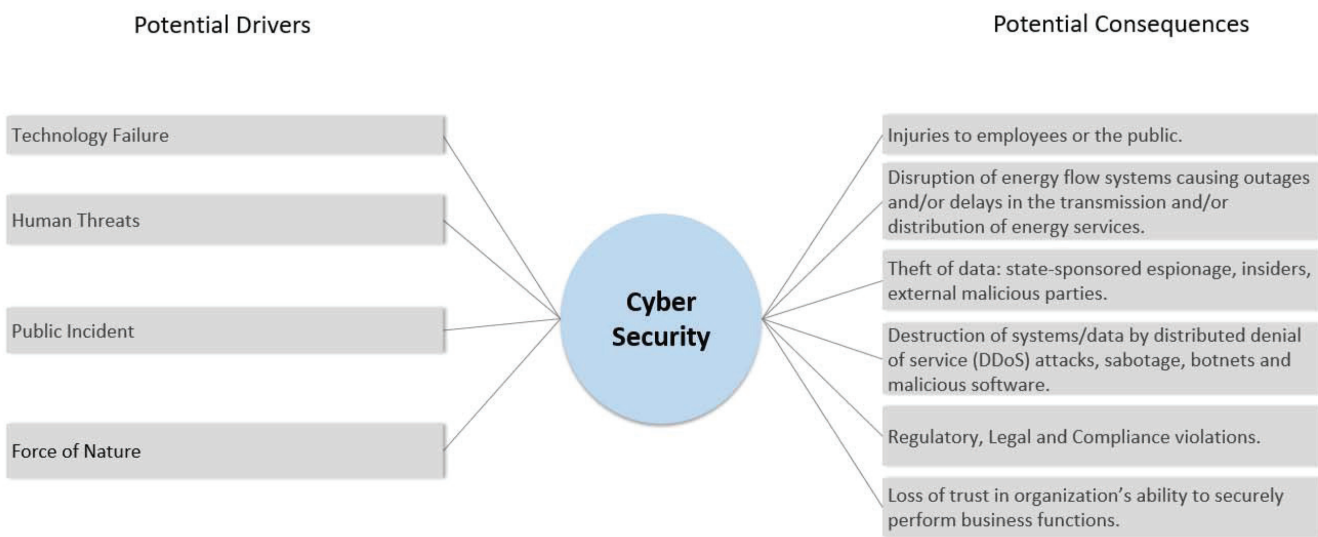
- Injuries to employees or the public.
  - Incorrect system information may result in unsafe operating conditions related to what the system operators believe to be happening versus the actual system state.
  - Loss of operational control of energy systems.
- Disruption of energy flow systems causing outages and/or delays in the transmission and/or distribution of energy services.
  - Direct impact to customer's lighting, heating, refrigeration, and other energy-related activities.
  - Social disruptions such as food distribution constraints, traffic light functions, gas distribution, water systems, telecommunications, and reliable support of other dependent industries.
- Theft of data: State-sponsored espionage, insiders, and external malicious parties.
  - Data may include system information, strategy and planning data, or other restricted or confidential information resulting in increased risk to assets, increased costs, and other business impacts.
  - Stolen customer information could be used to steal identities, perpetrate fraud or other criminal activities, or gain access to proprietary customer data.
  - Stolen data may also be used to plan and conduct exploitation of Cyber Security weaknesses or other risks.
- Destruction of systems/data by distributed denial of service (DDoS) attacks, sabotage, botnets, and malicious software.
  - The resulting impacts may include an inability to control energy delivery and other systems, failure of protective systems, loss of utility assets, customer disruption, or other system and financial impacts.
- Regulatory, Legal, and Compliance violations.
  - Breach of regulatory compliance (for example, an incident of non-compliance with NERC CIP (FERC) or a customer privacy breach (California Statutory)) resulting in adverse publicity, sanctions, and increased scrutiny of operations by the regulator.
- Loss of trust in organization's ability to securely perform business functions.
  - Business level impacts may include the inability to guard against Cyber Security incidents, technologically interact with partners, and retain employees.
  - Customer level impacts may make it difficult to collect necessary customer information and conduct other interactions, tainted by an unwillingness to share information.

These potential consequences were used in the scoring of Cyber Security that occurred during the Companies' 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. The Companies applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



4 Risk Score

The Companies' ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Cyber Security as one of the enterprise risks. During the development of the risk register, SMEs assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a public safety event can occur. For purposes of scoring this risk, SMEs used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The SMEs selected the following reasonable worst case scenario to develop a risk score for Cyber Security:

- An advanced, persistent threat infiltrates energy delivery management, monitoring, and safety systems to prepare for a coordinated attack that disrupts operator control systems; disables or destroys backup and redundant system protection and recovery assets; disrupts communication capabilities; and remotely launches attacks during a major local event.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen.

4.2 2015 Risk Assessment

Using this scenario, SMEs then evaluated the frequency of occurrence and potential impact of the risk using the Companies' 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[6] Using the levels defined in the REF, the SMEs applied empirical data to the extent it was available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the Cyber Security risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
4	6	5	5	4	44,548

4.3 Explanation of Health, Safety, and Environmental Impact Score

The Companies score Cyber Security a 4 (Major) in the Health, Safety, and Environmental impact area based on the potential to cause few serious injuries to the public or employees. This is because a cyber security incident within the control systems responsible for delivering energy into the service area could disrupt energy flow systems, causing widespread outages or infrastructure malfunctions, resulting in the potential for injuries. Also, an incident could impact local areas, resulting in neighborhoods or individuals experiencing impacts to health or safety-related equipment during periods of environmental stress (heat or cold), or to the use of necessary medical equipment.

[6] D.16-08-018, Ordering Paragraph 9.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, the Companies scored each of the other residual impact areas. The scenario, for example, such as the 2015 cyber security attack on the Ukrainian Power Grid (UPG), could have an impact on more than one of the risk areas. During that remote cyber security attack, power system components were maliciously operated and automation systems were disabled, resulting in disruption of power delivery to its customers. A third party gained illegal entry into UPG computers and SCADA systems. Multiple substations were remotely controlled and disconnected. Response and recovery activities were also hindered by changes in support systems, disabled devices, and attacks on the communications systems. The incident affected up to 225,000 customers in three different service territories for several hours. Service was recovered by operating in a manual mode.[7]

There are many, frequent stories in the media about information disclosure, vulnerabilities, threat agents, and compromises. Most of these stories, when applied to the Companies, would have a similar impact in one or more of the risk areas.[8]

The other risk impacts were scored using the worst case scenario, illustrated by these examples of cyber incidents:

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[7] Other examples of cyber incidents that would likely have impacts across all of the other risk impact areas include:

- The 2012 virus attack on Saudi Aramco did not directly result in an operational impact, however 30,000 systems were infected. The virus deleted data from computer hard drives. An incident of this type would severely impact business operations, have financial consequences, and likely result in regulatory, statutory, or compliance review and scrutiny.
- The Lansing Board of Water and Light ransomware attack that impacted significant numbers of corporate computers. In that situation, an employee opened an email leading to the incident. Utility service delivery was not impacted.

[8] For example:

- The United States Office of Personnel Management (OPM) had a data breach of information records for 21.5 million people, possibly including background check information and fingerprints. This type of information compromise would have both Regulatory, Legal, and Compliance impacts and Financial impacts.
- The recent Yahoo password breach affecting 500 million accounts provides an example of two issues that could impact utility customers. A compromise of our customer passwords would expose customer personal information with resulting identity theft risks. In this case, there would likely be Regulatory, Legal, and Compliance, as well as Financial, impacts. Further, the Yahoo passwords could be the same passwords customers have used for their utility accounts. In this case, customer information would also be exposed to unauthorized access.

- **Operational and Reliability:** A score of 6 (Severe) was given to this risk. A cyber security incident impacting transmission and/or distribution of energy would directly impact the reliable delivery of energy.
- **Regulatory, Legal, and Compliance**: Cyber Security was scored a 5 (Extensive) in the Regulatory, Legal, and Compliance impact area. This is reasonable because a severe impact to operations would likely result in an extended and in-depth review of the incident, as well as the existing mitigations and activities related to Cyber Security at the time of the event.
- **Financial:** The Financial impact of a cyber security incident was also scored as a 5 (Extensive). A variety of cyber incidents could potentially result in this level of financial impact due to the high visibility of this kind of incident in our industry. A customer information breach may potentially result in reparations, security investigation and improvement costs, and a loss of customer confidence. An energy outage could result in financial impacts, loss of confidence, and/or increased insurance costs. The possibility of an incident destroying assets or data, such as an Advanced Meter Infrastructure (AMI) solution, could also be severe.

4.5 Explanation of Frequency Score

SMEs used empirical data to the extent available and/or their expertise to determine the likelihood of a cyber security incident score as a 4 (Occasional), which is defined in the REF as the possibility of a Cyber Security-related event occurring once every 3-10 years. Those assigning this score considered reports in open media, security research, information-sharing entities, contracted information services, and threat intelligence sources.

5 Baseline Risk Mitigation Plan[9]

As stated above, Cyber Security risk is a major cyber security incident that causes disruptions to electric or gas operations (e.g., SCADA system) or results in damage or disruption to the Companies' operations, reputation, or disclosure of sensitive data. The 2015 baseline mitigations discussed below include the current evolution of the Companies' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time.

The Companies' baseline mitigation plan for this risk consists of five types controls aligned with the control functions in NIST Cyber Security Framework noted above: (1) Identify; (2) Protect; (3) Detect; (4) Respond; and (5) Recover. SMEs from the Information Security department collaborated to identify and document them. These controls focus on safety-related impacts[10] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018,[11] as well as controls and

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[9] As of 2015, which is the base year for purposes of this Report.
[10] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[11] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."

mitigations that may address reliability.[12] Accordingly, the controls and mitigations described in Sections 5 and 6 primarily address safety-related impacts. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Cyber Security events, not just the scenario used for purposes of risk scoring.

The control functions provide a framework for the activities and projects used to maintain the cyber security posture. Some sample activities and 2015 projects are discussed for each of the functional areas. Additional activities are also performed and projects implemented, which are not completely enumerated here due to the confidential nature of the cyber security function and mitigation strategies. Also, when technological capabilities are implemented, they are used as long as they continue to effectively mitigate the associated risks, so there are not necessarily projects in every functional area every year. In some cases, additional activities and projects are necessary to specifically address some mandates.

The benefits of the current baseline mitigation approach are that it has been active and maturing for several years with the corresponding improvements in risk identification, tracking, and mitigation. It has been integrated into business processes, technology projects, and the organizational culture. Because more people in the organization are security aware, more potential issues are addressed sooner so that risks can be avoided. Also, security is addressed earlier in the acquisition and development lifecycles.

Cyber Security has had consistent capital funding for several years as well. These projects have established a core set of control capabilities that are leveraged by business projects and ongoing operations.

1. Identify

Program activities in the Identify Function include maintaining a security policy framework, asset management, risk assessments, threat intelligence, and risk management. For example, in conjunction with the IT Enterprise Architecture group, the Information Security control capabilities are documented. Risk assessments conducted by internal and external resources review the security posture of practices, technology, security controls, and other business activities. The assessments identify opportunities for improvements. These opportunities are prioritized via the risk management process. As projects are identified, funded, and completed, the security capabilities are updated in the capability repository.

[12] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

2. Protect

Protection-oriented activities are focused on avoiding or limiting potential cyber security events. Activities in this functional area include: managing asset access, cyber security awareness and training, protective technologies, and system maintenance. Ongoing cyber security awareness and training is important for engaging all employees so that they understand their roles and responsibilities regarding cyber security. Other activities in this area include vulnerability management, system implementation, security consulting and support, and operating support for protection systems. This support can include: two-factor authentication, the public key infrastructure, malware prevention, web content management, and supporting network protections, such as firewalls and intrusion detection and prevention.

In 2015, several projects were completed to support this functional area, including:

- An update and enhancement of security of endpoints, such as employee laptops. This project added advanced malware detection and other protections to avoid or reduce the impact of endpoint compromises.
- A rebuild of the public key infrastructure used to issue and manage certificates to authenticate devices, applications, and services. Cryptographic algorithms have a limited lifetime and must be updated periodically to maintain their effectiveness. This rebuild was partially driven by the need to replace an encryption algorithm, which was not considered resilient to current computer processors.
- The initiation of a data loss prevention capability to detect potentially unauthorized movement of information. The primary focus of this initial effort was the protection of customer information.

Non-GRC projects at SDG&E were also completed in the Protection area:

- Improvements on the communication infrastructure security; and
- Implementation of an isolated infrastructure to support NERC CIP security activities to minimize exposure to unrelated risks.

Note that because these projects were completed in 2015, they are reflected in the baseline risk mitigation plan, but will not continue for purposes of the proposed mitigation plan, discussed in Section 6. However, other projects for the Protect functional area are proposed and anticipated in the proposed plan.

3. Detect

The Detect Function enables timely discovery of Cyber Security events by monitoring security-related activities in systems and applications, anomaly detection, and security event detection and escalation. The 7x24 Security Operations Center monitors detection infrastructure systems to investigate security events. If the security events have the potential to impact the organization, they are escalated to the security incident response process.

4. Respond

The Respond Function supports the ability to contain the impact of a cyber security event. The response team coordinates cyber security incident response when a security event is escalated. They also provide analysis of the incident, during the incident, to determine the most effective response, as well as after the incident in terms of lessons learned. During the incident, communications with stakeholders are maintained. This functional area is the focus of ongoing training to maintain readiness through exercises to validate the response plans for high impact systems.

5. Recover

The Recover Function supports timely recovery to normal operations to reduce the impact from a cyber security event. This function is a core capability of the Information Technology business unit. The Information Security department's focus on Recovery functions is to maintain resilience against a Cyber Security event and, if necessary, to restore cyber security capabilities to a known state after an incident.

6 Proposed Risk Mitigation Plan

Planning the mitigation of Cyber Security risk is particularly challenging because of the wide range of potential risk drivers, including: rapid changes in technology, innovations in business capabilities, evolving threats in terms of sophistication, automation, and aggressiveness, and increasing system interdependencies. Cyber Security risk cannot be completely mitigated or avoided; however, the Companies can manage it by following well understood principles, recommending best practices, and striving to keep pace with changing threats.

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan. However, due to the evolving nature of the threats associated with this risk, if only the baseline mitigations were to be maintained, the risk would likely grow. Accordingly, in addition to the baseline controls, there will be several, new capital projects to improve or replace existing security capabilities to address changing threats or supported technologies. Also, there is a proposed increase in on-site staff at SoCalGas, the introduction of an entry level staffing program, and use of external services for some solutions instead of internal resources.

The additional employees, located primarily in the SoCalGas facilities, will provide better business and IT project and operational support. Also, an Information Security Associates program is proposed to add more entry level staff at both Companies in order to support the transition of the aging workforce, as well as lowering the overall average employee cost. These incremental changes are further described below.

1. Identify
    - Compliance Records Management – implement a system of recordkeeping dedicated to compliance records to better support regulatory auditing and governance of required safety-related Cyber Security risk mitigation activity.
    - Enterprise Threat Intelligence – automate distribution of threat intelligence to business and system owners to improve Cyber Security risk awareness and engagement.

2. Protect
    - Web Applications and Database Firewalls – improve protective capabilities for web applications and databases to reduce the likelihood and impact of an incident.
    - Host Based Protection – improve host-based protections for direct attacks and to help prevent attackers from pivoting to a host from a neighboring host.

3. Detect
    - Insider Threat Detection/Prevention – leverage emerging technologies to improve the detection of insider threat activities and the related risk impacts.
    - Perimeter Tap Infrastructure Redesign – improve the performance and visibility into network traffic to limit impacts of incidents.

4. Respond
    - Incident Response Secure Collaboration – implement a secure, out-of-band communication capability to coordinate and support incident response activity.
    - Security Orchestration – automate and support enhancements to the workflow related to responding to and analyzing escalated events to better manage and learn from cyber events.

5. Recover
    - Information Security technology backup and recovery – refresh backup and recovery for sensitive information security systems so as to return to a safe and secure risk posture.

7 Summary of Mitigations

Table 4a and 4b summarize the 2015 baseline risk mitigation plans, the risk driver(s) a control addresses, and the 2015 baseline costs for Cyber Security risk for SDG&E and SoCalGas, respectively. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

The Companies do not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in these tables were estimated using assumptions provided by SMEs and available accounting data.

Mitigation costs include capital costs for new and updated infrastructure, as well as operating and maintenance costs for labor resources and non-labor expenses. The costs represented here are the initial costs of the baseline mitigations before they are reallocated between SDG&E and SoCalGas. In general, capital costs are allocated to SoCalGas, and O&M costs are allocated to SDG&E. Non-GRC costs are those supporting mandated NERC CIP compliance. Only SDG&E has non-GRC costs, and none of these costs are shared with SoCalGas.

Table 4a: SDG&E Baseline Risk Mitigation Plan[13]
(Direct 2015 $000)[14]

ID	Control	Risk Drivers Addressed	Capital[15]	O&M	Control Total[16]	GRC Total[17]
1	Identify*	Addresses all risk drivers by defining the foundational asset and risk information necessary for mitigation	n/a	$1,420	$1,420	$780
2	Protect*	Address all risk drivers via controls, training, and activities focused on preventing or minimizing impacts	1,820	2,880	4,700	3,870
3	Detect*	Address all risk drivers by monitoring, detecting, and analyzing cyber events	0	1,020	1,020	880
4	Respond*	Address all risk drivers by containing and remediating cyber incidents	n/a	810	810	620
5	Recover*	Address all risk drivers by planning	n/a	70	70	20

[13] Recorded costs were rounded to the nearest $10,000.
[14] The figures provided in Table 4a, 4b, 5a, and 5b are direct charges and do not include company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[15] Pursuant to D.14-12-025 and D.16-08-018, the Companies provided the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[16] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[17] The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[15]	O&M	Control Total[16]	GRC Total[17]
		and communicating the restoration of services after an incident				
	TOTAL COST		$1,820	$6,200	$8,020	$6,170

* Includes one or more mandated activities

Table 4b: SoCalGas Baseline Risk Mitigation Plan[18]
(Direct 2015 $000)

ID	Control	Risk Drivers Addressed	Capital[19]	O&M	Control Total[20]	GRC Total[21]
1	Identify	Addresses all risk drivers by defining the foundational asset and risk information necessary for mitigation	n/a	$50	$50	$50
2	Protect	Address all risk drivers via controls, training, and activities focused on preventing or minimizing impacts	6,370	400	6,770	6,770
3	Detect	Address all risk drivers by monitoring, detecting, and analyzing cyber events	n/a	n/a	n/a	n/a
4	Respond	Address all risk drivers by containing and remediating cyber incidents	n/a	10	10	10
5	Recover	Address all risk drivers by planning and communicating the restoration of services after an incident	n/a	n/a	n/a	n/a
	TOTAL		$6,370	$460	$6,830	$6,830

[18] Recorded costs were rounded to the nearest $10,000.
[19] Pursuant to D.14-12-025 and D.16-08-018, the Companies provided the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[20] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[21] The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[19]	O&M	Control Total[20]	GRC Total[21]
	COST					

* Includes one or more mandated activities

The baseline costs above in Tables 4a and 4b reflect the actual Information Security O&M and Capital costs based on accounting data.

The Companies have established a core set of control capabilities that are leveraged by business projects and ongoing operations. In 2015, there were no capital projects within the functional controls of Identify, Detect, Respond and Recover.

Table 5a and 5b summarize the proposed mitigation plans, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019 for SDG&E and SoCalGas, respectively. It is important to note that the Companies are identifying potential ranges of costs in this plan, and is not requesting funding approval. The Companies will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Tables 5a and 5b, the Companies are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 5a: SDG&E Proposed Risk Mitigation Plan[22]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[23]	2019 O&M	Mitigation Total[24]	GRC Total[25]
1	Identify*	Addresses all risk drivers by defining the foundational asset and risk information necessary for mitigation	n/a	$1,100 - 1,570	$1,100 - 1,570	$460 - 720
2	Protect*	Address all risk drivers via controls, training, and activities focused on preventing or minimizing impacts	3,000 - 9,000	4,000 - 6,020	7,000 - 15,020	6,170 - 14,130
3	Detect*	Address all risk drivers by monitoring, detecting, and analyzing cyber events	n/a	1,280 - 1,630	1,280 - 1,630	1,140 - 1,340
4	Respond*	Address all risk drivers by containing and	n/a	940 - 1,500	940 - 1,500	740 - 1,150

[22] Ranges of costs were rounded to the nearest $10,000.
[23] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018, and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
[24] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[25] The GRC Total column shows costs typically represented in a GRC.

		remediating cyber incidents				
5	Recover*	Address all risk drivers by planning and communicating the restoration of services after an incident	n/a	250 - 450	250 - 450	200 - 340
	TOTAL COST		$3,000 - 9,000	$7,570 - 11,170	$10,570 - 20,170	$8,710 - 17,680

☐	Status quo is maintained
☐	Expanded or new activity
*	Includes one or more mandated activities

Table 5b: SoCalGas Proposed Risk Mitigation Plan[26]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[27]	2019 O&M	Mitigation Total[28]	GRC Total[29]
1	Identify	Addresses all risk drivers by defining the foundational asset and risk information necessary for mitigation	$0 - 7,500	$110 - 560	$110 - 8,060	$110 - 8,060
2	Protect	Address all risk drivers via controls, training, and activities focused on preventing or minimizing impacts	28,700 - 41,300	400 - 1,060	29,100 - 42,360	29,100 - 42,360
3	Detect	Address all risk drivers by monitoring, detecting, and analyzing cyber	9,450 - 14,900	0 - 150	9,450 - 15,050	9,450 - 15,050

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26 Ranges of costs were rounded to the nearest $10,000.
27 The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018, and 2019 are the forecast years for SoCalGas' Test Year 2019 GRC Application.
28 The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
29 The GRC Total column shows costs typically represented in a GRC.

		events				
4	Respond	Address all risk drivers by containing and remediating cyber incidents	7,000 - 12,000	10 - 160	7,010 - 12,160	7,010 - 12,160
5	Recover	Address all risk drivers by planning and communicating the restoration of services after an incident	0 - 6,000	n/a	0 - 6,000	0 - 6,000
	TOTAL COST		$45,150 - 81,700	$520 - 1,930	$45,670 - 83,630	$45,670 - 83,630

☐	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

Capital cost estimates are based on the current Information Security project roadmap. Depending on other budget priorities, some projects may be implemented in later years. The low range is based on the roadmap timelines. The high range for the capital projects includes costs for projects from previous years being completed in that year, and projects that are identified and prioritized during the risk assessment process.

O&M costs have a labor and a non-labor component. The estimated labor costs are based on 2015 costs as the low range plus a minimal number of Information Security Associates (discussed in the benefits section below). The high range includes additional full-time staff to support the Companies' projects and operations, and other activities identified in risk assessments.

The non-labor component of the O&M costs is estimated by escalating costs associated with supporting the capital projects after their implementation. The high range also accommodates the costs of addressing capability improvements utilizing service-based offerings where there is a rate benefit and appropriate risk management.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent.[30] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[31]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts.

[30] D.16-08-018 Ordering Paragraph 8.
[31] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.

4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[32] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Tables 5a and 5b of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

Company analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Cyber Security risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

The NIST developed a cyber security framework to serve as an implementation guide for corporate countermeasures. In this framework, core activities and outcomes are placed into five functions: identify, protect, detect, respond, and recover. The Company has measures that address requirements under these functions.

[32] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

The migration activities (within the five functional control areas) were combined and assessed as one aggregated mitigation for the risk reduction analysis. Because cyber threats are in a constant evolutionary state, corporate countermeasures also evolve over time and, generally are lagging. Since countermeasures are designed to match known threats, all of them are categorized as baseline, so only one set of security measures was analyzed. The methodology used to estimate risk reduction was based on internal self-assessment results and the judgment of SMEs. This analysis addresses the mitigations at both utilities, collectively.

As self-assessments are performed over time, progress on each of the functions is noted. If the baseline portfolio were to not be funded, it can be assumed that risk would revert to an earlier state. This is the principle that is used in the estimation of risk reduction from this mitigation; namely that the benefit is the difference in performance between the current state and an earlier, known state.

Year 2015 assessment results are used to define the earlier, known state, and 2016 assessment results are used to define the current posture. Assessment results are given in units consistent with the 7X7 matrix of the risk evaluation framework. Because results are given for each of the five cyber security functions, and not for the full cyber security portfolio, it is necessary to consolidate them into a single value. Also, the functions were assigned weights that reflected the relative contribution of each to overall benefits, SMEs assigned determined these assignments as shown in Figure :

Figure 3: Control Functions - Contribution to Overall Benefits

Function	Contribution to overall benefits
Identify	15%
Protect	15%
Detect	20%
Respond	20%
Recover	30%

Applying these weights, SMEs estimated that the remaining risk is 35% of the original risk from the earlier, known state. This means 65% of the risk is estimated to have been mitigated. This is a conservative result because security measures existed before the year 2015.

8.3 Risk Spend Efficiency Results

Figures 4 and 5display the range[33] of RSEs for Cyber Security risk for SoCalGas and SDG&E.

[33] Based on the low and high cost ranges provided in Tables 5a and 5b of this chapter.

Figure 4: SoCalGas Risk Spend Efficiency

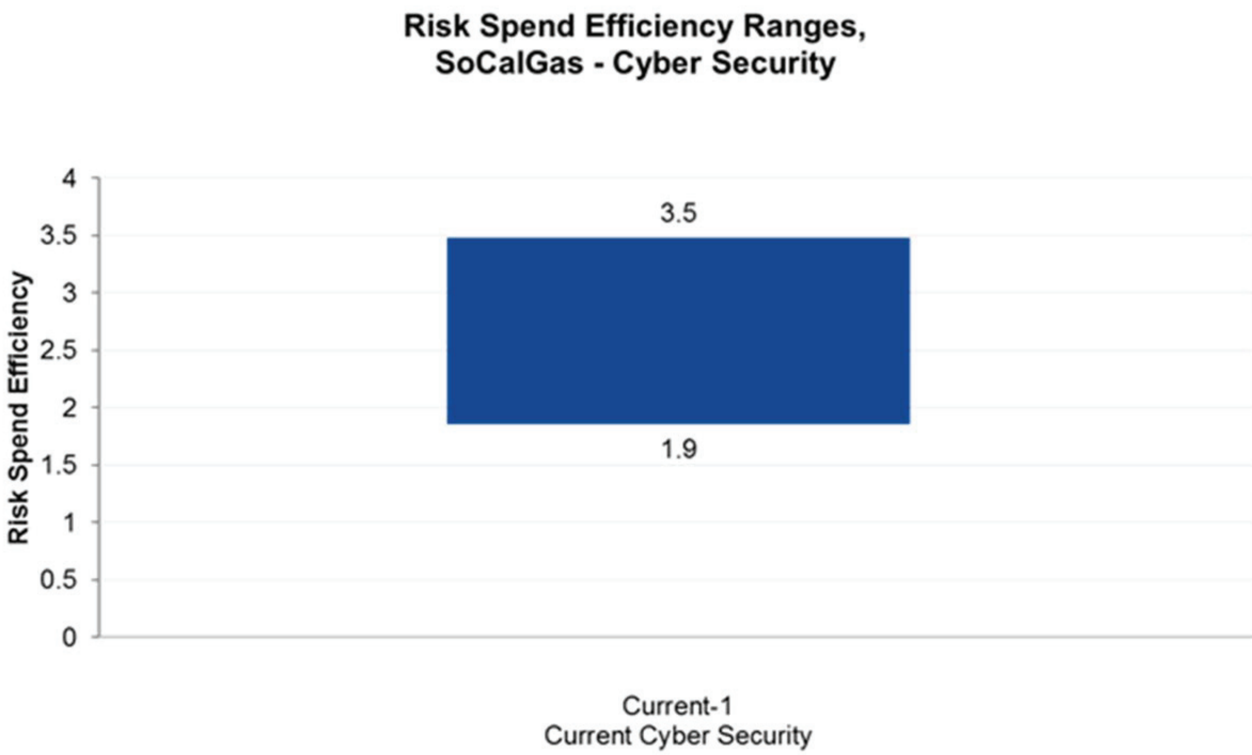
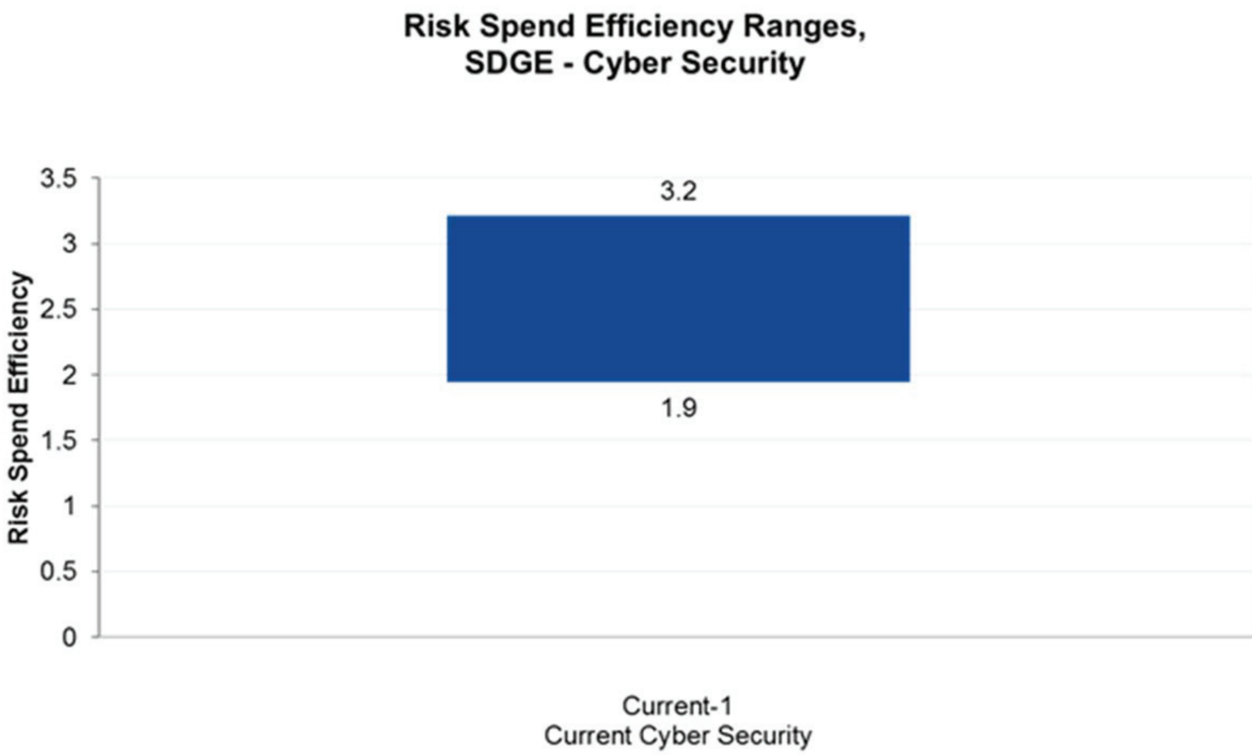


Figure 5: SDG&E Risk Spend Efficiency



9 Alternatives Analysis

The Companies considered alternatives to the proposed mitigations as it developed the proposed mitigation plan for the Cyber Security risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources.

9.1 Alternative 1 – Address All Known Issues

The first alternative considered was to more aggressively mitigate risk by quickly addressing all known issues. If the organization is less risk tolerant, then the Information Security program will address more of the medium and low risks more aggressively, reducing windows of vulnerability and addressing identified control capability risks sooner.

More aggressively addressing risk would increase capital spending, maintenance costs, and staffing in order to implement and operate more cyber security controls in a shorter period of time. Also, a more aggressive approach would lead to more business function-specific solutions instead of enterprise solutions, also increasing the cost of ownership. The amount of the cost increase depends on the degree of the accelerated activity. An increase in capital project costs also has a longer-term increase in labor and non-labor O&M costs in future years.

This alternative was dismissed in favor of the proposed plan due to resource, financial, and affordability constraints. The proposed plan balances resources and affordability by prioritizing projects and programs rather than addressing all known issues, while also reducing potential risk exposure to the extent it is feasible.

9.2 Alternative 2 – Delay Security Capability Implementation

The second alternative that was considered was to delay security capability implementation in response to a cyber threat, and business and Cyber Security technology changes. If the organization had a higher risk tolerance, then the Information Security program would slow down the implementation of security controls and focus on a smaller set of risks and business areas, increasing overall risk exposure.

Moderating the Cyber Security risk management would reduce capital spending and maintenance costs, as well as reduce increased staffing requirements. The amount of the decrease in cost would depend on the amount of moderation.

The Companies believe their risk management culture does not allow for this approach given the commitments to safety and cyber security. The current potential drivers of increasing capabilities of threat agents and higher risk exposure due to innovative technologies are increasing the Companies' risk. Only moderating cyber security activities and spending would not be beneficial to customers with respect to safe and reliable energy delivery and protecting sensitive customer information.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Aviation Incident
(SDG&E-8)

November 30, 2016

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Executive Summary

Aviation Incident is the risk of an aviation event by SDG&E contractors, subcontractors or other third parties who may enter SDG&E's service territory that results in damages to electric transmission, distribution and/or gas transmission facilities. SDG&E's 2015 baseline controls include:

- Aviation Safety Management System (SMS) – comprehensive safety management approach consisting of policies and procedures applicable for aviation
- Job Site Observation Program – program that provides SDG&E aviation oversight of internal and contractor aviation construction operations
- Service Provider Audit Program – third party oversight program that provides an independent perspective regarding how to meet a standard of safety recognized through the aviation industry.
- "Best Practices" Training – training implementing best safety practices from throughout the aviation industry from a variety of sources.

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability. The 2015 baseline mitigations will continue to be performed in the proposed plan. In addition, SDG&E proposes to expand and add new mitigations to address the risk of Aviation Incident. The expanded and new mitigation activities are:

- Service Provider Audit Program – expand the program by requiring audits be performed before a contractor flies on company property for the first time and audit all contracted vendors on an annual basis.
- Purchase a Twin-engine Helicopter – helicopter enables a dual-redundant system where single-point failure exists; thereby cutting the frequency of an accident (if one were to occur) by half.
- Aviation Safety Training – the policy and procedure foundation consisting of an initial training manual for internal use of pilot development, continued training costs for currency and performance development, and case-by-case skills performance development.
- Currency and Proficiency Training with New Helicopter – a training that socializes the best procedural practices and promotes institutional knowledge and safety.

A risk spend efficiency was calculated for the Aviation Incident risk. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. For purposes of the risk spend efficiency, the proposed mitigations were grouped into two: Effective SMS Program (include training, on-site observation, and audits); and More Reliable Equipment. Based on a benefit-cost assessment (e.g. risk spend efficiency), the mitigations for this risk can be ranked as follows:

1. Effective SMS program
2. More reliable equipment

Risk: Aviation Incident

1 Purpose

The purpose of this chapter is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of Aviation Incident. For the purposes of this filing, this risk is an aviation incident by SDG&E contractors, subcontractors or other third parties who may enter SDG&E's service territory that results in damages to electric transmission, distribution and/or gas transmission facilities. Additionally, Aviation Incident can be described as the combination of the Federal Aviation Administration's (FAA) definitions for *incident* and *accident*. For reference, an *aircraft accident* is an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person (either inside or outside the aircraft) suffers death or serious injury, or in which the aircraft receives substantial damage. An *aircraft incident,* by the FAA's definition, is an occurrence, other than any accident, that affects or could affect the safety of operations.[1] Direct and indirect damage is also accounted for in these evaluations of risk, as they directly impact the cost accountancy of accidents associated with any aviation incident.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[2] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

[1] 49 C.F.R. 830.2.
[2] Commission Decision (D.) 14-12-025 at p. 31.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

The risk assessment provided herein focuses on the drivers or hazards and potential resulting events for which SDG&E is aware,[3] and in which the leading regulatory and professional organizations that deal with flight are most concerned.[4] Hazards and events that are unknown to SDG&E are beyond the scope of this risk; however, SDG&E is making every effort to create a system by which new hazards can be identified quickly, moved upwards continuously, and evaluated through empowered employees and contractors such that new risks will be captured and evaluated pro-actively. Flying aircraft in support of SDG&E missions is within the scope of this risk.

2 Background

SDG&E's Aviation Services Department (ASD) supports electric transmission, electric distribution, and gas operations with manned and unmanned aircraft. Manned operations are primarily flown with rotary wing aircraft and include: scheduled powerline patrols, fault patrols, infrared camera patrols, vegetation management surveys, external load work, LiDAR[5] data collections, and aerial assessments. In addition, ASD provides an air-rescue capability to structures and areas that are accessible by helicopter only, and in close proximity to powerlines. Unmanned operations include pole-top and structure integrity assessments, environmental and sensitive area surveys, LiDAR data collection, and post storm or fire damage assessments.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[6] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within

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[3] SDG&E Aviation Services Department. SDG&E Draft Aircraft Operations Manual, Draft Version 1. June 2016.
[4] Federal Aviation Administration. Safety Management Systems: SMS Explained. June 5, 2016. https://www.faa.gov/about/initiatives/sms/explained/.
[5] LiDAR stands for Light Detection and Ranging. According to https://www.LiDARusa.com, it is "used to detect and measure the distance of an object or surface from an optical source."
[6] A.15-05-002, filed May 1, 2015, at p. JMD-7.

its evaluation and prioritization of risks.[7] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Aviation Incident risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as an electric, operational risk as shown in Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	ELECTRIC/OTHER FACILITIES	Elect Transmission OH; Electric Distribution OH

3.2 Potential Drivers[8]

When performing the risk assessment for Aviation Incident, SDG&E identified potential indicators of risk, referred to as drivers. The term "drivers" is consistent with the risk lexicon approved by the California Public Utilities Commission in the S-MAP Decision (D.) 16-08-018. However, in accordance with industry best practices within the aviation industry, such "drivers" are referred to as hazards.[9] It should be recognized that SDG&E does not believe incidents or accidents are caused by a single failure, but often are the culmination of both active errors and latent conditions aligning to create an incident or accident.[10] This understanding is pervasive throughout many industries, and is considered an aviation industry best practice as established by such governing authorities as the international Civil Aviation Organization (ICAO), FAA, and academia.[11] Based on reviewing events in the industry, SDG&E identified the following drivers that could lead to an incident or accident.

[7] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[8] An indication that a risk could occur. It does not reflect actual or threatened conditions.
[9] International Civil Aviation Organization. Doc. 9859 Safety Management Manual (SMM). 2013 http://www.icao.int/safety/SafetyManagement/Documents/Doc.9859.3rd%20Edition.alltext.en.pdf
[10] Civil Aviation Safety Authority of Australia. SMS for Aviation—A Practical Guide. 2nd Edition. 2014 Pg14 https://www.casa.gov.au/sites/g/files/net351/f/_assets/main/sms/download/2014-sms-book1-safety-management-system-basics.pdf.
[11] Reason, James. Managing the Risk of Organizational Accidents Ashgate Publishing, UK. 2013.

- **Active Errors** – An error can that occur due to someone not doing something correctly, in accordance with procedure or policies, even when the intent is to act in accordance with policy or procedure. The drivers that fall into this category are:
    - Pilot error or inexperience inclusive of intrusion into airspace
    - Inadequate pre-flight risk assessment
    - Field error or inexperience of ground crew
    - Loss of situational awareness, confusion (Controlled Flight into Terrain)

- **Latent Conditions** – A failure of programs/procedures intended to maintain safe flight or operation, yet creates conditions that lead directly to failure. Often these lead to non-regulation "workarounds" or "shortcuts" that can create unsafe environments, and in which active errors create incidents. The drivers that fall into this category are:
    - Inadequate visual markings or lighting of overhead transmission/distribution lines
    - Incorrect policy or procedure
    - Lack of oversight, complacency
    - Normalization of deviance that is uncorrected
    - Weather conditions that change rapidly

- **Hardware Failure** – A failure of the system from any elements in the aircraft that contributes to normal flight operations, such as material or avionics failure. The drivers that fall into this category are:
    - Aircraft or other equipment failure not related to maintenance
    - Maintenance failure leading to system failure
    - Malicious third-party software or signal
    - Incorrect automation inputs
    - On-board communications interference

Table 2 maps the specific drivers of Aviation Incident to SDG&E's risk taxonomy.

Table 2: Operational Risk Drivers

Driver Category	Aviation Incident Driver(s)
Asset Failure	• Aircraft or other equipment failure not related to maintenance • Maintenance failure leading to system failure
Asset-Related Information Technology Failure	• Incorrect automation inputs • On-board communications interference
Employee Incident	• Pilot error or inexperience inclusive of intrusion into airspace • Inadequate pre-flight risk assessment • Field error or inexperience of ground crew • Loss of situational awareness, confusion (Controlled Flight into Terrain) • Inadequate visual markings or lighting of overhead transmission/distribution lines • Incorrect policy or procedure • Lack of oversight, complacency • Normalization of deviance that is uncorrected
Contractor Incident	• Pilot error or inexperience inclusive of intrusion into airspace • Inadequate pre-flight risk assessment • Field error or inexperience of ground crew • Incorrect policy or procedure • Lack of oversight, complacency • Normalization of deviance that is uncorrected
Public Incident	• Malicious third-party software or signal • Pilot error/inexperience • Disgruntled individual or terrorist attack • Negative separation with aircraft • Inadequate visual markings or lighting of overhead transmission/distribution lines
Force of Nature	• Weather conditions that change rapidly

The abovementioned drivers capture the most probable causes of an aviation incident on SDG&E property or in support of SDG&E activities.

Failure rates in the aviation environment are fairly well known and, therefore. Based on these aviation industry statistics applicable to this risk, SDG&E determined that risks associated with failures in communication, situational awareness and risk-assessment, which can all be categorized as pilot error, will continue to attribute to over 90% of all incidents or accidents.[12] By understanding that human error (pilot error) is the leading cause of a large majority of aviation accidents and incidents, the prime mitigation strategy should likewise address these failures. Likewise, while material failures (asset failure) are less prevalent than human error focused incidents, they still can occur and, therefore, must be acknowledged and assessed.

3.3 Potential Consequences

The above drivers/hazards exist in all aviation oriented operations, and it is up to employees/contractors to develop proper mitigation strategies to eliminate incident or accident. The "Swiss-Cheese Model" of Aircraft Accident Causation illustrates that many layers of defense can be instituted to prevent these hazards from manifesting incidents or accidents. This model of accident causation and mitigation can be seen in Figure 1 below. The model, widely accepted as industry best practice in the aviation industry, is the foundation for a robust Safety Management System (SMS). It provides that while there are many layers of protection between potential drivers and accidents, there are flaws in each layer that, if aligned, can result in an incident. The overall system produces failures when a hole in each slice (a slice representing mitigation attempts such as policies, procedures, IT security, training, redundant systems, etc.) momentarily aligns, permitting an opportunity for a potential event to occur. When multiple layers of the mitigation fail, the incident or opportunity for accident can manifest an event.[13]

The goal of safety management is to identify these gaps in mitigations, before they culminate in the production of accidents – proactively through hazard (driver) identification, documentation, and education. Understanding that latent conditions often lead to active errors, it is important to create policies and procedures that evaluate and monitor all aspects of the operation for appropriateness. Monitoring incidents of pilot error and ensuring proper training is driven by these problems, helps fill these "holes" in the various mitigation layers, and therefore protects against catastrophic accidents.

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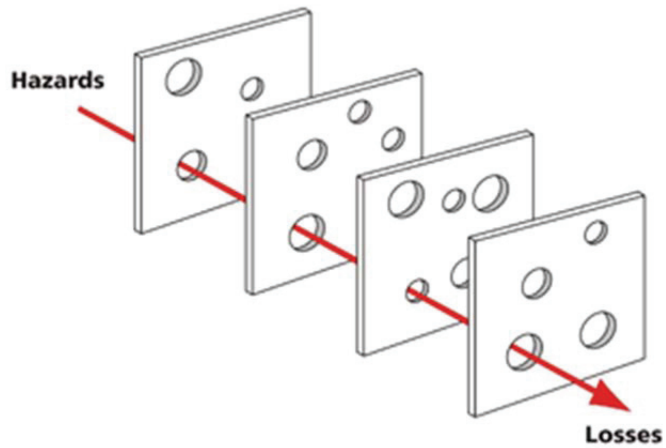
[12] Hansen, Frederick. Human Error: A Concept Analysis. Journal of Air Transportation, at p 62. http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20070022530.pdf.
13 Daryl Raymond Smith; David Frazier; L W Reithmaier & James C Miller (2001). Controlling Pilot Error. McGraw-Hill Professional. p. 10. ISBN 0071373187.

Figure 1: Swiss-Cheese Model of Hazards and Losses



Conversely, if proper mitigations are not in place to reduce the frequency of an event occurring, or the severity of the event is not diminished to a satisfactory result, then the following potential consequences, in a reasonable worst case scenario, could include:

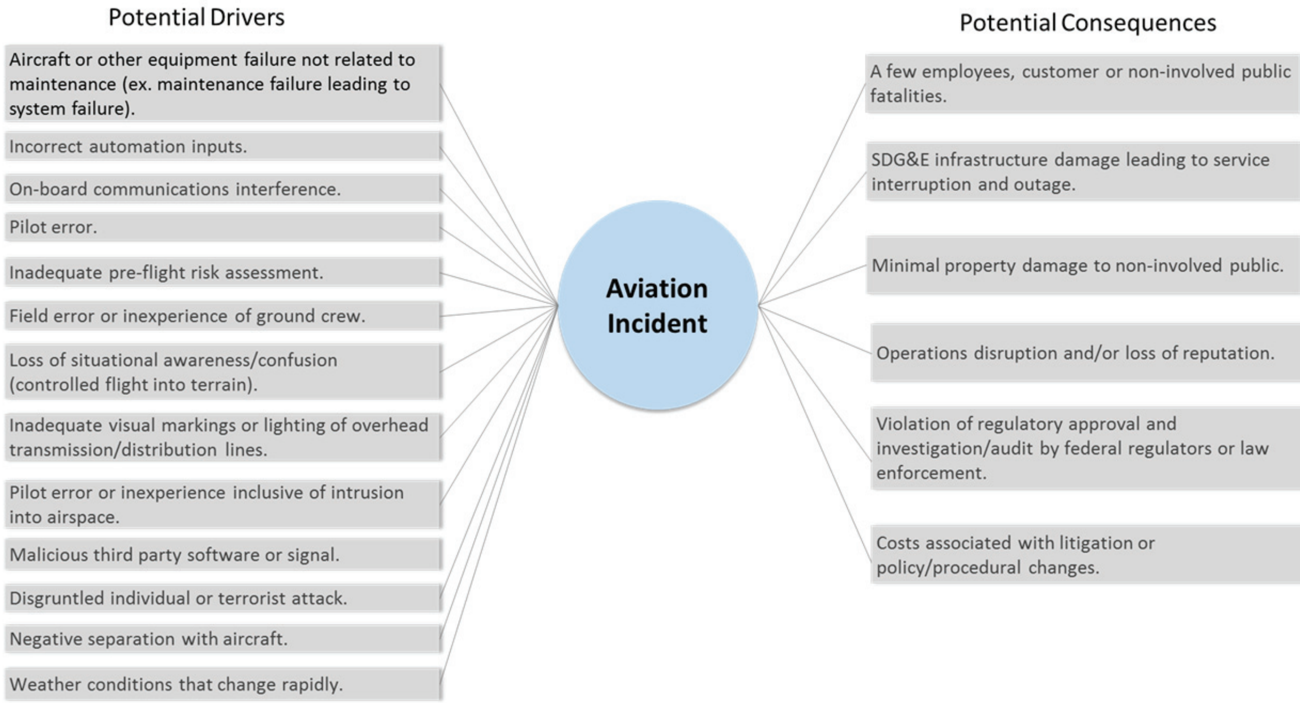
- A few employees, customer, or non-involved public fatalities.
- SDG&E infrastructure damage leading to service interruption and outage.
- Minimal property damage to non-involved public.
- Operations disruption and/or loss of reputation.
- Violation of regulatory approval and investigation/audit by federal regulators or law enforcement.
- Costs associated with litigation or policy/procedural changes.

These potential consequences were used in the scoring of Aviation Incident that occurred during the SDG&E's 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown in Figure 2, is a commonly-used tool for risk analysis that shows the relationship between hazard conditions and the potential result if an event were to occur. The left side of the bow tie illustrates potential drivers/hazards that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

Figure 2: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Aviation Incident as one of the enterprise risks. During the development of the risk register, subject matter experts from SDG&E's Electric Distribution Operations department assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

The resulting risk score was calculated in the interest of providing acceptable knowledge of mitigation strategies prior to any Aviation Incident in accordance with the FAA Safety Management Manual (SMM), and the International Civil Aviation Organization (ICAO) Annex 19. This best approach for risk scoring is to analyze the severity of the potential outcome of a hazardous event, and the likelihood of that event occurring. This is calculated using both qualitative and quantitative methods, using subject matter expertise, industry rates of failures and accident causation, and studies conducted in support of aviation operations. There is an extensive amount of industry information for manned aviation and, therefore, encountering reliable quantitative methods for accident rates provides a pathway for reliable risk mitigation strategies. The risk score presented is based upon a worst case, but reasonable, scenario as identified as necessary by the FAA, ICAO, and other industry stakeholders to protect organizational interests.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which an aviation incident can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Aviation Incident:

- A Company-contracted helicopter experiences a mechanical failure inflight and enters out-of-control flight, leading to a crash with employee injuries or fatalities and a post-crash fire. This affects service to customers and results in litigation and financial impacts.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[14] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the Aviation Incident risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

[14] D.16-08-018 Ordering Paragraph 9.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	2	2	3	3	23,108

In addition to the risk assessment performed as part of the ERM risk registry process, a risk assessment was also conducted for the Aviation Incident risk in accordance with the ICAO Doc. 9859, industry best practices/FAA guidance, denoting appropriate severity and likelihood criteria for Aviation Incidents in order to compare the resulting risk scoring.[15] This alternative risk assessment produced comparable results to that of SDG&E's ERM risk evaluation; thereby validating the results of both. The results of the industry best practices/FAA guidance assessment determined that some of the baseline mitigations should be adapted. Largely this is due to the catastrophic nature of an accident leading to one or more fatalities. It should be recognized that the likelihood of the event selected in the risk scenario is extremely improbable; largely due to a fatal accident rate of .59 per 100,000 flight hours, and a representation in the utility industry of only 2.4%.

4.3 Explanation of Health, Safety, and Environmental Impact Score

A score of 6 (severe) was given in the Health, Safety, and Environmental impact area. In determining this risk score, ASD evaluated the most likely outcome of a helicopter crash, based off industry and National Transportation and Safety Board (NTSB) data. In examining industry accident rates, it is noted that the environmental conditions, within which SDG&E will be most likely to operate, provide the most likely environments for helicopter accidents to occur. In a 2012 report by the FAA, recognized that 88% of all helicopter accidents occur in daylight conditions, and over 95% occur in Visual Meteorological Conditions (VMC). This makes the most sense as these conditions have the vast majority of flights taking place. Utility Patrols/Construction provided for 2.1% of all aircraft accidents between 2000 and 2006 (523 total accidents).[16] When looking at the likelihood of the event occurring, we can also see that there is an accident rate for the industry of roughly 3.64 helicopter accidents per 100,000 flight hours in 2014. With respect to the severity of these accidents, the rate dropped to a new industry low in 2014 as well, reaching .59 fatal accidents per 100,000 flight hours.[17] The most common reasons given for fatal

[15] International Civil Aviation Organization. Safety Management Manual Document 9859 AN/474. ICAO 2013, at p. 2-28.
[16] Roskop, Lee. FAA. US Rotorcraft Accident Data and Statistics January 2012. PPT, at p. 13. https://www.aea.net/events/rotorcraft/files/US_Rotorcraft_Accident_Data_And_Statistics.pdf.
[17] Jackman, F. US Helicopter Accident Rates Down in 2014. Flight Safety Foundation. May 2015 http://flightsafety.org/aerosafety-world-magazine/may-2015/us-helicopter-accident-%E2%80%A8rates-down-in-2014.

accidents are "loss of control, obstacle and wire strikes, degraded visibility, system component failures and fuel issues." It should be noted that the close proximity to ground crews and "wires and obstacles" increases the likelihood of a fatal accident if any accident were to occur.[18]

Should a crash occur, likely fatalities will include pilot(s) and passengers, with the potential to affect personnel on the ground. This is especially true during construction operations, during which the helicopter is positioned in a hover above ground crews, often with external loads.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SDG&E gave the other residual impact areas each a score for the following reasons:

- **Operational and Reliability:** Aviation Incident was assigned a score of 2 (minor) as any service disruption to customers was determined using empirical data to the extent it is available and/or subject matter expertise to be minimal, affecting a small area or greater than 100 customers for a short period of time. An incident which would affect vital infrastructure, or customers directly, is mitigated by onboard pilot emergency procedures, standard operating limitation for proximity to distribution networks, and other items.
- **Regulatory, Legal, and Compliance:** SDG&E scored this risk a 2 (minor) due to the well-regulated and documented environment for manned aviation. Commercial manned aviation has had a long history of regulatory, legal, and compliance foundations and therefore procedures to align the program within these limitations are also well known. The responsibilities of an operator are well understood by SDG&E and training and policy protects the organization. While there is potential impact from litigation, regulatory and compliance elements would have little impact.
- **Financial:** A score of 3 (moderate) was given in this impact area. In accordance with SDG&E's 7X7 matrix, a 3 is defined as a financial impact ranging from $1 to $10 million. SDG&E subject matter experts determined this to be reasonable given the potential for litigation, as well as damage to private property or Company facilities, that could result from an aviation incident.

4.5 Explanation of Frequency Score

Based off Company, industry and NTSB data, the frequency of an incident related to this risk is infrequent (Extremely Improbably) - once every 10-30 years. Accordingly, a score of 3 (infrequent) was given for the Aviation Incident risk. This is reflective of industry findings and accident rates, especially within the utility industry.

5 Baseline Risk Mitigation Plan[19]

As stated above, Aviation Incident risk entails an aviation-related event by SDG&E contractors, subcontractors or other third parties that may result in damages to electric and/or gas facilities. The 2015 baseline mitigations discussed below includes the current evolution of the utilities' risk

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[18] *Id.*
[19] As of 2015, which is the base year for purposes of this Report.

management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time. The baseline controls include an aviation safety management system, a job site observation program, an audit program and "best practices" training. These controls focus on safety-related impacts[20] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[21] as well as controls and mitigations that may address reliability.[22] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various aviation-related events, not just the scenario used for purposes of risk scoring.

1. **Aviation Safety Management System**

   In 2015, SDG&E began implementing an aviation SMS - the leading mitigation currently in place. In essence, the SMS is the international leading, comprehensive safety management approach consisting of policies and procedures applicable for aviation. It is an absolutely critical system of management recognized as an industry best practice for minimizing aviation risk to the significant benefit and protection of SDG&E's employees, contractors, and the public at large. This mitigation stands on the four pillars outlined below as required by ICAO, FAA, and industry stakeholder certifications. It does this by establishing industry recognized best practices in risk management and safety focus from the top down. The public, contractors, and employees enjoy reduced risk benefits, increased access and communication to leadership, and continuous proactive safety program developments in a systematic and data driven manner. The additional baseline mitigations fall into one of the four categories below.

   a. **Safety Policy** — Establishes senior management's commitment to continually improve safety; defines the methods, processes, and organizational structure needed to meet safety goals.
   b. **Safety Risk Management (SRM)** — Determines the need for, and adequacy of, new or revised risk controls based on the assessment of acceptable risk.
   c. **Safety Assurance (SA)** — Evaluates the continued effectiveness of implemented risk control strategies; supports the identification of new hazards.
   d. **Safety Promotion** — Includes training, communication, and other actions to create a positive safety culture within all levels of the workforce.

[20] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[21] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[22] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

2. **Job Site Observation Program**

The job site observation program is a function of "Safety Assurance" and is associated with the SMS mitigation. It provides SDG&E aviation oversight of internal and contractor aviation construction operations. It provides direct oversight and "fact finding" to see how policies and procedures are being handled in a "live" environment. This position is staffed with an employee having both aviation and electrical line experience to maximize the effectiveness of the safety oversight.

3. **Service Provider Audit Program**

Auditing and third-party oversight and qualification is another portion of the Safety Assurance function within SMS, and is directly related to acquiring feedback and unbiased assessment of any aviation operation. The FAA and ICAO have all identified auditing and third-party inspection as a vital element of a healthy aviation organization. Audits require bringing in external companies for three to four days at a time to examine documentation of policies and procedures, data acquisition, and witness operations, both announced and unannounced. A third party audit program and oversight is a fundamental best practice in the aviation industry. Utilizing one of the major oversight programs such as IS-BAO or Wyvern, the aviation program will have "fresh" eyes to meet a standard of safety recognized through the industry.

4. **"Best Practices" Training**

Implementing best safety practices from throughout the industry from a variety of sources helps mitigate any number of risks and their drivers continuously and in support of the SMS approach to safety management. It is low cost, pro-active in nature, and able to be immediately pursued.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. In addition, SDG&E is proposing expanded and new mitigations to further address the risk of Aviation Incident. These incremental changes, along with updates about other controls are described in below and in Section 6.

SDG&E's proposed plan has many benefits in applying, implementing, and evolving the operational framework envisioned for mitigating the risk of Aviation Incident. By adopting industry best practices that touch upon SMS, Crew Resource Management (CRM), and aircraft with redundant capabilities that provide much greater protection against the most common fatal failure types, SDG&E will take a huge leap forward in eliminating errors that can be attributed to the majority of aviation accidents.[23] While helicopter accident rates are considered among the lowest in aviation (due to many factors, including less flight hours by amateur pilots, and a requirement for more training than much of aviation), Vertical Take-Off and Landing (VTOL) flight is still prone to very specific incident drivers (hazards), including airworthiness or maintenance problems, situational-awareness reduction, human error, a lack of area of operation knowledge, and problems of non-detailed communications. By adopting the measures above – especially through the implementation of a robust SMS that captures hazards, analyzes them for risk, and mitigates risk before they become accidents – safety and security of the Aviation program and its tangential operations will follow.

Likewise, it is an industry practice to invite third party auditing and internal on-site verification for all operations. These elements provide the ongoing external expertise to identify hazard drivers that organizations often become accustomed to and don't see directly. These elements are vital to the Safety Assurance component of SMS that can be very difficult to develop and are considered an industry best practice throughout aviation.

SDG&E's proposed plan is further discussed in detail below.

1. **Aviation Safety Management Systems**

   SDG&E will continue with its aviation SMS. Developing a robust SMS program enables the support and expansion of manned aviation activity throughout SDG&E strategic operations. The FAA has identified SMS as the main enabling operational approach to aviation operations that provides succinct and successful operations. This will allow continued integration of operations

[23] Wiegmann, D. et. Al; Federal Aviation Administration. Human Error and General Aviation Accidents: A Comprehensive, Fine-Grained Analysis using HFACS. December 2005. https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/2000s/media/0524.pdf.

through the incorporation of data processing, fleet management, and operational training, for all operations. SMS comes with a cost, but the return on investment comes through continued safety, proactive hazard identification, and minimized loss through incidents and accidents. By avoiding even one fatal accident, the cost of the program is recovered.[24]

Additionally, according to Subject Matter Experts, Safety Management Systems is the future of all aviation operations, and will likely be required by FAA in accordance with International Civil Aviation Organization, Annex 19.[25] Currently, Part 121 and 135 aircraft operators are required to implement SMS into their operations; however, the FAA has expressed an interest in continuing to implement SMS through all commercial operations. SDG&E will be positioned to avoid the risk of a costly program overhaul when the proposed requirement becomes reality; avoiding a necessity to change the procedures in place that often leads to residual and unidentified risk. Implementing a robust SMS mitigates the following risks: asset failure, policy or procedure failure, employee incident, contractor incident, and public incident.

2. Job Site Observation Program

This program is also continuing from the 2015 baseline control. Line Operations Safety Audits (LOSA) and job site inspections will be adapted and integrated into the ongoing SMS oversight program to maintain policies and procedures without organizational drift or the normalization of deviance – which is a major contributor to incidents and accidents in aviation as noted above. This increased oversight will mitigate the risk of an employee or contractor incident related to helicopter operations.

3. Service Provider Audit Program

This program is also continuing from the 2015 baseline control. Utilizing experienced aviation consultants to conduct audits is a function of "Safety Risk Management" and "Safety Assurance." The "Safety Risk Management" portion deals with continuing to update existing procedures. Procedures will be updated to require that audits be performed before a contractor flies on company property for the first time and that all contracted vendors are audited annually.

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[24] https://www.rand.org/content/dam/rand/pubs/reports/2007/R3421.pdf.
[25] EASA. ICAO ANNEX 19. https://www.easa.europa.eu/system/files/dfu/ICAO-annex-19.pdf Accessed 2016.

4. Purchase a Twin-engine Helicopter

Purchasing a twin-engine helicopter for SDG&E use provides a unique opportunity in aviation to enable a dual-redundant system where single-point failure exists; thereby cutting the frequency of an accident (if one were to occur) by half. This increases the SDG&E safety margin by 2-fold in cases of engine failure (one of the most important safety increases possible), as the engine point of failure leads directly to loss of life and expansive costs to operation, mission, personnel, and litigation. It is likely that if a single engine helicopter accident were to occur, the aircraft in question would enter immediately into an autorotation and be required to land directly below the current location, whereas a twin-engine helicopter may continue powered flight to a safe landing. As an aviation accident at the catastrophic level may potentially harm the public and/or employees and contractors, as well as reach the tens of millions of dollars (if striking another aircraft, or killing multiple individuals), reducing the likelihood of such an event is paramount.[26] SDG&E strives to operate all its assets safely and in a manner that will avoid potential serious injuries or fatalities. It is estimated a twin-engine helicopter will help reduce the frequency of this type of an accident from once every 10 years to once every 20 years.[27] This represents a significant avoidance of a safety incident (lives both in the air and on the ground), and costs associated with physical damage, extensive litigation, and reputation.

Operating a twin-engine helicopter with advanced avionics will provide the Company with a reduction in the risk of engine failure and many human factors, due to an increase in automation. As human error is considered to be a causal factor in roughly 90% of all aviation accidents; reducing that occurrence in any form pays tremendous dividends. Further, if an accident were to occur that is related to single engine failure, the resulting accident would be catastrophic in a single point failure configuration. For a twin-engine aircraft, the risk is still serious, however the aircraft has an extended ability to fly and the severity, therefore, is significantly reduced.

5. Aviation Safety Training and Dispatch and Advisor Roles within ASD

Training and operational codifications provide the policy and procedure foundation upon which all operations must be based. It is estimated the training will require constant development in the early and middle phases of program development. The training program consists of an initial training manual for internal use of pilot development, continued training costs for currency and performance development, and case-by-case skills performance development. Training is the core element of the fourth pillar (Safety Promotion) of SMS and, therefore, required in an on-going programmatic methodology that goes beyond that required by other operational core competencies of SDG&E. Further, providing an Aviation advisor and leadership role continues

[26] Schuffman, P et al. Direct and indirect cost of general aviation crashes. https://www.ncbi.nlm.nih.gov/pubmed/12234034.
[27] Measuring Safety in Single- and Twin Engine Helicopters. http://flightsafety.org/fsd/fsd_aug91.pdf.

to reinforce the needed management engagement and guidance at the senior supervisor level, required by SMS in both the ICAO and FAA frameworks.

This mitigation addresses the risk of communication errors, lack of codified rules, and provides institutional foundation for operations.

6. Currency and Proficiency Training with New Helicopter

The purpose of currency and proficiency training is to socialize best procedural practices and promote institutional knowledge and safety. While it is a vital element in any aviation operation, it is even more important for pilots unfamiliar with a new aircraft. Familiarity within a system fosters good flying, but it takes time and vigilance through training to cultivate that ease of flight and expertise. The FAA went so far as to identify training problems and insufficient training as a direct contributor to many aviation accidents throughout the United States.[28] As new systems are introduced into the flight operations environment, training will need to be incorporated to educate and adapt pilots to new policies, procedures, and technological elements.

The mitigation addresses the drivers of equipment misuse, recurrent training deficiencies, and limitations operational knowledge.

7 Summary of Mitigations

Table 4 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for Aviation Incident. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

[28] Federal Aviation Administration. Fact Sheet General Aviation Safety. July 30, 2014 Accessed 10/4/2016 http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=16774.

Table 4: Baseline Risk Mitigation Plan[29]
(Direct 2015 $000)[30]

ID	Control	Risk Drivers Addressed	Capital[31]	O&M	Control Total[32]	GRC Total[33]
1	Aviation Safety Management System	• On-going Hazards • Inadequate Policies or Procedures	$20	$30	$50	$50
2	Job Site Observation Program	• Pilot Error • Crew or other support personnel error • Communication Issues	n/a	10	10	10
3	Service Provider Audit Program	• Aircraft/equipment failure (due to either maintenance or non-maintenance-related causes • Crew or other support personnel error • Inadequate Policies and Procedures • Communication Issues	n/a	10	10	10
5	"Best Practices" Training	• Communication Issues • Situational Awareness • Crew or other support personnel error	10	0	10	10

[29] Recorded costs were rounded to the nearest $10,000.
[30] The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[31] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[32] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[33] The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[31]	O&M	Control Total[32]	GRC Total[33]
		• Operational Limitations				
	TOTAL COST		$30	$50	$80	$80

The costs identified in the Table 4 were primarily gathered using data from SDG&E's accounting systems.

Table 5 summarizes SDG&E's proposed mitigation plan and associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan, and is not requesting funding approval. SDG&E will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC.

Table 5: Proposed Risk Mitigation Plan[34]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017 - 2019 Capital[35]	2019 O&M	Mitigation Total[36]	GRC Total[37]
1	Aviation Safety Management Systems	• On-going Hazards • Inadequate Policies or Procedures	n/a	$60 - 80	$60 - 80	$60 - 80
2	Job Site Observation Program	• Pilot Error • Crew or other support personnel error • Communication Issues	n/a	10 - 20	10 - 20	10 - 20
3	Service Provider Audit Program	• Aircraft/equipment failure (due to either	n/a	18 - 24	18 - 24	18 - 24

34 Ranges of costs were rounded to the nearest $10,000.
35 The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
36 The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
37 The GRC Total column shows costs typically represented in a GRC.

		maintenance or non-maintenance-related causes • Crew or other support personnel error • Inadequate Policies and Procedures • Communication Issues				
4	Purchase a Twin-Engine Helicopter	• Aircraft/equipment failure (due to either maintenance or non-maintenance-related causes • Pilot Error	7,650 - 11,050	200 - 260	7,850 - 11,310	7,850 - 11,310
5	Aviation Safety Training	• Pilot Error • Crew or other support personnel error • Communication Issues	n/a	18 - 23	18 - 23	18 - 23
6	Currency and Proficiency Training with New Helicopter	• Pilot Error • Crew or other support personnel error • Communication Issues	n/a	3 - 4	3 - 4	3 - 4
	TOTAL COST		$7,650 - 11,050	$310 - 410	$7,960 - 11,460	$7,960 - 11,460

☐	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

Generally, the costs were developed utilizing the subject matter experts' knowledge of how much similar projects and programs will cost to implement. As seen in Table 5, the SMS and the Job Site Observation Program are maintained or even slightly declining compared in the 2015 baseline levels. The Service Provider Audit Program is expanding and the remaining proposed mitigations are new. The range of costs provides flexibility as SDG&E implements these programs and finalizes the scope of these activities.

1. Aviation SMS
   The costs associated with the SMS provided in Table 5 were developed as a result of previous work and proposals for work by third-party vendors, and vetted through inter-industry discussions for appropriateness. Accordingly, the forecast methodology that was selected was base year (2015) as it was most representative of this previous work.

2. Job Site Observation Program
   A base year forecast methodology was selected for this mitigation. The costs provided in Table 5 are in line with aviation industry estimates and are needed elements of any robust safety program.

3. Service Provider Audit Program

   The costs for this activity as presented in Table 5 include expert time and travel as well as the certification itself which will provide insight, approval, and recognition, enabling flight operations for SDG&E.

4. Purchase Twin-Engine Helicopter
   The forecasted costs for the purchase of a twin-engine helicopter were zero-based. Subject matter experts researched the acquisition cost of a twin-engine helicopter using various models, makers, and condition of asset. The capital costs will be largely dependent on aircraft availability and cost of bundled systems.

5. Aviation Safety Training
   The costs for this mitigation were forecasted based on vendor proposals and industry standard rates, as well as the number of hours for labor expected for SDG&E employees to implement the training.

6. Currency and Proficiency Training with New Helicopter
   Training costs were developed through an industry survey and discussion with SMEs responsible for this type of training. The cost of not training and still acquiring the new aircraft is in line with accident data, as it is likely insufficient training would beget an aviation incident ($Millions).

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[38] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the

[38] D.16-08-018 Ordering Paragraph 8.

effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[39]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score).** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental

[39] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[40] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure 3 shows the RSE calculation.

Figure 3: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 5 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 8.1 above, in order to assess the RSE for the Aviation risk. The RAMP Approach section in this Report provides a more detailed example of the calculation used by the Company.

The risk assessment team used two groupings of the mitigations for the analysis. The first consists of a mandated SMS program, its associated training, audits, and on-site observation. This is a current control. The second is an equipment upgrade. This is an incremental mitigation. Much of this analysis was based on estimates and research conducted by SDG&E subject matter experts.

The mitigations groupings included:

(a) Effective SMS program (include training, on-site observation, and audits)

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[40] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

- Aviation SMS which is inclusive of a contractor qualification process and further development and implementation of real-time flight management control.
- Implement an aviation job site observation program.
- Develop service provider audit program to conduct and "as needed" audits.
- Conduct currency and proficiency training with helicopter.
- Conduct audits of ASD's SMS utilizing a reputable aviation audit service.
- Provide aviation safety training for dispatch and advisor roles within ASD.
- Utilize an aviation safety contractor to develop governing documents for internal and external aviation operations.

(b) More reliable equipment

- Purchase a twin-engine helicopter to the maximum extent practical.

- Analysis of Effective SMS Program (current controls)

This mitigation grouping consists of an SMS program and activities to ensure its effectiveness. These include training, audits, and routine on-site observation to ensure that the program is being followed. FAA provides guidelines on what elements constitute an SMS program and SDG&E must comply with each of these elements. SDG&E conducts audits to ensure that each of these guidelines in its SMS are being followed by employees and contractors.

The risk team estimated that if training were discontinued for three years, the effectiveness of this risk would drop by 30%. This was based on an assumption of diminishing effectiveness of previous training, using SME input and corroboration.

Regarding on-site observation, changes in pilots or contractors have historically been made based on flight observations. The program has successfully identified inadequate contractors. Out of 11 potential contractors, four are no longer permitted to work for SDG&E.

Based on these factors, the risk team's SMEs estimated that, if these mitigations were discontinued, the likelihood of an incident would increase by 33%.

- Analysis of More Reliable Equipment (incremental mitigations)

SDG&E staff conducted a cost benefit analysis of the purchase of a twin-engine helicopter using a 10-year time horizon. Due to factors such as autopilot and engine redundancy, the likelihood reduction was estimated to be 50%.

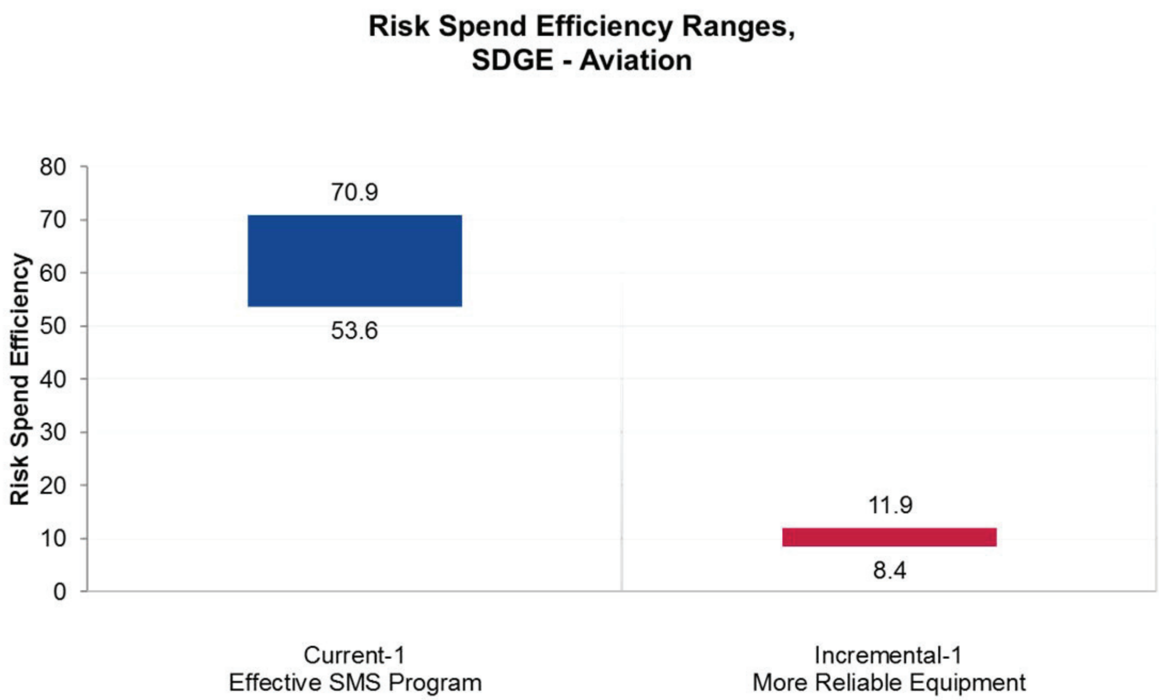
8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Effective SMS program (current controls)
2. More reliable equipment (incremental mitigations)

Figure 4 displays the range[41] of RSEs for each of the SDG&E Aviation risk mitigation groupings, arrayed in descending order.[42] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

Figure 4: Risk Spend Efficiency



9 Alternatives Analysis

An analytical comparison of the feasibility, affordability impacts, safety and environmental risks associated with the proposed mitigations and their alternatives was performed to determine the preferred solutions. Due to the serious safety concerns of aviation incidents, an effort was made not to consider

[41] Based on the low and high cost ranges provided in Table 5 of this chapter.

[42] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

the status quo as a plausible alternative. Instead, addition of new activities was selected to derive alternatives during the selection process.

9.1 Alternative 1 – Continued Use of Single Engine Helicopter

The alternative to purchasing a twin-engine aircraft is to utilize a single engine helicopter. This alternative is less expensive, currently available, requires less maintenance, and has a higher degree of maneuverability compared to the proposed plan. However, the single engine has significant flaws including multiple single points of failures, reduced payload, and legacy avionics. Accident likelihood is believed to be increased at the systems levels. As such, the twin engine helicopter is preferred because it will reduce the likelihood of a potential safety incident related to aviation.

9.2 Alternative 2 – Development of In-House Flight Program

The second alternative would be for SDG&E to develop an in-house helicopter flight program. This alternative would require significant start-up costs, additional personnel, and result in increased liability. It would also require extensive overhead cost and resource development to meet administrative, maintenance, and management requirements currently not experienced. Note also that the twin engine helicopter, mentioned above, will be managed and operated by SDG&E's exclusive use-contractor.

SDG&E does not need to bring the helicopter program in-house as the core competencies of the aircraft flight contractors allow them to perform at a high level, while SDG&E supports operations in cooperation. The costs associated with bringing the flight program in-house completely are prohibitive. It is not in the interest of SDG&E to focus on internal flight operations, and the cost is not justified.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Workplace Violence
(Chapter SDG&E-9/SCG-5)

November 30, 2016

309941

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Executive Summary

The purpose of this chapter is to present the mitigation plan of the San Diego Gas & Electric Company (SDG&E) and Southern California Gas Company (SoCalGas) (collectively, the Companies) for the risk of Workplace Violence. The Workplace Violence risk involves a violent incident related to the workplace, resulting in emotional or physical harm to an employee(s) or third parties. The Companies' 2015 baseline mitigation plan for this risk consists of four controls:

1. Physical Security Systems
2. Contract Security
3. Planning, Awareness, and Incident Management
4. Training

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the California Public Utilities Commission (Commission or CPUC) in Decision 16-08-018, as well as controls and mitigations that may address reliability. The Companies' proposed mitigation plan comprises both baseline and new mitigation activities. The Companies are proposing to continue supporting their physical security systems and contract security personnel.

Based on the foregoing assessment, the Companies proposed future mitigations. Generally, the baseline projects described above have been completed and placed into service. For Workplace Violence, the Companies proposed to continue the four control categories, identified above, but included enhancements within each category. The enhancements include:

1. Physical Security Systems and Contract Security
    - Install or upgrade access control and detection capabilities
    - Add security guards to new locations and comply with new laws enacted since the baseline evaluation that increase labor costs
2. Planning, Awareness, and Incident Management
    - Upgrade or replace the incident/case management system
    - Add social media monitoring tool
    - Add personnel in the risk management and corporate security areas

The risk spend efficiency (RSE) is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The RSEs for Workplace Violence are evaluated at the risk portfolio level, with the activities grouped into one, aggregated mitigation.

Risk: Workplace Violence

1 Purpose

The Companies consider workplace violence to be a violent incident related to the workplace, resulting in emotional or physical harm to an employee(s) or third parties. Emotional harm or distress includes, but is not limited to, mental distress, mental suffering, or mental anguish. Physical harm refers to any physical injury to the body, including an injury that caused, either temporarily or permanently, partial or total physical disability, incapacity or disfigurement.

This risk is a product of the Companies' September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Companies. The Companies take compliance and managing risks seriously, as can be seen by the numerous actions taken to mitigate each risk. This is the first time, however, that the Companies have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the Companies do not currently track expenditures in this way, so the baseline amounts are the best effort of the Companies to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the Commission and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety-related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the Companies take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the Companies have made efforts to identify those costs.
This risk assessment focuses on the drivers or factors that could potentially cause an incident and result in potential consequences. Drivers and events that are unknown to the Companies are outside the scope of this risk. Further, this chapter focuses on events that could potentially occur at the Companies' facilities. However, any actions that could result in emotional or physical harm to employees or third

[1] D.14-12-025 at p. 31.

parties related to the workplace for which the Companies are reasonably aware, regardless of the facility type, are within the scope of this risk.

2 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Applications (A.) 15-05-002/004, "SDG&E[/SoCalGas] is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[2] The Enterprise Risk Management (ERM) process and lexicon that the Companies have put in place were built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Companies are committed to increasing the use of quantification within its evaluation and prioritization of risks.[3] This includes identifying leading indicators of risk. Sections 2 – 8 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers, and potential consequences of the Workplace Violence risk.

2.1. Risk Classification

Consistent with the taxonomy presented by the Companies in A.15-05-002/004, the Companies classify this as a cross-cutting risk that affects people and is a function of employee or former employee conduct. Workplace Violence is a cross-cutting risk because an incident could occur in any department of the company. The risk classification is provided in

Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
CROSS-CUTTING	PEOPLE	EMPLOYEE CONDUCT

[2] A.15-05-002/004, filed May 1, 2015, at p. JMD-7.
[3] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.

2.2. Potential Drivers[4]

When performing the risk assessment for Workplace Violence, the Companies identified potential indicators of risk, referred to as drivers, that could potentially lead to a Workplace Violence incident. These include, but are not limited to, the following drivers as defined below:

- **Human Error** – an error that occurs due to someone not doing something correctly.
- **Process Failure** – an inadequacy in programs/procedures that are intended to help avoid the risk from occurring and control the consequence of the risk if it occurs.
- **System Failure** – an inadequacy in security systems that are intended to help avoid the risk from occurring.

In addition to the above potential drivers, the Companies have identified potential circumstances that could contribute to Workplace Violence. These include, but are not limited to: extremist ideologies, personal issues or conflict, and mental health issues.

These potential drivers and circumstances are not intended to be a comprehensive list, as the types of workplace violence incidents vary greatly. The potential drivers and circumstances noted in this plan correspond with those in studies, such as the New York City Police Department's "Active Shooter: Recommendations and Analysis for Risk Mitigation" and the Federal Bureau of Investigation's "A Study of Active Shooter Incidents in the United States Between 2000 and 2013." These studies provide analysis of active shooter incidents showing a wide range of motivations, including domestic quarrels, professional differences, and mental health issues.

2.3. Potential Consequences

If one of the drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

- Emotional abuse, injury, or fatality;
- Operational disruptions;
- Citations, adverse litigation, and related financial impacts; and/or
- Costs associated with policy/procedure changes.

These potential consequences were used in the scoring of the Workplace Violence risk that occurred during the Companies' 2015 risk registry process. See Section 3 for more detail.

2.4. Risk Bow Tie

The risk "bow tie," shown in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. The Companies applied this framework to identify and summarize the information provided above.

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[4] An indication that a risk could occur. It does not reflect actual or threatened conditions.

Figure 1: Risk Bow Tie

3 Risk Score

The Companies' ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Workplace Violence as one of the enterprise risks. During the development of the risk registry, subject matter experts (SMEs) assigned a score to this risk, based on empirical data to the extent it was available and/or using their expertise, following the process outlined in this section.

3.1. Risk Scenario – Reasonable Worst Case

There are many possible ways in which a Workplace Violence risk event can occur. For purposes of scoring this risk, SMEs used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The SMEs selected the following reasonable worst case scenario to develop a risk score for Workplace Violence:

- An active shooter at a well-populated SDG&E facility takes action, which results in injuries and fatalities.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen.

3.2. 2015 Risk Assessment

Using this scenario, SMEs then evaluated the frequency of occurrence and potential impact of the risk using the Companies' 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[5] Using the levels defined in the REF, the SMEs applied empirical data to the extent it was available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 2 provides a summary of the Workplace Violence risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 2: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	1	2	3	3	23,107

3.3. Explanation of Health, Safety, and Environmental Impact Score

Based on the risk scenario of an active shooter at a well-populated company facility, such an incident could result in a few life-threatening injuries and/or fatalities. A Federal Bureau of Investigation's report, "A Study of Active Shooter Incidents in the United States Between 2000 and 2013," states that 160 active shooter incidents occurred, with 486 deaths and 557 injured people, over the 13-year span of the study. The report also explains that the number of individuals killed or injured during an active shooter incident has increased as well.

Notably, in December 2011, Southern California Edison Company (SCE) experienced a workplace shooting at its office complex in Irwindale by an alleged SCE employee, resulting in multiple injuries and fatalities.[6] Another shooting incident in 2009, involving two current and one former SoCalGas employees, left three people dead.[7]

Accordingly, SDG&E scored Workplace Violence a 6 (Severe) in the Health, Safety, and Environmental impact area, as there could likely be several fatalities and/or life threatening injuries based on the risk

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5 D.16-08-018 Ordering Paragraph 9.
6 http://articles.latimes.com/2011/dec/17/local/la-me-shooting-follow-20111218.
7 http://www.washingtontimes.com/news/2009/mar/19/suspect-in-killing-of-socal-gas-workers-found-shot/.

scenario. A 7 (Catastrophic) did not seem appropriate, as this score would reflect a large-scale event with a high number of deaths and/or irreversible impacts to the environment.

3.4. Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, the Companies gave the following scores to the remaining impact categories:

- **Operational and Reliability**: Workplace Violence was scored a 1 (Insignificant) as it is likely that the Companies' primary operations of gas and electricity transmission and distribution would continue, and that there would be minimal disruption to service, if a Workplace Violence incident were to occur. This rating focused on the overall operational capability of the Companies and service impact to customers; it did not rate the level of impact to an individual business unit.
- **Regulatory, Legal, and Compliance**: Workplace Violence was scored a 2 (Minor) as the potential for regulatory penalties with respect to an active shooter incident is anticipated to be minimal (if any). The potential legal issues associated with this risk are most likely to be civil in nature; the potential impacts of these legal issues are addressed in the Financial impact area.
- **Financial**: Workplace Violence was scored a 3 (Moderate) as there could be potential financial impacts to the company from potential litigation (e.g., a wrongful death lawsuit) and possible associated costs for security remediation and upgrades, training programs, and potential policy/procedures changes. Although it is difficult to predict the amount of litigation a company may face after an active shooter incident, based on the risk scenario, the Companies estimated that potential costs could be between $1 million and $10 million.

3.5. Explanation of Frequency Score

The SMEs considered an active shooter incident to occur infrequently (a score of 3), which is defined as having the potential to occur every 10-30 years in the company's service territory. As a comparison, it was assumed that facilities with a history of active shooting incidents, such as schools or government facilities, may merit a score of 4 (Occasional), which is defined as occurring every 3-10 years. There have been few active shooter incidents specific to the utility industry; however, the Companies did not consider it to be appropriate to elevate the rating higher than a 3.

4 Baseline Risk Mitigation Plan[8]

As stated above, Workplace Violence risk involves a violent incident related to the workplace, resulting in emotional or physical harm to an employee(s) or third parties. The 2015 baseline mitigations discussed below include the current evolution of the Companies' management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time. The Companies' mitigation plan for this risk includes the following controls:

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[8] As of 2015, which is the base year for purposes of this Report.

- Physical Security Systems and Contract Security
- Planning, Awareness, and Incident Management
    - o Workplace Violence Mitigation Team
    - o Training
    - o Investigations
    - o Employee awareness
    - o New-hire screening processes
    - o Employee Assistance Program(s)
    - o Incident/Case Management System
    - o Risk Management Program

SMEs from Corporate Security, which is a function of the Companies' parent company Sempra Energy, and each company's Human Resources (HR) department collaborated to identify and document them. These controls focus on safety-related impacts[9] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018,[10] as well as controls and mitigations that may address reliability.[11] Accordingly, the controls and mitigations described in Sections 4 and 5 primarily address safety-related impacts. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Workplace Violence incidents, not just the scenario used for purposes of risk scoring.

The United States Department of Labor outlines the components of an effective workplace violence program,[12] including:

- Work Environment – creating a professional, healthy, and caring work environment
- Security – maintaining a secure and physically safe workplace
- Education – communicating awareness regarding workplace violence
- Performance / Conduct Indicators – identifying conduct that may present warning signs
- Employee Support Services – assisting employees in dealing with personal/professional issues

The Companies' workplace violence mitigation plans address each of these components as described below.

1. <u>Physical Security Systems and Contract Security</u>

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[9] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[10] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal of RAMP is to "make California safer by identifying the mitigations that can optimize safety."
[11] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.
[12] https://www.dol.gov/oasam/hrc/policies/dol-workplace-violence-program.htm.

The purpose of physical security is to maintain the safety of employees, contractors, and the public, as well as the Companies' facilities, through the use of systems, personnel, policies, and procedures. Two physical security mitigation activities in the current risk mitigation plan align with this purpose: physical security systems and contract security (e.g., security guards).

Security enhancements to infrastructure and security guards posted at company facilities each improve access control, intrusion detection, and interdiction capabilities, to deter, detect, delay, or help prevent undesirable events at company facilities. Depending on the facility, several physical security system upgrades have been completed, including, but not limited to, improvements with access control, intrusion detection systems, and interdiction capabilities.

In addition to security systems, the Companies employ contract security (security guards) to secure and physically protect assets and people. These security guards are located at critical facilities and work locations. Company policies and procedures outline physical security procedures, including access control, officer post orders and incident reporting.

2. Planning, Awareness, and Incident Management

The Planning, Awareness, and Incident Management mitigation includes projects and programs that largely provide services to try to manage this risk before an event can occur. These mitigations consist of the Workplace Violence Mitigation Team, training, investigations, employee awareness, new hire screening processes, employee assistance and wellness programs, and Corporate Security's risk management program. Each is discussed below.

Workplace Violence Mitigation Team (WVMT)

The Workplace Violence Mitigation Team (WVMT), formed in 2011, is a joint team of Managers, Directors, or Vice President level representatives within Corporate Security, HR, and Legal. The team is specifically trained to assess and respond to the threat posed by an individual that may be prone to violence. The WVMT is responsible for developing and executing an effective Workplace Violence Prevention program that includes, but is not limited to:

- Training supervisors and employees to detect early warning signs of possible workplace violence;
- Investigating and mitigating potential workplace violence incidents;
- Responding appropriately to threat-related emergencies;
- Identifying and enlisting the assistance of qualified professionals in workplace violence assessment, security, and incident management; and
- Documenting all activities related to workplace violence prevention and control.

The WVMT uses various threat management tools provided by outside professional resources or developed and adapted by the WVMT. These tools are intended to guide the WVMT in their data collection and decision making throughout the management of a case. The tools may be used in conjunction with appropriate degrees of professional threat management consultation.

The WVMT meets as needed when an individual displays signs that he/she may be prone to violence or engage in violent action on company property. Upon notification of an alleged threat, an initial investigation helps determine if additional action is warranted.

A recent third-party review of Sempra Energy security and investigative programs stated: "The Sempra approach to Workplace Violence Mitigation Teams is considered to be of a high caliber. We have identified this as an area where Sempra has adopted 'leading practices' in the area of workplace violence prevention."

Training

The Companies offer a variety of training opportunities to employees to increase awareness regarding the identification and response to criminal activity, including workplace violence. Examples include, but are not limited to: Active Shooter Training, Security Awareness Training, Workplace Violence Training, and Hostile Intruder Training. A few are described in more detail below.

Active Shooter Training has been provided to thousands of employees and focuses on the actions employees should take during an active shooter scenario. The training was developed by Corporate Security, and is based upon the Department of Homeland Security (DHS) training titled "Run, Hide, Fight." Through interactive discussion, this training provides basic awareness of recognizing an active shooter situation and how to respond accordingly. Topics include:

- Active Shooter Definition
- Active Shooter Incidents
- Active Shooter Characteristics and Triggers
- Run, Hide, Fight
- Last Resort Survival Measures
- Police Arrival
- Preparation

This training goes beyond a simple explanation of the issue, and provides employees with actions to take during an active shooter incident, including considerations for evacuation, appropriate hiding locations and instructions, and, when necessary, how to take action when confronted with an active shooter. The training also offers reporting procedures and proper conduct when police arrive.

Corporate Security also provides *Security Awareness Training* to employees, which focuses on identifying threats and suspicious activity, response to threats, and proper reporting protocols. *Workplace Violence training* is provided every other year by two board-certified forensic psychologists who consult to numerous federal, state, and local law enforcement agencies. This training instructs on the use of Workplace Assessment of Violence Risk (WAVR-21), a screening tool used by workplace violence mitigation teams.[13]

As discussed in the following section, Corporate Security recommends this training continue to be offered through regular instructor-led sessions or through online viewing of materials provided on the Corporate Security website.

Investigations

Corporate Security agents investigate hundreds of incident reports each year, including, but not limited to, disruptive incidents, burglary, theft, employee misconduct, and suspicious activity. Corporate Security works closely with Legal, HR, affected business units, and, when necessary, law enforcement, to thoroughly investigate allegations of workplace violence. This process assists with gathering or validating information needed for decision makers to act accordingly.

Employee Awareness

The Companies use a variety of methods to increase employee awareness, including, but not limited to: emergency and incident planning, training, education, drills, and communication. Workplace violence, safety, and security awareness training is provided on a regular basis to employees. Evacuation plans have been developed, updated, trained, and drilled. Security alerts and bulletins are provided as needed through email and posted on digital message boards, or on the company website. In addition, an emergency notification system, often referred to as a reverse 911 system, is in place to rapidly distribute emergency information to employees. This system will call, text, and email employees so that emergency messages are distributed efficiently and effectively. These efforts can provide employees with a heightened security awareness and effective communication platforms to assist with mitigation of security incidents, including workplace violence.

New Hire Screening Processes

There may be several reasons for performing new hire screening for job applicants. Some job duties are conducted in potentially hazardous environments. In these circumstances, the Companies take steps to try to avoid hiring that could result in safety or security incidents. The importance of the electric and natural gas transmission and distribution systems, including their interdependency with life/safety, emergency response, and national security, also provides a basis for heightened security and identity-verification processes. The Companies perform new hire screening in accordance with federal, state, and local laws.

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[13] http://www.wavr21.com/

Employee Assistance and Wellness Programs

Some workplace violence incidents are a result of domestic, financial, health, substance abuse, or other types of issues, which may have the potential to be resolved with employee assistance programs. As described on the company website, since their inception in 1990, the Energy For Life Wellness Programs have been committed to enhancing the physical and mental well-being of all company employees through programs, resources, information, and support services that promote safe and healthy lifestyles.

These company-provided wellness programs are offered to all employees through methods such as on-site and online services, work groups, health fairs, fitness programs, and educational brochures. In addition, the Employee Assistance Program (EAP) is a confidential counseling and referral service to help employees' family members deal with life's daily challenges. These services may assist employees with personal and/or work-related problems that may impact their job performance, health, mental, and emotional well-being. As stated above, the Department of Labor outlines the importance of early intervention in the prevention of workplace violence, including employee assistance and wellness programs.

Employees have access to the 24/7 support services if they feel threatened by another employee. Every matter reported will be investigated by the company and, if requested, a response given to the individual reporting the issue. If necessary, the matter may be referred to staff or outside counsel for professional evaluation and recommendations on how to respond. This mitigation is recognized by the Department of Labor as a critical component in the prevention of workplace violence and should continue to be provided and updated as necessary.

Incident/Case Management System

Corporate Security maintains an incident/case management system to track incidents and investigations, such as, burglary, theft, vandalism, and workplace violence. The system provides data necessary for analysis of security programs, and assists with strategic planning to improve security and safety of company facilities, employees, and the public.

Risk Management Program

Corporate Security has established an intelligence program to collect, analyze, and disseminate intelligence that may assist with decision making regarding energy operations and security procedures. An intelligence program helps anticipate, identify, and assess threats that could harm the company, its employees, guests, or assets, and provides actionable strategic and tactical intelligence to mitigate risk. The program develops and maintains regular contact with local, national, and international law enforcement and intelligence community partners on a regular basis. The program also creates a risk management process to prioritize and mitigate threats, vulnerabilities, and consequences. Threat assessments and security plans specific to company infrastructure support regulatory requirements.

5 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 4 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. In addition, the Companies are proposing during the 2017-2019 timeframe to expand or add the mitigations addressed below.

1. Physical Security Systems and Contract Security

The Companies are proposing to continue supporting their physical security systems and contract security personnel. The purpose of these activities is to reduce the likelihood of a Workplace Violence event by increasing protective measures at company facilities that have employees.

Generally, the baseline projects described above have been completed and placed into service. The Companies are proposing to complete similar security projects to increase protection, such as installing or updating access control and detection capabilities at facilities that have employees. Similarly, the presence of security guards increases protection with the aim of reducing the likelihood of an intentional event.

There are two expanded activities, as compared to the baseline, with respect to security guards. First, the Companies propose to add security guards to new locations. Second, SDG&E must comply with Senate Bill (SB) 3, which will become effective January 1, 2017. The resulting effects are increases in costs above the GRC standard escalation. In other words, the cost associated with doing business (i.e., employing security guards) has increased. This is sometimes referred to as non-standard escalation.

2. Planning, Awareness, and Incident Management

This mitigation consists of expanded and new activities: upgrade or replacement of the incident/case management system; addition of social media monitoring tool; and additional personnel in the risk management and corporate security areas.

Incident/Case Management System

The current incident/case management system manages security incidents by capturing information from investigations and providing historical querying capability. This system is approximately ten years old. With the increase of requests for information and data calls from state and federal regulatory entities, it is recommended that this system be upgraded or replaced. The current system does not allow for querying of data at the appropriate level of detail. Simple changes that may provide some additional functionality to assist with querying will be expensive and may only provide some of the necessary upgrades. It is possible alternate systems already used by Sempra may provide suitable incident/case management services to meet this increased need. Costs of upgrading the existing system are currently being compared to other options.

Social Media Monitoring

Many utilities, other private sector companies, and public agencies are using social media monitoring for emergency notifications, incident updates, threat identification, customer communications, and to identify the misuse of branding. In a security setting, these tools can provide real-time updates to incidents, which may affect the safety or security of employees. These tools also can provide insight into emerging or imminent threats to company employees or infrastructure.

Risk Management

Based on new federal and state laws, the Companies are required to provide additional workplace violence risk management. The Companies are required to identify and prioritize threats, vulnerabilities, and consequences due to federal and state mandates and requests for information. In addition, this information will assist with security planning and mitigation development. Currently, Corporate Security has one risk/intelligence analyst. Given the increase in workload due to increased regulations, another resource is needed.

Corporate Security Agent

Over the last couple of years, the demand for Corporate Security services has increased as well as regulatory requirements, including the RAMP process, are requiring more detailed security planning and reporting. Currently, SDG&E's Corporate Security has two agents covering the security for the entire service area, 4,300 employees, 3.6 million customers, and all facilities. SoCalGas' Corporate Security has four agents covering the security for the entire service area, 8,400 employees, 21 million customers, and approximately 130 facilities.

6 Summary of Mitigations

Tables 3a and 3b summarize the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for Workplace Violence. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

The Companies do not account for and track costs by activity, but rather by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

While all the controls shown on Table 3a and 4b mitigate Workplace Violence, some of the controls also mitigate other risks presented in this RAMP Report. Specifically, for SDG&E, Physical Security Systems and Contract Security, managed by Corporate Security, also help mitigate the RAMP risk of Public Safety Events - Electric. Accordingly, because the benefits associated with these activities can be attributed to both this risk and Public Safety Events - Electric, the costs are presented in both chapters.

For SoCalGas, Physical Security Systems, Contract Security, Investigations, the Incident Management System, the Risk Management Program, and Security Agent managed by Corporate Security also help mitigate the RAMP risk of Physical Security of Critical Infrastructure. Accordingly, because there are benefits associated with these activities attributed to both this risk and Physical Security of Critical Infrastructure, the costs are also presented in both chapters.

Table 3a: SDG&E Baseline Risk Mitigation Plan[14]
(Direct 2015 $000)[15]

ID	Control	Risk Drivers Addressed	Capital[16]	O&M	Control Total[17]	GRC Total[18]
1	Physical Security Systems Contract Security	• Human Error • Process Failure • System Failure	$3,450 840	$400 3,930	$3,850 4,770	$3,850 4,770
2	Planning, Awareness, and Incident Management	• Human Error • Process Failure • System Failure	250	290	540	540
	TOTAL COST		$4,540	$4,620	$9,160	$9,160

* Includes one or more mandated activities

[14] Recorded costs were rounded to the nearest $10,000.
[15] The figures provided in Tables 3a, 3b, 4a and 4b are direct charges and do not include company loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[16] Pursuant to D.14-12-025 and D.16-08-018, the Companies provided the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[17] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[18] The GRC Total column shows costs typically presented in a GRC.

Table 3b: SoCalGas Baseline Risk Mitigation Plan[19]
(Direct 2015 $000)

ID	Control	Risk Drivers Addressed	Capital[20]	O&M	Control Total[21]	GRC Total[22]
1	Physical Security	• Human Error • Process Failure • System Failure				
	Systems		$90	$210	$300	$300
	Contract Security		40	1,670	1,710	1,710
2	Planning, Awareness, and Incident Management	• Human Error • Process Failure • System Failure	10	420	430	430
	TOTAL COST		$140	$2,300	$2,440	$2,440

* Includes one or more mandated activities

Tables 4a and 4b summarize the Companies' proposed mitigation plan (which comprises both baseline and new mitigation activities) and associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that the Companies are identifying potential ranges of costs in this plan, and are not requesting funding approval. The Companies will request approval of funding in their next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Tables 4a and 4b, the Companies are using a 2019 forecast provided in ranges based on 2015 dollars.

[19] Recorded costs were rounded to the nearest $10,000.
[20] Pursuant to D.14-12-025 and D.16-08-018, the Companies provided the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[21] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[22] The GRC Total column shows costs typically presented in a GRC.

Table 4a: SDG&E Proposed Risk Mitigation Plan[23]

(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[24]	2019 O&M	Mitigation Total[25]	GRC Total[26]
1	Physical Security	• Human Error • Process Failure • System Failure				
	Systems		$12,040 - 14,720	$370 - 400	$12,410 - 15,120	$12,410 - 15,120
	Contract Security		2,660 - 2,950	6,400 - 7,170	9,060 - 10,120	9,060 - 10,120
2	Planning, Awareness, and Incident Management	• Human Error • Process Failure • System Failure	530 - 580	530 - 720	1,060 - 1,300	1,060 - 1,300
	TOTAL COST		$15,230 - 18,250	$7,300 - 8,290	$22,530 - 26,540	$22,530 - 26,540

(white box)	Status quo is maintained
(shaded box)	Expanded or new activity
*	Includes one or more mandated activities

[23] Ranges of costs were rounded to the nearest $10,000.
[24] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018, and 2019 are the forecast years for the Companies' Test Year 2019 GRC Applications.
[25] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[26] The GRC Total column shows costs typically represented in a GRC.

Table 4b: SoCalGas Proposed Risk Mitigation Plan[27]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[28]	2019 O&M	Mitigation Total[29]	GRC Total[30]
1	Physical Security	• Human Error • Process Failure • System Failure				
	Systems		$1,660 - 2,420	$150 - 230	$1,810 - 2,650	$1,810 - 2,650
	Contract Security		410 - 460	3,450 - 3,700	3,860 - 4,160	3,860 - 4,160
2	Planning, Awareness, and Incident Management	• Human Error • Process Failure • System Failure	30 - 33	670 - 890	700 - 920	700 - 920
	TOTAL COST		$2,100 - 2,910	$4,270 - 4,820	$6,370 - 7,730	$6,370 - 7,730

☐ (white)	Status quo is maintained
☐ (shaded)	Expanded or new activity
*	Includes one or more mandated activities

1. <u>Physical Security and Contract Security</u>
The capital cost estimates for physical security systems were zero-based, derived from projections used to seek internal approval. The O&M costs were estimated as a percentage of the capital costs using subject matter expertise and experience with historical projects.

The physical security systems are largely capital projects. While the projects will change (e.g., expansion to additional locations), the projected annual spend is anticipated to be in line with historical spending. This estimate is only for physical security systems of manned locations that

[27] Ranges of costs were rounded to the nearest $10,000.
[28] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018, and 2019 are the forecast years for the Companies' Test Year 2019 GRC Applications.
[29] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[30] The GRC Total column shows costs typically represented in a GRC.

may have a risk of Workplace Violence. Unmanned locations, such as substations, were not included in this calculation.

The costs for security guards are based on a five-year average labor cost, plus the cost of complying with SB 3, plus the cost of additional guarded locations. The five-year average was used as there was no discernable trend from 2011-2015.

2. Planning, Awareness and Incident Management Mitigation
   The cost estimates for many of the activities (e.g., training, awareness, screening, employee assistance) in this group were based on applicable, historical costs. For some activities that were anticipated to increase, the Companies used the 2015 base year amounts and added the costs related to incremental activities. The range provides flexibility as the Companies finalize the scope of the mitigation activities.

   For the proposed incident/case management system mitigation, costs of upgrading the existing system are currently being compared to other options available on the market. The range for this activity in the proposed plan took into account the variability of pricing when upgrading this system.

   Corporate Security has received several presentations, demonstrations, and trial periods of social media monitoring tools ranging from $25,000 to $100,000. Some of the more beneficial tools may cost around $65,000 per year. Accordingly, the range for this activity reflects the price variations of such tools.

   Additional personnel are included in the proposed plan: one for Corporate Security's risk management function and one Corporate Security agent. A range was provided based on an average salary as the actual costs will depend upon the individuals' experience.

7 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[31] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[32]

[31] D.16-08-018 Ordering Paragraph 8.
[32] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 6). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

7.1. General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

7.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 2 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what

the potential risk score would be) if that control was removed.[33] For incremental mitigations, the analysis assesses the anti–cipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

7.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 6. They multiplied the risk reduction developed in subsection 0 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another.

Figure shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Tables 4a and 4b of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

7.2. Risk Spend Efficiency Applied to This Risk

SDG&E and SoCalGas analysts used the general approach discussed in Section 7.1, above, in order to assess the RSE for the Workplace Violence risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

This analysis used a metric (or proxy) – the national victimization rate for all crimes – to assess risk reduction. The Federal Bureau of Justice Statistics (BJS), within the Department of Justice, compiles victimization information through annual, comprehensive surveys. There are crimes with human victims and victimless crimes. The Federal surveys are meant to capture information on the former type. Survey information represents national statistics and does not contain data that can be used to separate workplace events from other events.

The Utilities compile crime information of both types as well. The categories of crime information collected by the Federal government and the Company are:

- Federal: robbery, rape/sexual assault, simple assault, and aggravated assault.
- Corporate: robbery, indecent exposure, workplace violence, and assault.

[33] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

There is not an exact match between the crime information collected by both entities, but the data collected is similar enough to make reasonable comparisons.

An assumption of this analysis is that a victimization rate comparison reflects how safe or how unsafe a workplace environment is, and that this difference in crime exposure can be used as a proxy to evaluate the risk scenario. This proxy seems reasonable because it enables the comparison of the Utilities' workplace experience over time to the national experience; representing "at work" and "not at work" possibilities. It should be noted the Utilities' victimization rates include all threatening communication, not physical assaults only, as the BJS uses. Where applicable, the more conservative estimate was used for calculation.

The risk reduction for current controls (analyzed as one group) was calculated by determining the percent decrease from the highest victimization rate between 2010-2014 (either internal Company data or BJS data) to the 2014 internal Company victimization rate. The risk reductions from incremental mitigations (analyzed as one group) were determined by estimating the percent decrease of the residual risk (2014 internal Company rate) resulting from these proposed activities. Subject matter experts estimated this decrease to be 10%. For comparison purposes, victimization rates were calculated "per thousand people," with BJS rates representing the U.S. population and internal Company rates representing the number of respective Company employees.

SDG&E's highest victimization rate over this period occurred in 2010 and was 31.2 victimizations per thousand people (employees) per year. The national average over this period is 18.6 victimizations per thousand people per year. The higher of these two figures is used for improvement calculations and results in a baseline victimization rate decrease of 22.4 or 72%. The incremental mitigations are estimated to provide a 10% decrease of the residual risk (SDG&E 2014 victimization rate).

SoCalGas' highest victimization rate over this period occurred in 2012 and was 53.8 victimizations per thousand people (employees) per year. The national average over this period is 18.6 victimizations per thousand people per year. The higher of these two figures is used for improvement calculations and results in a baseline victimization rate decrease of 12.1 or 23%. The incremental mitigations are estimated to provide 10% decrease of the residual risk (SoCalGas 2014 victimization rate).

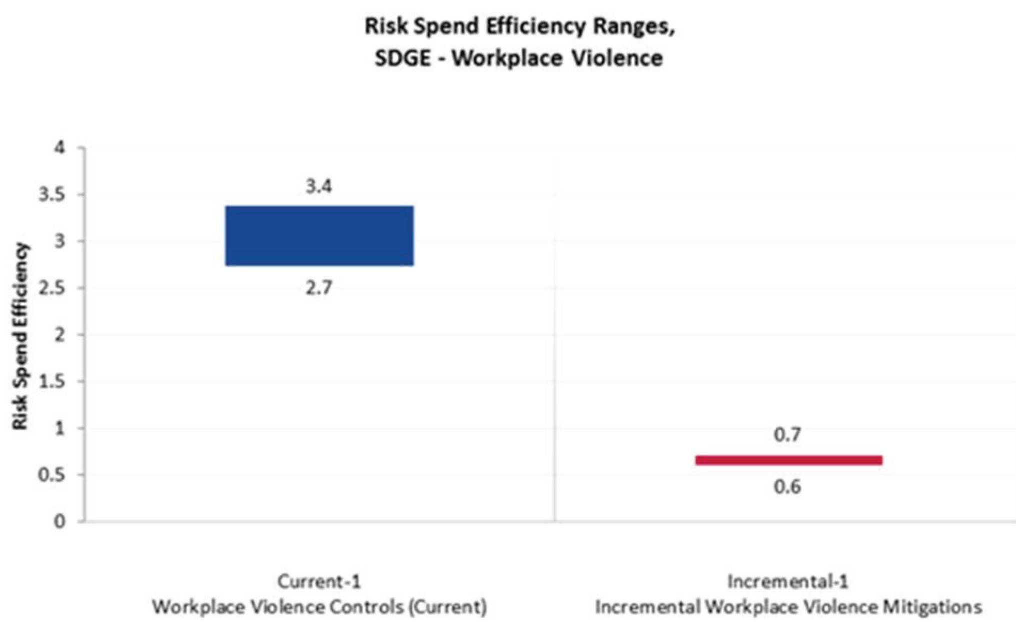
7.3. Risk Spend Efficiency Results

Based on the foregoing analysis, the utilities calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Workplace Violence Controls
2. Incremental Workplace Violence Mitigations

Figures 3 and 4 display the range[34] of RSEs for each of the utilities' Workplace Violence risk mitigation groupings, arrayed in descending order.[35] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

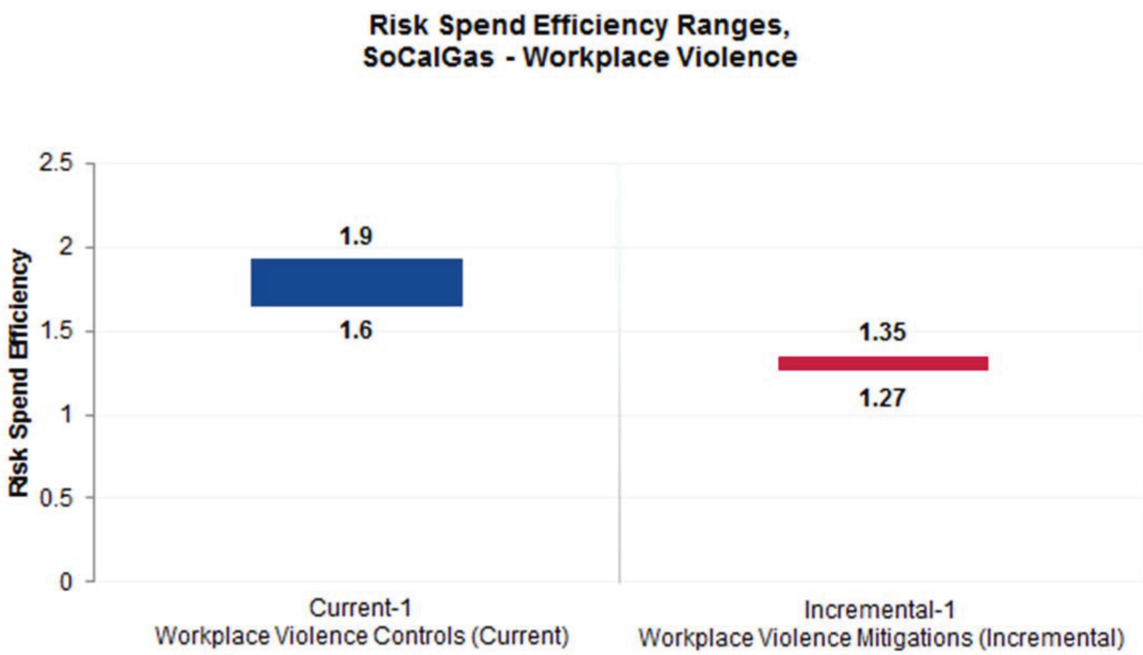
Figure 3: SDG&E Risk Spend Efficiency



[34] Based on the low and high cost ranges provided in Tables 4a and 4b of this chapter.

[35] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 4: SoCalGas Risk Spend Efficiency



8 Alternatives Analysis

The Companies considered alternatives to the proposed mitigations as it developed the incremental mitigation plan for the Workplace Violence risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources. The following represents alternatives for training and for physical security. The viability of each alternative was determined through discussions with stakeholders.

8.1. Alternative 1 – Training Changes

A potential alternative for training is to outsource training or develop computer-based training. Although this alternative may have an increased cost in the short term (i.e., to hire the outside agency or develop the training), it would generally reduce costs in the future. Current training uses Corporate Security agents as instructors. Ideally, it is best to use Corporate Security agents as they provide greater insight into company employees, history, locations, and operations. Accordingly, this alternative was dismissed. However, as demand increases for security-related training, it may be necessary to further explore alternatives.

8.2. Alternative 2 – Physical Security Tradeoffs

Physical security systems (cameras, fences, etc.) and guards may be used as alternatives to each other in some locations for some threats. This would mean that some company locations would only have security guards while others would only have security systems. The potential benefit to this alternative is a reduction of costs; however, it would also increase the risk exposure. Accordingly, this alternative was dismissed in favor of the proposed plan. Implementing physical security systems and guards together often provides increased risk reduction and provides a back-up to one another.

Risk Assessment and Mitigation Phase
Risk Mitigation Plan

Catastrophic Impact Involving High-Pressure Gas Pipeline Failure
(Chapter SDG&E-10)

November 30, 2016

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Executive Summary

The Catastrophic Damage Involving a High-Pressure Gas Pipeline Failure (High-Pressure Pipeline Failure) risk relates to the potential public safety and property impacts that may result from the failure of high-pressure pipelines.

To assess this risk, SDG&E first identified a reasonable worst case scenario, and scored the scenario against four residual impact and residual frequency categories. Then, SDG&E considered the 2015 baseline mitigations in place for High-Pressure Pipeline Failure. The 2015 controls are primarily based on Code of Federal Regulation (CFR) Part 192; General Order (GO) 112 state requirements; and Public Utility Code Sections 957 and 958, and include the following: (1) Maintenance (e.g., Patrolling, Leak Survey, etc.); (2) Qualifications of Pipeline Personnel (Training); (3) Requirements for Corrosion Control; (4) Operations (e.g., Odorization, etc.); (5) Pipeline Integrity (e.g., Threat Evaluation, etc.); and, (6) PSEP (e.g., Pressure testing and pipeline replacement, and valve automation and replacement).

These controls focus on safety-related impacts (e.g., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability.

For the High-Pressure Pipeline Failure risk, SDG&E will continue its 2015 baseline controls. In addition, based on the foregoing assessment, SDG&E proposes to expand its mitigations for the following categories:

1. Maintenance: SDG&E proposes to expand class location activities to be able to identify areas of growth and strategically pressure test, replace, or derate pipeline segments.
2. Operations: SDG&E proposes, for example, to expand efforts to survey and maintain Company's Right of Way (ROW) to increase span painting, pipeline maintenance, storm damage repair, removal of previously abandoned pipelines, vegetation removal, and ROW maintenance.

Next, SDG&E developed the risk spend efficiency (sometimes referred to as RSE). The risk spend efficiency is a new tool that SD&GE developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The RSE was determined using the proposed mitigations and resulted in prioritizing mitigation activities.

Finally, SDG&E considered two alternatives to the proposed mitigations for the High-Pressure Pipeline Failure risk, and summarizes the reasons that the two alternatives were not selected as a proposed mitigation.

Risk: Catastrophic Damage Involving a High-Pressure Pipeline Incident

1 Purpose

The purpose of this chapter is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of catastrophic damage involving a high pressure asset (pipelines and related components). An asset is considered high pressure when it is operating at a pressure greater than 60 psig. These high pressure assets are operated by Transmission, and Distribution. The internal organizations responsible for scoring and managing this risk are Gas Engineering, Gas Operations and System Integrity.

The medium pressure assets operating at a pressure of 60 psig and less are included in the Risk Assessment Mitigation Phase (RAMP) chapter of Catastrophic Damage Involving Medium-Pressure Pipeline Failure. Similarly, events caused by third party damage are included in the RAMP chapter of Catastrophic Damage Involving Gas Infrastructure (Dig-Ins).

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the Companies) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the Companies have presented a RAMP Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the Companies do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the Companies take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

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[1] Commission Decision (D.) 14-12-025 at p. 31.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the Companies have made efforts to identify those costs.

2 Background

The SDG&E transmission and distribution system spans from the California-Mexico border to the Pacific Ocean and to the SoCalGas territory border. In total, SDG&E operates 584 miles of high-pressure pipelines in its service territory, which includes the 226 miles of transmission defined pipelines. The number of miles operated by operating unit is listed in Table 1:

Table 1: SDG&E Assets

Operating Unit	Total High-Pressure Miles	Number of High Consequence Area Miles
Transmission	226	104
Distribution	358	236
Total	584	340

The U.S. Department of Transportation Pipeline and Hazardous Materials and Safety Administration (PHMSA) and ASME B31.8S, "Managing System Integrity of Gas Pipelines" categorizes nine types of threats that could lead to a high-pressure pipeline incident. They include:

1) External Corrosion
2) Internal Corrosion
3) Stress Corrosion Cracking
4) Manufacturing Defect
5) Construction & Fabrication
6) Outside Forces
7) Incorrect Operation
8) Equipment Threat
9) Third Party Damage[2]

These factors, also known as potential risk drivers, can work independently, interactively together, or in combination with fatigue.

[2] This threat has been removed from this risk plan and is being addressed under a standalone risk and mitigation plan. In the RAMP, this risk chapter is Catastrophic Damage Involving Gas Infrastructure (Dig-Ins).

When a gas pipeline has a loss of product, PHMSA categorizes it as a non-hazardous release of gas or a leak. Specifically, when the loss of gas cannot be resolved by lubing, tightening or adjusting, it is defined as a "leak." A leak may cause little-to-no risk from a safety standpoint, but it may have other impacts to the environment depending on the magnitude of the release. Risk to the public and employees can occur when leaks are in close proximity to an ignition source and/or where there is a potential for gas to migrate into a confined space. Safety of the leak is addressed by the Company's leak indication prioritization and repair schedule procedures. In most cases, a pipe with a leak will continue to function as intended in the transport of gas, and therefore is not considered a failure using the definition defined by ASME B31.8S.

However, in some instances a pipeline may be weakened to the extent that the pipe can overload and will "break open" or burst apart. This is referred to as a pipeline rupture and considered a failure of the pipeline as it can no longer function as intended. This type of failure could be catastrophic in nature, releasing a high level of energy, and sometimes igniting, resulting in damage to the surrounding area, injury and potentially loss of life.

The leak verses rupture failure mode is generally dependent on the stress to the pipe, the pipe material properties and the geometry of the latent weak point on a pipeline. As a general rule, the rupture failure mode does not occur on a pipeline operating under 30% of Specified Minimum Yield Strength (SMYS), unless there is an egregious pipe anomaly acting as an initiation growth point and there is interacting threats involved.

Due to the catastrophic nature of a potential rupture failure mode, this risk category discusses the potential consequences of a rupture event occurring on the Company's high-pressure gas system.

The extent of damage of an incident can be modeled through the use of a potential impact radius (PIR) around a pipe. PHMSA has incorporated the PIR into its methods for determining a high consequence area (HCA) along the pipeline right-of-way.

The presence of HCA miles in a transmission system provides an indication of the potential consequences of an incident to the public. Applying mitigative measures as outlined in 192.935 such as increased inspections and assessments, additional maintenance, participation in a one-call system, community education and consideration of the installation of additional remote controlled valves can help reduce the likelihood or consequence of a rupture event in both high consequence and lesser populated areas.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in A.15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[3] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks.[4] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, potential drivers and potential consequences of the High-Pressure Pipeline Incident risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in the S-MAP, SDG&E classifies this as a gas, operational risk. The risk classification is provided in Table 2.

Table 2: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	GAS	HIGH PRESSURE (>60 psig)

3.2 Potential Drivers[5]

When performing the risk assessment for High-Pressure Pipeline Failure, SDG&E identified potential indicators of risk, referred to as potential drivers. These include, but are not limited to:

- **Corrosion (external corrosion, internal corrosion, and stress corrosion cracking)**

  This category includes internal, external and stress corrosion cracking. Corrosion is a degradation of a material due to a reaction to its environment.

- **Manufacturing Threat**

  This category includes the potential for a latent manufacturing anomaly in the body or the seam of a pipe that could affect the integrity of a pipe. These types of latent anomalies can often be deemed "stable" unless changes in pressure cycling or other interactive mechanisms cause anomaly growth to an injurious condition. According to PHMSA's "Significant Incident 20 year Trend," approximately 4.4% of all incidents are a result of material, weld, or equipment failure.[6] It is evident that material failures are one the most common.

[3] A.15-05-004, filed May 1, 2015, at p. JMD-7.
[4] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[5] An indication that a risk could occur. It does not reflect actual or threatened conditions.
[6] http://phmsa.dot.gov/pipeline/library/data-stats/pipelineincidenttrends.

- **Construction/Fabrication**

  This category includes the potential for construction errors to occur on installation as well the potential risk from legacy construction practices such as the installation of miters, wrinkle bends and oxy-acetylene welds.

- **Outside Forces**

  This category includes both natural forces and those from external sources. Examples of natural forces include: ground movement from earthquakes, floods, landslides, subsidence, and lightning. Some of these outside forces are addressed in the RAMP chapter of Climate Change Adaptation. Other external outside forces include vandalism, sabotage, vehicular damage, fire and other damages caused by external sources (excluding excavating equipment).

  According to PHSMA, Outside Force damage and Incorrect Operation are tied for the third highest cause count. Within the Outside Force damage cause, vehicular damage is responsible for 75% of the incidents.[7]

- **Incorrect Operation**

  This category includes a variety of operational and procedural processes that could lead to human error or incorrect operation of a pipeline. Areas where incorrect operations can occur include, but are not limited to: inadequate inspection or monitoring, inadequate records, inadequate maintenance and construction practices.

- **Equipment**

  This category includes equipment related. This includes: o-ring /gasket failure, seal, packing failure, and malfunction of control equipment).

In accordance with the taxonomy of SDG&E, the potential drivers above can be classified as an asset failure, employee incident, contractor incident, public incident, or force of nature. Table 3 listed below maps the potential drivers to categories used in the risk taxonomy.

Table 3: Potential Operational Risk Drivers

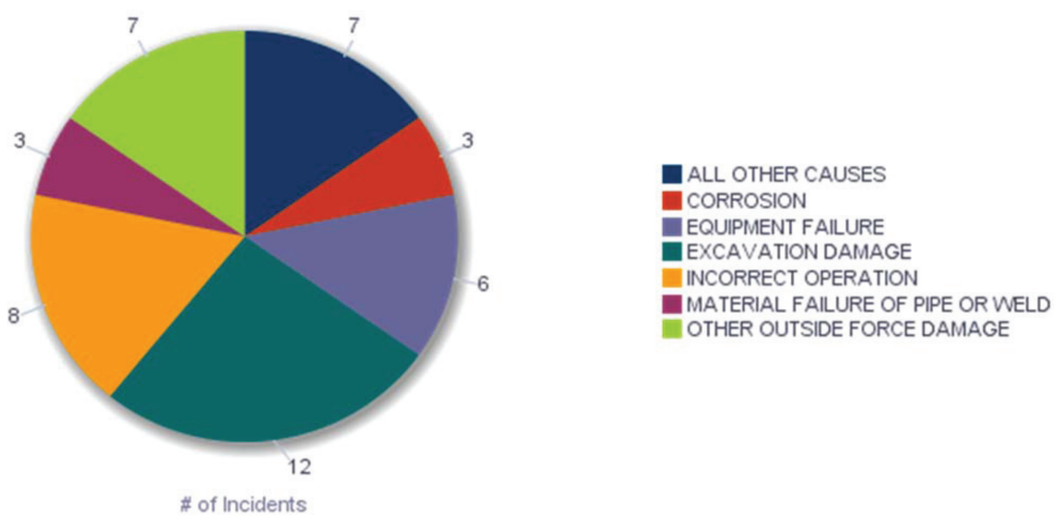
Potential Driver Category	Potential High-Pressure Pipeline Failure Driver(s)
Asset Failure	• Corrosion • Manufacturing Threat • Construction/Fabrication • Equipment

[7] https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?Portalpages&NQUser=PDM_WEB_USER&NQPassword=Public_Web_User1&PortalPath=%2Fshared%2FPDM%20Public%20Website%2F_portal%2FGT%20Performance%20Measures.

Potential Driver Category	Potential High-Pressure Pipeline Failure Driver(s)
Asset-Related Information Technology Failure	Not applicable
Employee Incident	• Construction/Fabrication • Outside Forces • Incorrect Operation
Contractor Incident	• Construction/Fabrication • Outside Forces • Incorrect Operation
Public Incident	• Outside Forces
Force of Nature	• Outside Forces

Figure 1 below, provided by PHSMA, demonstrates the leading causes of incidents related to high-pressure pipelines. This depicts the seriousness of this risk through the potential drivers and number of incidents, safety-related events.

Figure 1: Gas Transmission Serious Incident Cause 2005-2015[8]



[8] Figure from online metrics published by PHMSA on https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?Portalpages as 10/4/2016. Serious incidents include a fatality or injury requiring overnight, in-patient hospitalization.

3.3 Potential Consequences

If one of the potential drivers listed above were to occur resulting in a High-Pressure Pipeline Failure incident, the potential consequences may include:

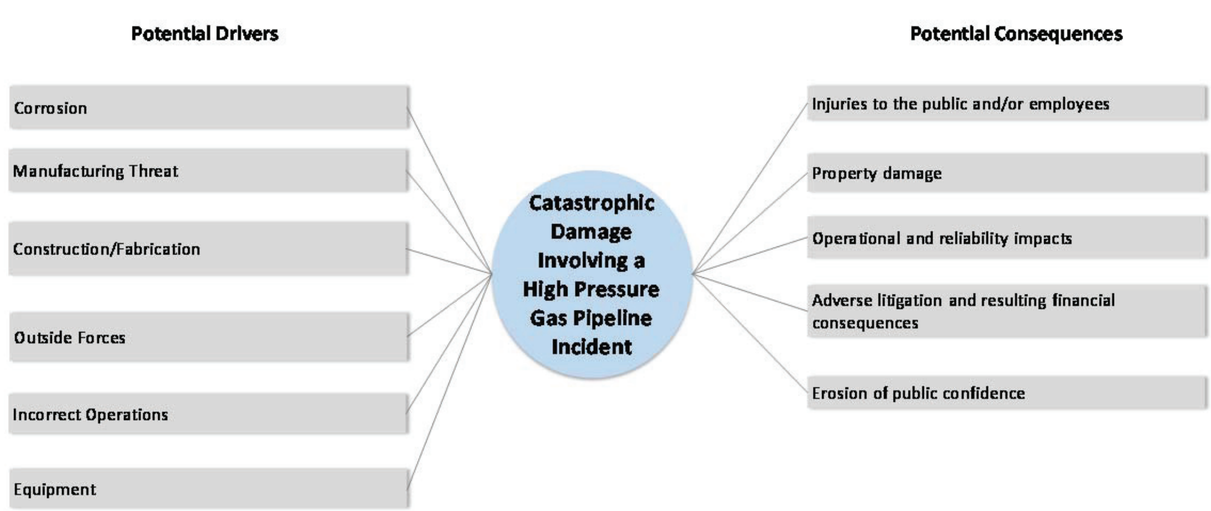
- Injuries to employees and/or the public.
- Property damage.
- Operational and reliability impacts.
- Adverse litigation and resulting financial consequences.
- Increased regulatory scrutiny.
- Erosion of public confidence.

These potential consequences were used in the scoring of the High-Pressure Pipeline Failure risk that occurred during the development of SDG&E's 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown below, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates the potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. The risk bow tie was developed for the High-Pressure Pipeline Failure risk to summarize all the information provided above.

Figure 2: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of High-Pressure Pipeline Failure as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a high-pressure pipeline failure can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for High-Pressure Pipeline Failure:

- A natural gas high pressure pipeline incident in a populated residential area resulting in fatalities, injuries, and property damage. The incident resulted in reliability concerns in the surrounding gas network threatening curtailments and loss of core customers.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP. Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the High-Pressure Gas Failure risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 4: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	5	5	6	3	36,950

4.3 Explanation of Health, Safety, and Environmental Impact Score

A score of 6 (severe) was given in 2015 in the impact area of Healthy, Safety, and Environmental. The basis for the score is that a fatality or serious injuries to employees and/or the public is a potential consequence for this risk due to the possibility of a failure of high-pressure pipelines located in populated areas. Furthermore, there is potential for a few fatalities to occur from a single incident.

4.4 Explanation of Other Impact Scores

The High-Pressure Pipeline Failure risk also impacts other consequence categories including: operational and reliability; regulatory, legal, and compliance; and financial.

- Operational and Reliability: A score of 5 (extensive) was given in the Operational and Reliability impact category. A risk score of 5 is defined in the 7X7 matrix as greater than 50,000 customers affected, impacts a single critical location or customers, or disruption of service for greater than 10 days. Based on the risk scenario, it is probable that there would be significant customer disruption which can include a whole street, several homes, or a whole city losing gas service depending if the damages involved high pressure gas lines.
- Regulatory, Legal and Compliance: A score of 5 (extensive) was given in this impact category. Similar risk events over the past 20 years have resulted in new regulations and compliance requirements such as the California Public Utility Code 958, the Notice of Proposed Rulemaking (NPRM), and modifications to General Order 112. Additionally, litigation could result from the risk scenario.
- Financially: The Company could suffer various financial repercussions as a result of the other risk areas. Potential litigation and other financial consequences from the Commission and PHMSA are prime examples of the costs associated with the high-pressure pipeline system failing. Though the exact cost can vary depending on the type of incident, if a failure were to occur, these could have the potential financial impact loss of $1 billion to $3 billion. The risk score of a 6 (severe) is assigned due to the fact that all incidents are collateral damages of the first risk area, health, safety, and environment assigning it a secondary type of risk.

4.5 Explanation of Frequency Score

A score 3 (infrequent), indicating the frequency of this event being once every 10-30 years, was chosen taking into account industry-wide data combined with the current state of the Company's system and operations. The lack of an incident at the Company must be tempered by the fact that, according to PHMSA, the number of fatalities that have occurred due to high-pressure failures in California are 10 persons.[9] Therefore, the risk score is a reasonable estimate of how frequently these types of events happen.

5 Baseline Risk Mitigation Plan[10]

As stated above, High-Pressure Pipeline Failure entails a pipeline failure event resulting in fatality/injuries to the public or damage to property and/or environmental damage. The 2015 baseline mitigations discussed below include the current evolution of the utilities' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time.

These controls focus on safety-related impacts[11] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[12] as well as controls and mitigations that may address reliability.[13] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various events related to High-Pressure Pipeline Failure, not just the scenario used for purposes of risk scoring.

The 2015 controls are primarily based on the Code of Federal Regulation (CFR) Part 192, General Order (GO) 112-E state requirements and Public Utility Code (PUC) §957 and §958. The CFR Part 192 prescribes minimum safety requirements for pipeline facilities and the transportation of gas and GO 112-E complements and enhances the requirements set forth on a federal level on a state level. In addition, PUC §957 and §958 required gas corporation to prepare and submit to the Commission a proposed comprehensive valve location plan and pressure testing plan for transmission pipelines that lack sufficient record of pressure test. The Company meets this requirement through the filing of the Pipeline Safety Enhancement Plan (PSEP) in 2011. SD&GE engages in compliance activities in order to mitigate this risk and to comply with applicable laws.

The primary areas highlighted in the risk registry are:

1. Maintenance: Patrolling, Leak Survey, Pressure Limiting and Regulator Station Inspections and Maintenance, Valve Maintenance
2. Qualifications of Pipeline Personnel (Training)
3. Requirements for Corrosion Control: Corrosion Control, Monitoring and Remedial Measures
4. Operations: Locate and Mark, Odorization, Emergency Preparedness, Continual Surveillance
5. Pipeline Integrity: Threat Evaluation, Risk Analysis, Pipeline Assessments and P&M

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9 https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?Portalpages.
10 As of 2015, which is the base year for purposes of this Report.
11 The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
12 D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
13 Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

6. PSEP: Pressure Testing and Pipeline Replacement, and Valve Automation and Replacement

Each mitigation is further discussed below.

1. Maintenance

   The minimum safety requirements prescribed by CFR 192 Subpart M – Maintenance include performing pipeline patrol, bridge and span inspections and meter set assemblies, valve and regulator inspection and maintenance on regular basis throughout the year. These activities are intended to address threats as identified by PHMSA specifically outside forces (vandalism, fault lines, liquefaction, etc.), equipment failure (pipeline facilities and components) and corrosion. These preventive measures provide an opportunity to address issues that otherwise could lead to an incident or failure. The following details the required intervals for completing the preventative measures per CFR 192 Subpart M:

   - Bridge and Span inspections are required at least once every two calendar years, but with intervals not exceeding 27 months
   - Pressure limiting station, relief device, signaling device, and pressure regulating station and its equipment must be inspected and tested at intervals not exceeding 15 months, but at least once each calendar year.
   - Valve must be checked and serviced at intervals not exceeding 15 months, but at least once each calendar year.
   - The frequency of patrols is determined by the size of the line, the operating pressures, the class location, terrain, weather, and other relevant factors and range from one to four times per calendar year.

2. Training

   The minimum safety training and qualification requirements of field personnel that perform Cathodic Protection, Construction and other activity on the pipeline are prescribed by CFR 192 Subpart N – Qualification of Pipeline Personnel. The prescribed training is intended to address Incorrect Operations as identified by PHMSA, which includes incorrect operating procedures or failure to follow a procedure that could lead to a serious incident or failure. The training and qualifications is intended to increase the safety of the personnel and public by focusing on understanding and proficiency of the concepts through testing.

3. Requirements for Corrosion Control

   The minimum safety requirements prescribed by CFR 192 Subpart I – Requirements for Corrosion Control Operations include monitoring of cathodic protection areas, remediation of CP areas that are out of tolerance and preventative installations to avoid areas out of tolerance. These activities are intended to address threats as identified by PHMSA specifically external and internal corrosion. These preventive measures provide an opportunity to address issues that otherwise could lead to a serious incident or a failure. The following details the required intervals for completing these preventative measures as prescribed in Subpart I:

- Each pipeline that is under cathodic protection must be tested at least once each calendar year, but with intervals not exceeding 15 months, to determine whether the cathodic protection meets the requirements of §192.463.
- Each cathodic protection rectifier or other impressed current power source must be inspected six times each calendar year, but with intervals not exceeding 2 ½ months, to insure that it is operating.

4. Operations

The minimum safety requirements prescribed by CFR 192 Subpart L – Operations include locate and mark, emergency preparedness and odorization. These activities are intended to address threats as identified by PHMSA. Locate and mark activities are specific to third party damage while emergency preparedness and odorization are intended to address all threats. These preventive measures provide an opportunity to address issues that otherwise could lead to a failure. The following details the required intervals for completing these preventative measures as prescribed in Subpart L:

- To assure the proper concentration of odorant in accordance with this section, each operator must conduct periodic sampling of combustible gases using an instrument capable of determining the percentage of gas in air at which the odor becomes readily detectable (# of samples).

5. Pipeline Integrity

The minimum safety requirements for assessment of transmission pipelines within high consequence areas are prescribed by CFR 192 Subpart O – Gas Transmission Pipeline Integrity Management (TIMP) and include threat identification, risk analysis, assessment, remediation, preventative, and mitigative measures. These activities are intended to address all threats as identified by PHMSA as applicable to each pipelines. This program provides an opportunity to address issues that otherwise could lead to a serious incident or failure.

- An operator must establish a reassessment interval for each covered segment in accordance with the requirements of this section. The maximum reassessment interval by an allowable reassessment method is seven years.

6. PSEP

Commission Decision (D.) 11-06-017 found that "natural gas transmission pipelines in service in California must be brought into compliance with modern standards for safety" and ordered all California natural gas transmission pipeline operators "to prepare and file a comprehensive

Implementation Plan to replace or pressure test all natural gas transmission pipelines in California that has not been tested or for which reliable records are not available."[14] The Commission required that the plans "also address retrofitting pipeline to allow for in-line inspection tools and, where appropriate, automated or remote controlled shut off valves."[15] Many of the requirements of D.11-06-017 were later codified into California Public Utilities Code Sections 957 and 958. As a benefit to these plans, material failure and outside force (earthquakes, landslides, third party impact) threats as identified by PHMSA may be addressed because of pressure testing, replacing and valve automation.

On August 26, 2011, the Company complied through the filing of their PSEP. The PSEP encompasses the following four objectives:

- Enhance public safety
- Comply with the Commission's directives
- Minimize customer impacts
- Maximize cost effectiveness

The PSEP identifies pipeline sections with a record of a pressure test to 1.25 MAOP and, through the Decision Tree process, recommends either pressure testing or replacement taking into consideration the four objectives listed above. PSEP also includes a Valve Enhancement Program to enhance system safety by installing and upgrading valve infrastructure to support the automatic and remote isolation and depressurization of the transmission pipeline system in 30 minutes or less in the event of a pipeline rupture.

In June, 2014, the Commission issued D.14-06-007 which approved SoCalGas' and SDG&E's proposed PSEP and set forth a process for reviewing and approving PSEP Phase 1 (work in more populated areas) implementation costs after-the-fact through Reasonableness Reviews. The next phase of PSEP is Phase 2A, which addresses work in less populated areas, primarily pressure testing. SDG&E does not have any Phase 2A pipeline work.

6 Proposed Risk Mitigation Plan

SDG&E will continue with its baseline, compliance activities described in Section 5 above. In addition, SDG&E is proposing to expand and add new mitigations to further address the risk of High-Pressure Pipeline Failure. The proposed activities are for mitigations that are primarily based on the CFR Part 192, GO 112-F state requirements and PUC §957 and §958. The additional mitigations not specifically prescribed in CFR 192 and GO 112-F are intended to enhance the prescribed minimum requirements in areas identified as contributing to potential risk drivers.

It should be noted that the proposed activities do not account for the NPRM issued by PHMSA on Pipeline Safety: Safety of Gas Transmission and Gathering Pipelines which may expand the integrity

[14] D.11-06-017, mimeo., at 18-19.
[15] D.11-06-017, mimeo., at 21.

requirements beyond HCAs, require the verification of Maximum Allowable Operating Pressure (MAOP), and records requirements among other items. The expanded requirements of General Order 112-F have been included, which include a change in leak survey from annual to semi-annual.

The baseline mitigations below are maintaining their current levels in the proposed plan. These mitigations are needed to keep the risk from increasing.

1. Qualifications of Pipeline Personnel (Training)
2. Requirements for Corrosion Control: Corrosion Control, Monitoring and Remedial Measures
3. Pipeline Integrity: Threat Evaluation, Risk Analysis, Pipeline Assessments and P&M

SDG&E proposes to expand the following baseline mitigations, as further described below.

4. Maintenance: Patrolling, Leak Survey, Pressure Limiting and Regulator Station Inspections and Maintenance, Valve Maintenance
5. Operations: Locate and Mark, Odorization, Emergency Preparedness, Continual Surveillance

With regard to PSEP, SDG&E does not have Phase 2A work (i.e., work in less populated areas).

Maintenance

As part of pipeline patrol, construction activity and growth is monitored to identify the need for class location studies. In certain instances, these class location studies indicate sufficient growth in the area to require a class location change, which could lead to the transmission pipeline being replaced, pressure tested, or the pipeline's pressure being de-rated.[16] In order to address, class location changes driven by population growth and construction activity in SDG&E's service territory, SDG&E is proposing to expand this activity to be able to identify areas of growth and strategically pressure test, replace, or derate pipeline segments. Taking action to pressure test, replace, or derate the pipeline mitigates catastrophic damage involving a high pressure asset by validating the pipelines integrity (pressure test), replacing a pipeline with a new modern pipeline (replace), or increase the pipeline's safety margin by lowering the operating pressure (derate).

Operations

As part of SDG&E's efforts to continually survey and maintain Company's Right of Way (ROW), additional funding is being proposed to increase span painting, pipeline maintenance, storm damage repair, removal of previously abandoned pipelines, vegetation removal, and right of way maintenance. Incremental efforts to survey and maintain SDG&E's ROWs reduces risks associated with high pressure pipelines and enhances employee, contractor, and public safety by repairing pipeline and related infrastructure, improving pipeline and line marker visibility, and increasing pipeline accessibility.

[16] See 49 CFR 192.611.

In addition to the maintenance of the ROW itself, maintenance of access roads allows SDG&E personnel to access ROWs, enables pipelines to be accessed in a timely manner, minimizes third party pipeline damages, prevents of wild fire damages, and improves the overall general safety of employees and the public.

Finally, upcoming changes to GO 112-F will require instrumented leak survey of all Transmission pipelines. Currently, instrument leak survey is only required where pipelines are operating in a Class 3 or Class 4 locations, which means, currently, 900 miles of Transmission pipeline are required to be leak surveyed. GO 112-F requires an additional 1,800 miles of Transmission pipeline to be instrument leak surveyed in Class 1 and 2 locations. GO 112-F does, however, allow difficult to access pipelines operating in a Class 1 and Class 2 locations to be patrolled by aircraft. Accordingly, this activity is being expanded to comply with revisions to GO-112-F.

7 Summary of Mitigations

Table 5 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for mitigating High-Pressure Pipeline Failure. While control or mitigation activities may address both potential risk drivers and potential consequences, potential risk drivers link to the likelihood of a risk event. Thus, potential risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 5 were estimated using assumptions provided by SMEs and available accounting data.

Table 5: Baseline Risk Mitigation Plan[17]
(Direct 2015 $000) [18]

ID	Mitigation	Potential Risk Drivers Addressed	Capital[19]	O&M	Control Total[20]	GRC Total[21]

[17] Recorded costs were rounded to the nearest $10,000.
[18] The figures provided in Tables 5 and 6 are direct charges and do not include Company loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[19] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[20] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[21] The GRC Total column shows costs typically presented in a GRC.

1	CFR 192 Subpart M – Maintenance *	• Outside Forces • Equipment and Corrosion	n/a	$1,160	$1,160	$1,160
2	CFR 192 Subpart N – Qualifications of Pipeline Personnel*	• Incorrect Operations	n/a	100	100	100
3	CFR 192 Subpart I – Requirements for Corrosion Control *	• Internal and External Corrosion	n/a	50	50	50
4	CFR 192 Subpart L – Operations*	• Third Party Damage • Corrosion, Manufacturing • Construction • Equipment • Incorrect Operations	410	100	510	510
5	CFR Part 192 Subpart O – Gas Transmission Pipeline Integrity Management*	• Corrosion • Manufacturing • Construction • Equipment • Incorrect Operations	7,070	3,880	10,950	50
6	CPUC 958 – PSEP: High Pressure Testing and Replacement*	• Manufacturing • Construction	86,690	4,450	91,140	0
	TOTAL COST		$94,170	$9,740	$103,910	$1,870

* Includes one or more mandated activities

Table 6 summarizes SDG&E's proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan, and is not requesting funding approval. SDG&E will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 6 the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 6: Proposed Risk Mitigation Plan Overview[22]
(Direct 2015 $000)

ID	Mitigation	Potential Risk Drivers Addressed	2017-2019 Capital[23]	2019 O&M	Mitigation Total[24]	GRC Total[25]
1	CFR 192 Subpart M – Maintenance *	• Outside Forces • Equipment and Corrosion	n/a	$1,040 - 1,150	$1,040 - 1,150	$1,040 - 1,150
2	CFR 192 Subpart N – Qualifications of Pipeline Personnel*	• Incorrect Operations	n/a	130 - 180	130 - 180	130 - 180
3	CFR 192 Subpart I – Requirements for Corrosion Control *	• Internal and External Corrosion	n/a	40 - 50	40 - 50	40 - 50
4	CFR 192 Subpart L – Operations*	• Third Party Damage • Corrosion, Manufacturing • Construction • Equipment • Incorrect Operations	1,170 - 1,300	100 - 110	1,270 - 1,410	1,270 - 1,410
5	CFR Part 192 Subpart O – Gas Transmission Pipeline Integrity Management*	• Corrosion • Manufacturing • Construction • Equipment • Incorrect Operations	15,190 - 16,780	4,970 - 5,500	20,160 - 22,280	30 - 40
6	CPUC 958 – PSEP: High Pressure Testing and Replacement*	• Manufacturing • Construction	50,400 - 61,600	n/a	50,400 - 61,600	0
	TOTAL COST		$66,760 - 79,680	$6,280 - 6,990	$73,040 - 86,670	$2,510 - 2,830

While all the mitigations and costs presented in Tables 5 and 6 mitigate the High-Pressure Pipeline Failure risk, some of the activities also mitigate other risks presented in this RAMP Report, including: Catastrophic Damage Involving Third Party Dig-Ins (Dig-Ins) and Employee, Contractor and Public

[22] Ranges of costs were rounded to the nearest $10,000.
[23] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
[24] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[25] The GRC Total column shows costs typically represented in a GRC.

Safety. Because these activities mitigate High-Pressure Pipeline Failure as well as these aforementioned risks, both the costs and risk reduction benefits are included in all applicable RAMP chapters.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[26] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[27]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from

[26] D.16-08-018 Ordering Paragraph 8.
[27] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.

4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 4 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[28] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure 3 shows the RSE calculation.

Figure 3: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 6 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the High Pressure Pipeline Incident risk. The RAMP Approach chapter in this Report, provides a more detailed example of the calculation used by the Company.

To calculate the RSE, SDG&E began with the six mitigations in its proposed plan:

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[28] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

1. Maintenance
2. Qualifications of Pipeline Personnel (Training)
3. Requirements for Corrosion Control
4. Operations
5. Pipeline Integrity (TIMP)
6. PSEP (Pressure Testing and Replacement)
7. PSEP (Valve Automation and Replacement)

SDG&E then analyzed and arranged these mitigations into common groupings that address similar drivers or consequences, for RSE analysis:

(a) Transmission integrity (current controls)
(b) PSEP (current controls)
(c) Technical training (current controls)
(d) Regulatory compliance activities (current controls)

For the High-Pressure Pipeline Incident risk in particular, there were limited new or expanded activities in the proposed plan. Accordingly, only the four groups listed above, with no incremental mitigations, were analyzed.

For each of the four mitigation groupings, SDG&E determined the preferred methodology for quantifying the RSE. The primary assumption for the RSE for the High-Pressure Pipeline Incident risk was that performance would deteriorate in absence of the mitigation. Data from the PHMSA and asset data, where applicable, was used to model the deterioration boundaries. The appropriate data is selected based on the judgment of SMEs.

- **Transmission Integrity**

The modeling approach for transmission integrity programs was to find the level of possible performance deterioration if these programs did not exist, which would represent the baseline, inherent risk level. It is assumed that should these programs were not to be funded, then performance would deteriorate to at best the pipeline failure incident rate of the worst state in the nation. The term "at best" is used because even the worst-performing states are assumed to have some similar programs in place.

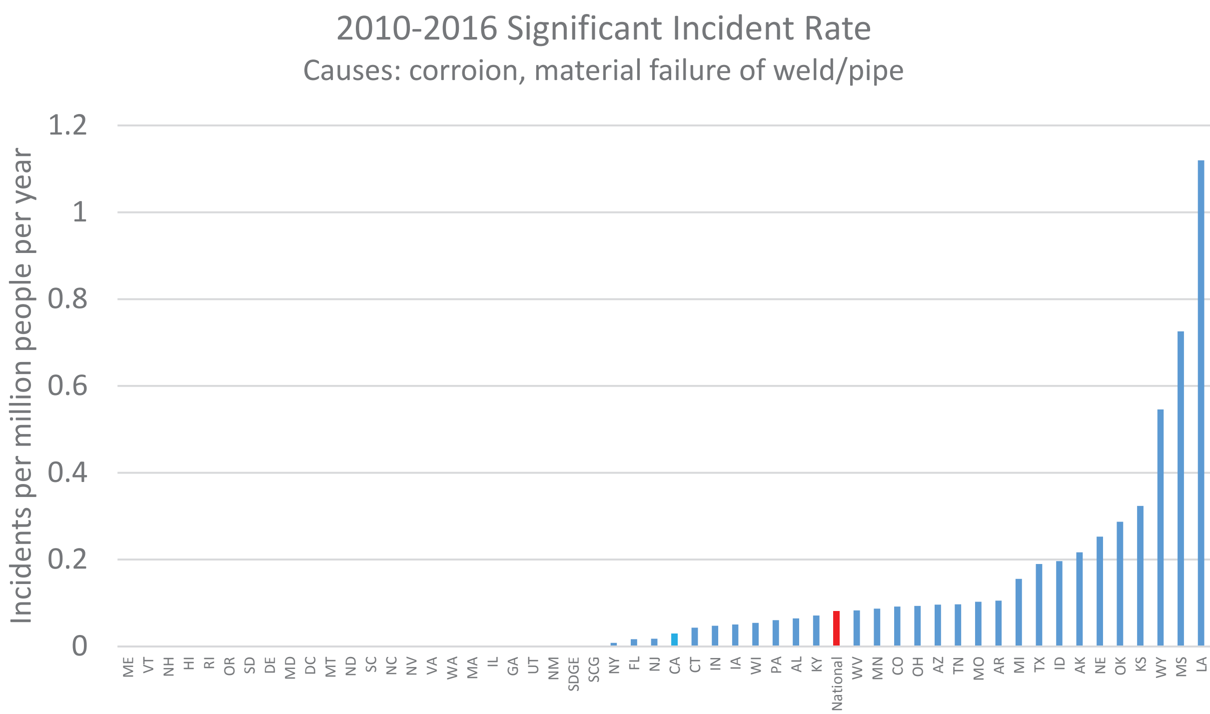
The potential drivers associated with a high-pressure pipeline incident were corrosion and material failure of weld or pipe. This was compared to the incident rate due to all causes to attain the residual risk multiplier, which is the ratio of future to current performance.

Not all targeted assets will be remediated within the time period of interest. To account for this, the residual risk multiplier will be adjusted proportionally to the proportion of remediated assets to all high pressure assets.

The chart shown below contains the pipeline failure incident rates of all 50 states, in addition to SDG&E and the national average. SDG&E is among the entries with zero incidents per million people per year, and the worst-performing state is Louisiana at 1.120 incidents per million people per year. Using

SDG&E's service population of 3.6 million people, the incident rates can be converted to an incident expectation, given by the following calculation:

$$
\begin{aligned}
&Expected\ Incident\ Rate = \ \Delta(Incident\ Rate) * Service\ Population \\
&= (1.120 - \ 0)\ incidents\ per\ million\ people\ per\ year * 3.6\ million\ people \\
&= 4.0\ incidents\ per\ year
\end{aligned}
$$



The average number of incidents per year from all causes for the same time period is 0.2[29] and the proportion of targeted miles being addressed is 42.9%. Putting it all together, the residual risk multiplier is given by the following calculation:

$$
\begin{aligned}
&Residual\ Risk\ Multiplier \\
&\qquad = \frac{Incident\ Rate\ from\ select\ Causes}{Incident\ Rate\ from\ all\ Causes} * Proportion\ of\ Remediated\ Assets
\end{aligned}
$$

[29] Expected Incidents per year for All Causes for SDG&E = Current Incidents per year per million people * Service population
= 0.0427 incidents per year per million people * 3.6 million people
= 0.2 incidents per year

$$Residual\ Risk\ Multiplier = \frac{4.0\ incidents\ per\ year}{0.2\ incidents\ per\ year} * 42.9\%$$
$$Residual\ Risk\ Multiplier = 11.2$$

Therefore, if the mitigation is not funded, the projected risk is 11.2 times the current residual risk.

PSEP

The RSE modeling approach for these programs is the same as that used for transmission integrity programs with a couple of slight differences. The first difference was that a different set of incident drivers were used to establish the deteriorated performance level. Potential drivers chosen as applicable to this category were: corrosion, material failure of weld or pipe, and equipment failure, and other.[30] The second difference was that the national average was used rather than the worst state performance, to account for the fact that the benefit of this mitigation has a high chance of being duplicative with the other mitigations in place (e.g., compliance activities, TIMP).

Using the same methodology as above, the residual risk multiplier for this category of projects is (0.7 / 0.2) X (7.6%) = 0.3. Therefore, if the mitigation is not funded, the projected risk is 0.3 times the current residual risk.

Technical Training

The RSE modeling approach for these programs was the same as that used for transmission integrity programs with two exceptions. The first exception was that a different set of incident drivers was used to establish the worst state's performance. Potential drivers chosen as applicable to this category were: incorrect operations. The second exception was that there is no secondary adjustment for the percentage of targeted assets, but there was an adjustment for the fact that it takes some time for the effects of technical training to wear off.

For this category of projects, the residual risk multiplier is (0.5 / 0.2) X (33.3%) = 1.2. Therefore, if the mitigation is not funded, the projected risk is 1.2 times the current residual risk.

Regulatory Compliance Activities

The RSE modeling approach for these programs was the same as that used for transmission integrity programs with two exceptions. The first exception was that a different set of incident drivers was used to establish the worst state's performance. Potential drivers chosen as applicable to this category were: all causes with incorrect operations and natural and other forces excluded. Further, the performance deterioration is impacted only slightly, as the funding is limited. The second exception is that 100% of assets are targeted, so no secondary adjustment is necessary.

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[30] The "other" potential drivers are derived from the PHMSA data base. They were grouped into an "other" category because these entries do not have any obvious relationship to another.

Using the same methodology as above, the residual risk multiplier for this category of projects is (0.1 / 0.2) X (100%) = 0.4. Therefore, if the mitigation is not funded, the projected risk is 0.4 times the current residual risk.

8.3 Risk Spend Efficiency Results

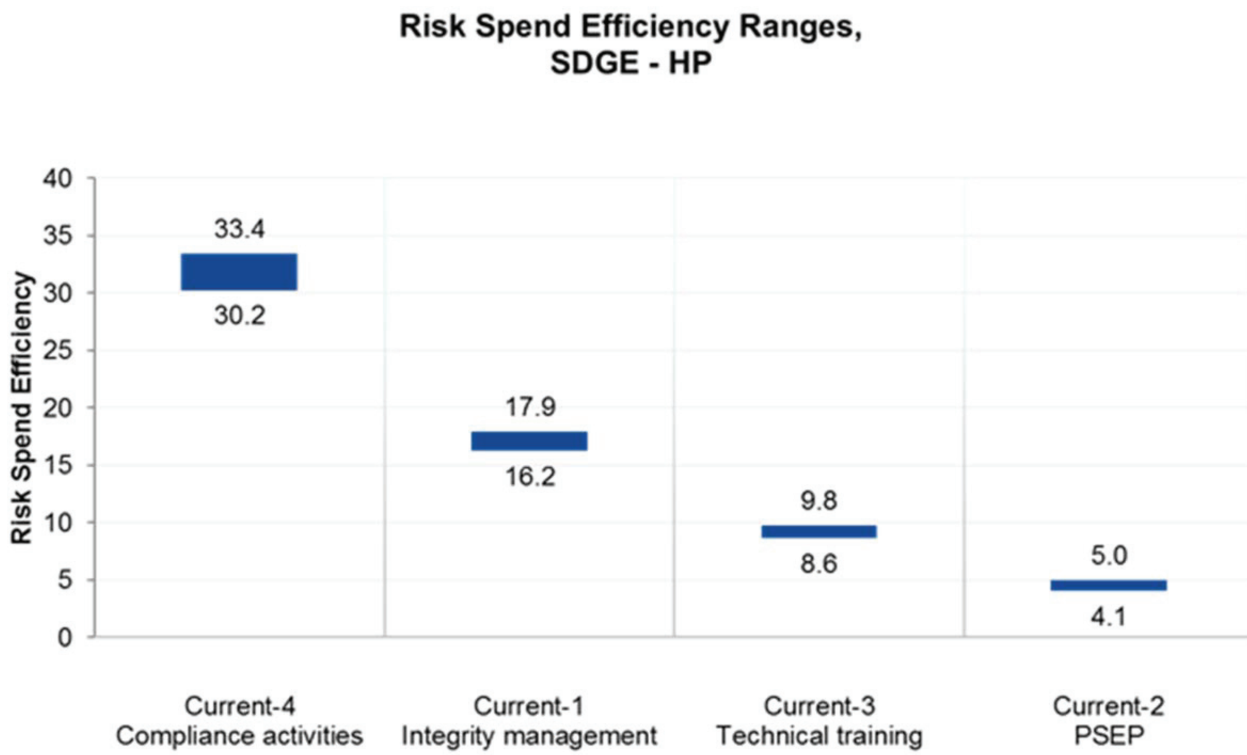
Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Regulatory compliance activities (current controls)
2. Transmission integrity (current controls)
3. Technical training (current controls)
4. PSEP (current controls)

Figure 4 displays the range[31] of RSEs for each of the SDG&E High Pressure Pipeline Incident risk mitigation groupings, arrayed in descending order.[32] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

[31] Based on the low and high cost ranges provided in Table 6 of this chapter.
[32] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 4: Risk Spend Efficiency



9 Alternatives Analysis

SDG&E considered alternatives when developing its proposed plan. These alternatives, discussed below, were dismissed in favor of the proposed plan.

9.1 Alternative 1 – Acceleration of TIMP

SDG&E considered expanding TIMP-related work as an alternative into non-HCA. However, this alternative was not selected due to the pending NPRM and in recognition that conflicts may arise with scheduling and resources. SDG&E will continue to expand TIMP-related work into non-HCA as dictated by assessment results and overall system performance as part of Preventative and Mitigative measures.

9.2 Alternative 2 – Acceleration of PSEP

In addition, SDG&E considered increasing the pace of PSEP-related work. Again, this would reduce the risk exposure more expeditiously, but would also require additional capital to accommodate the accelerated pace. Similar to the TIMP alternative, the proposed PSEP pace is preferred because it balances affordability, risk reduction and financial constraints with available resources.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Unmanned Aircraft System Incident
(Chapter SDG&E-11)

November 30, 2016

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Executive Summary

The Unmanned Aircraft System (UAS) Incident risk incident involves an employee, contractor, subcontractor, third party or parties, or external entities operating a UAS which results in damage to SDG&E infrastructure. This is considered by SDG&E to be an emerging risk due to the relatively new and evolving technology. To mitigate this risk in 2015, SDG&E's baseline mitigation plan consisted of the following requirements and best practices:

- **UAS Weight Limitations** – SDG&E restricted the acquisition of any UAS with a weight in excess of 55 pounds to lessen the severity of an aircraft accident.
- **Pilot in Command Experience and Training Requirements** – Federal Aviation Administration (FAA) regulations required licensed recreational pilots to operate a commercial UAS.
- **UAS Software and Hardware Checked Prior to Flight** – SDG&E systematically checked UAS software and hardware for latest upgrades as a best practice.
- **Flights Not Conducted Near Aircraft, People or Within Five Miles of an Airport Without Air Traffic Control Permission** – SDG&E UAS maintained distance from the general public and private property, and suspended flight operations as safety measures.
- **Compliance with state and Federal UAS Regulations** – SDG&E monitored state and federal rules and regulations concerning UAS.

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability. The 2015 baseline mitigations will continue to be performed in the proposed plan. In addition, SDG&E proposes to add new mitigations to further address the UAS Incident risk including:

- **Develop and Implement a UAS Safety Management System** – a systematic approach to managing safety to better capture, analyze, and understand performance information and flight data, leading to programmatic changes that prevent failures.
- **Develop a UAS Training Program for SDG&E Employees** – the policy and procedure foundation for SDG&E employees upon which all operations would be based.
- **Develop Contractor Qualification, Oversight and Audit Program** – a third-party assessment of SDG&E's operational processes allowing external input into an otherwise internal workflow.
- **Develop Flight Management Controls** – fleet management software to monitor, track, and maintain aircraft data.
- **Research Best Use Cases for Specific Systems as Technology Advances** – the utilization of outside vendors and consultants to incorporate the latest opportunities for safety, efficiency, and efficacy into SDG&E's UAS operations.

The risk spend efficiency was developed for UAS Incident. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. For purpose of calculating the risk spend efficiency, SDG&E grouped the six proposed mitigations into one, aggregated mitigation: an effective UAS safety program. SDG&E's Subject Matter Experts determined that implementing the proposed aggregated mitigation would move the 2015 UAS Incident frequency score from a 2 to a score of 1 on SDG&E's 7X7 risk matrix. Because Effective UAS Safety Program is the only proposed mitigation for purposes of calculating the risk spend efficiency, there is no relative ranking or risk prioritization for the risk of UAS Incident.

SDGE

A Sempra Energy utility

Risk: Unmanned Aircraft System Incident

1 Purpose

The purpose of this chapter is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risks associated with Unmanned Aircraft System (UAS) flight. This is considered by SDG&E to be an emerging risk as the UAS technology is evolving. SDG&E understands that any flight operation will have certain inherent hazards that must be evaluated for overall severity and likelihood. SDG&E considers the risk of UAS Incident to be an incident involving an employee, contractor, or subcontractor operating a UAS which damages any SDG&E infrastructure (including electric transmission/distribution), causes injury and/or death, and/or causes a major outage in service. This risk is specific to UASs employed by or UAS flights in support of SDG&E's operations. Direct and indirect damage are also accounted for in these evaluations of risk, as they directly impact the cost accountancy of accidents or incidents associated with a UAS incident.[1] While infrastructure damage, aircraft loss, and potential injury may be the most obvious risk to an operation, there are also associated indirect costs such as loss in reputation or public image for SDG&E or loss of internal support for this nascent UAS program.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of the utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[2] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

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[1] http://www2.worksafebc.com/Topics/YoungWorker/Resources-FocusReport2011.asp?reportID=36320.
[2] Commission Decision (D.) 14-12-025 at p. 31.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

The risk assessment provided herein focuses on the drivers or hazards and potential resulting events for which SDG&E is aware,[3] and about which the leading regulatory and professional organizations that deal with UAS flight are most concerned.[4] Hazards and events that are unknown to SDG&E are beyond the scope of this risk; however, SDG&E is making every effort to create a system by which new hazards can be identified quickly, moved upwards continuously, and evaluated through empowered employees and contractors, such that new risks will be captured and evaluated pro-actively. Any and all actions that could result in a UAS incident as a result of an employee, contractor, subcontractor, third party or parties, or external entities, flying UAS in support of SDG&E missions, is within the scope of this risk. Lastly, activities that mitigate a UAS coming into contact with SDG&E's electrical equipment are being addressed as part of the Risk Assessment Mitigation Phase (RAMP) risk of Electric Infrastructure Integrity. Likewise, mitigation activities concerning potential acts of terrorism and other security-related items are being addressed in the RAMP risk of Public Safety Events – Electric.

2 Background

SDG&E's Aviation Services Department (ASD) supports electric transmission, electric distribution, and gas operations with manned and unmanned aircraft. Manned operations are primarily flown with rotary wing aircraft and include: scheduled powerline patrols, fault patrols, infrared camera patrols, vegetation management surveys, external load work, LiDAR[5] data collections, and aerial assessments. In addition, ASD provides an air-rescue capability to structures and areas that are accessible by helicopter only, and in close proximity to powerlines. Unmanned operations include pole-top and structure integrity assessments, environmental and sensitive area surveys, LiDAR data collection, and post storm or fire damage assessments.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[6] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in

[3] SDG&E Aviation Services Department. SDG&E Draft Aircraft Operations Manual, Draft Version 1. June 2016.
[4] 14 Code of Federal Regulations (CFR) Part 107 (NPRM Operation and Certification of Small Unmanned Aircraft Systems). https://www.faa.gov/regulations_policies/rulemaking/recently_published/media/2120-AJ60_NPRM_2-15-2015_joint_signature.pdf.
[5] LiDAR stands for Light Detection and Ranging. According to https://www.LiDARusa.com, it is "used to detect and measure the distance of an object or surface from an optical source."
[6] A.15-05-002, filed May 1, 2015, at p. JMD-7.

place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks.[7] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Aviation Incident risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as an electric, operational risk as shown in Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	ELECTRIC	TRANSMISSION/DISTRIBUTION/SUBSTATION

3.2 Potential Drivers[8]

When performing the risk assessment for UAS Incident, SDG&E identified, categorized, and evaluated potential leading indicators, referred to as drivers. The term "drivers" is consistent with the risk lexicon approved by the California Public Utilities Commission in the S-MAP Decision, Decision (D.) 16-08-018. However, in accordance with industry best practices within the aviation industry, such "drivers" are referred to as hazards.[9] It should be recognized that SDG&E does not believe incidents or accidents are caused by a single failure, but often are the culmination of both active errors and latent conditions aligning to create an incident or accident.[10] SDG&E identified the following drivers that could lead to an incident or accident event.

- **Active Errors** – An error can occur due to someone not doing something correctly, or in accordance with procedure or policies, even when the intent is to act in accordance with policy or procedure. The drivers that fall into this category are:
    - Pilot error/inexperience
    - Inadequate pre-flight risk assessment

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[7] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[8] An indication that a risk could occur. It does not reflect actual or threatened conditions.
[9] International Civil Aviation Organization. Doc. 9859 Safety Management Manual (SMM). 2013. http://www.icao.int/safety/SafetyManagement/Documents/Doc.9859.3rd%20Edition.alltext.en.pdf.
[10] Civil Aviation Safety Authority of Australia. SMS for Aviation—A Practical Guide. 2nd Edition. 2014 Pg14 https://www.casa.gov.au/sites/g/files/net351/f/_assets/main/sms/download/2014-sms-book1-safety-management-system-basics.pdf.

- Field error/inexperience
- Intrusion into incorrect airspace
- Improper software install
- Disgruntled individual or terrorist attack
- Malicious third-party software

- **Latent Conditions** – A failure of programs/procedures intended to maintain safe flight or operation, yet creates conditions that lead directly to failure. Often these lead to non-regulation "workarounds" or "shortcuts" that can create unsafe environments, and in which active errors create incidents. The drivers that fall into this category are:
  - Incorrect policy or procedure
  - Lack of oversight, complacency
  - Normalization of deviance
  - Inclement Weather (Winds, Rain)

- **Hardware Failure (Asset Failure, IT Failure)** – A failure of the hardware from any elements in the UAS that contributes to normal flight operations. The drivers that fall into this category are:
  - Aircraft or other equipment failure
  - Improper software install
  - Malicious third-party software
  - GPS lock failure or software malfunction
  - Radio interference with the vehicle

Table 2 maps the specific drivers of UAS Incident to SDG&E's risk taxonomy.

Table 2: Risk Drivers

Driver Category	UAS Incident Driver(s)
Asset Failure	• Aircraft or other equipment failure
Asset-Related Information Technology Failure	• Improper software install • Malicious third-party software • GPS lock failure or software malfunction
Employee Incident	• Pilot error/inexperience • Inadequate pre-flight risk assessment • Field error/inexperience • Intrusion into incorrect airspace • Improper software install • Incorrect policy or procedure • Lack of oversight, complacency • Normalization of deviance

Contractor Incident	• Pilot error/inexperience • Inadequate pre-flight risk assessment • Field error/inexperience • Intrusion into incorrect airspace • Improper software install • Incorrect policy or procedure • Lack of oversight, complacency • Normalization of deviance
Public Incident	• Disgruntled individual or terrorist attack • Malicious third-party software • Pilot error/inexperience • Inadequate pre-flight risk assessment • Field error/inexperience • Intrusion into incorrect airspace
Force of Nature	• Radio interference with the vehicle • Inclement Weather (Winds, Rain)

Failure rates in the Unmanned Aircraft industry are relatively unknown; however, there are extensive similarities between manned and unmanned failure rates with respect to pilot error and systematic failures in procedures and policies. Given the "new" nature of the hardware and software, as well as the continued failures in organizational management for UAS operations, SDG&E assumed risks associated with failures in communication (pilot error), degradation of situational awareness (pilot error) and improper risk-assessment (pilot error), will continue to attribute to over 90% of all incidents or accidents.[11] By understanding that human error (pilot error) is the leading cause of a large majority of all aviation accidents and incidents, SDG&E's prime mitigation strategy likewise addresses these failures.

Exemptions should also be made to understand that, in lieu of airworthiness certification, hardware and software failures may be more common in UAS than manned aircraft.

3.3 Potential Consequences

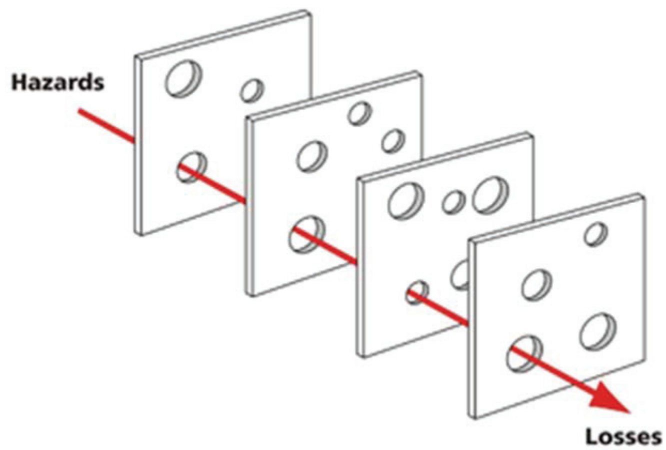
The above drivers/hazards exist in all aviation oriented operations, and it is up to employees/contractors to develop proper mitigation strategies to eliminate incidents or accidents. The "Swiss-Cheese Model" of Aircraft Accident Causation illustrates that many layers of defense can be instituted to prevent these hazards from manifesting incidents or accidents. This model of accident causation and mitigation can be seen in Figure 1 below. The model, widely accepted as industry best practice in the aviation industry, is the foundation for a robust Safety Management System. It provides that "although many layers of defense lie between hazards and accidents, there are flaws in each layer that, if aligned, can allow

[11] Hansen, Frederick. Human Error: A Concept Analysis. Journal of Air Transportation. Pg 2 http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20070022530.pdf.

accidents to occur." The overall system produces failures when a hole in each slice (a slice representing mitigation attempts such as policies, procedures, IT security, training, redundant systems, etc.) momentarily aligns, permitting "a trajectory of accident opportunity." When multiple layers of the mitigation fail, the incident or opportunity for accident can manifest an accident.[12]

The goal is to identify these gaps in mitigations, before they manifest accidents, proactively through hazard (driver) identification, documentation, and education. Understanding that latent conditions often lead to active errors, it is important to create policies and procedures that evaluate and monitor all aspects of the operation for appropriateness. Monitoring incidents of pilot error and ensuring proper training is driven by these problems, helps fill these "holes" in the various mitigation layers, and therefore protects against catastrophic accidents.

Figure 1: Swiss Cheese Model of Hazards and Losses



Conversely, if proper mitigations are not in place to reduce the likelihood of an event occurring, or the severity of the event is not diminished to a satisfactory result, then the following potential consequences, in a reasonable worst case scenario, could include:

- Employee, customer, or non-involved public fatalities.
- SDG&E infrastructure damage leading to service interruption and outage.
- Minimal property damage to non-involved public.
- Operations disruption and/or loss of reputation.
- Violation of regulatory approval and investigation/audit by federal regulators or law enforcement.
- Costs associated with litigation or policy/procedural changes.

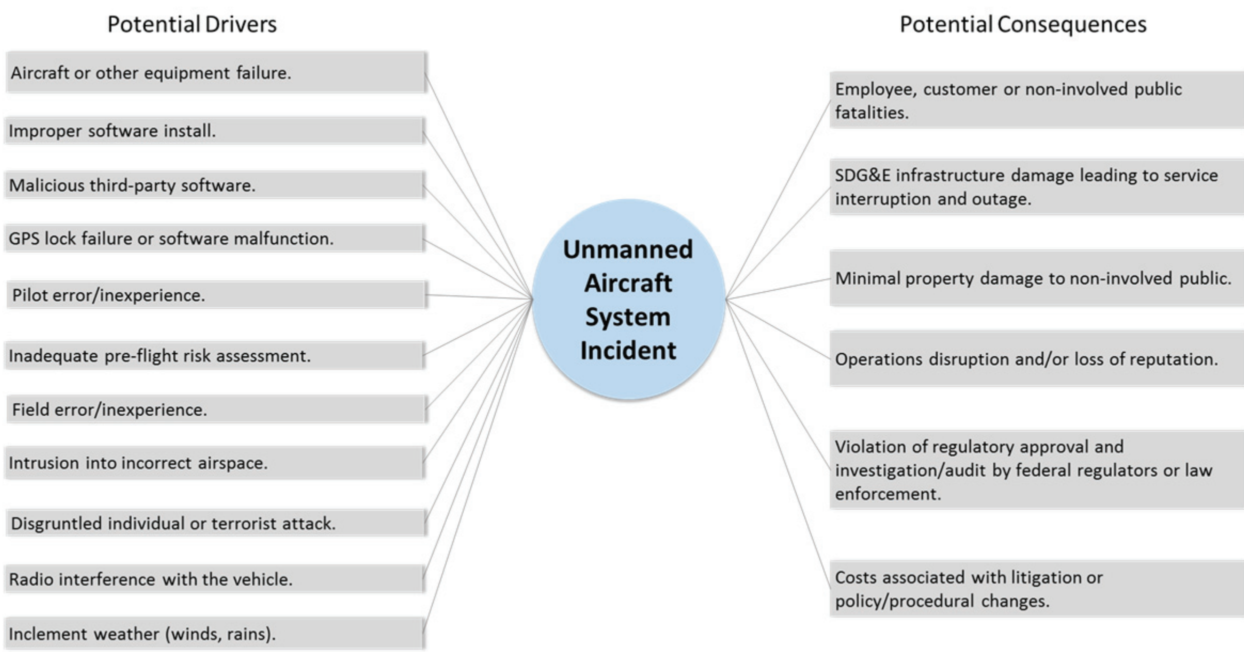
12 Daryl Raymond Smith; David Frazier; L W Reithmaier & James C Miller (2001). Controlling Pilot Error. McGraw-Hill Professional. p. 10. ISBN 0071373187.

These potential consequences were used in the scoring of UAS Incident that occurred during the SDG&E's 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The Risk "bow tie," shown below, is a commonly-used tool for risk analysis that shows the relationship between hazard conditions and the potential result if an event were to occur. The left side of the bow tie illustrates potential drivers/hazards that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

Figure 2: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of UAS Incident as one of the enterprise risks. During the development of the risk register, subject matter experts from SDG&E's Electric Distribution Operations department assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

The resulting risk score was calculated in the interest of providing acceptable knowledge for mitigation strategies, prior to any incident or accident and in accordance with ASTM F-38 Draft Best Practices in

Operational Risk Assessment WK49619.[13] This best approach for risk scoring is to analyze the severity of the potential outcome of a hazardous event, and the likelihood of that event occurring. This is calculated using both qualitative and quantitative methods using subject matter expertise, failure rates, and studies conducted in support of operations. Unfortunately, a lack of information is pervasive throughout the UAS industry, as is any cutting edge, new technology. Therefore, security and safety practices that may be more burdensome than necessary are required in the short-term. As operations become more standard, the known risks will be better understood and mitigation strategies may be less required. The risk score presented is based on a worst reasonable case scenario as identified by the Federal Aviation Administration (FAA), International Civil Aviation Organization (ICAO), and other stakeholders.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which an UAS incident can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a hypothetical situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for UAS Incident:

- A UAS incident by contractors or internal employees from a collision with infrastructure, manned aircraft, or personnel on the ground that damages the electric transmission/distribution system, and/or causes a significant incident resulting in an employee and/or customer injury and/or death, and/or causes a major outage.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[14] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

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[13] ASTM International is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services. Based in the United States, it is the leading industry standards for UAS operations and airworthiness standards available. This standard in particular is under review for final publication. Industry best Practices are noted in the accompanying Advisory Circular for 14 CFR Part 107's accompanying Advisory Circular (AC 107-2) Pg. 72.
[14] D.16-08-018 Ordering Paragraph 9.

Table 3 provides a summary of the UAS Incident risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
6	4	3	4	2	7,380

In addition to the risk assessment performed as part of the ERM risk registry process, a risk assessment was also conducted for the UAS Incident risk in accordance with recently published AC 107-2 by the FAA, which denotes appropriate severity and likelihood criteria for UAS.[15] This alternative risk assessment produced comparable results to that of SDG&E's ERM risk evaluation; thereby validating the results of both. The results of the industry best practices/FAA guidance assessment determined that some of the baseline mitigations should be adapted.[16] Largely, this is due to the catastrophic nature of an accident leading to one or more fatalities. Only collisions between manned and unmanned aircraft have been document accurately in the military, and in those cases damage was incurred, but no loss of life. Overall, a comprehensive risk analysis was completed for SDG&E's UAS Incident risk.

4.3 Explanation of Health, Safety, and Environmental Score

Based on the scenario of a UAS incident which damages any SDG&E infrastructure (including electric transmission/distribution), causes injury and/or death, and/or causes a major outage in service, it is anticipated that such an incident could result in a few fatalities and/or life threatening injuries to those in the air and on the ground. Many mid-air collisions between manned aircraft have resulted in complete losses of aircraft, both rotor and fixed-wing. Likewise, complete loss of aircraft has been well documented when manned aircraft ingest medium to large sized birds (roughly the same weight category

[15] US Department of Transportation, Federal Aviation Administration. Advisory Circular 107-2. Small Unmanned Aircraft Systems. June, 21 2016. Pg. 42 http://www.faa.gov/uas/media/AC_107-2_AFS-1_Signed.pdf.
[16] It is the belief of the SME involved with risk mitigation for UAS activities that all "yellow" outcomes (as noted in Table 6) should be considered to require mitigations, at least at the policy and procedure level. Any efforts made to diminish the severity or likelihood of either "catastrophic" or "frequent" should be considered, which is in line with FAA recommendations in AC 107-2 Pg A-5 and A-6. This recommendation is backed up by FAA recommendations in AC 107-2.

as the UAS in use by SDG&E) into engines.[17] UAS often resemble the size, shape, and density of medium sized birds, and the long-term study is still being undertaken through academic and industry partnerships.[18] These accidents are the main focus of safety requirements taken into consideration by SDG&E in motivating mitigations related to the reasonable worst case scenario. These are also the main justifications for new regulations, as yet unpublished, by the FAA to enable safe use for commercial operations, while limiting proliferation in an unsafe manner.

Accordingly, SDG&E scored the severity of the UAS incident risk a 6 (severe) in the Health, Safety, and Environmental impact area, because of its potential for loss of life. A 7 (catastrophic), resulting in many fatalities, did not seem reasonable because SDG&E assumed that the multi-passenger plane would be small in nature, rather than a commercial aircraft that holds hundreds of passengers.

4.4 Explanation of Other Impact Scores

In addition to the Health, Safety and Environmental impacts, based on the selected reasonable worst case scenario, SDG&E also analyzed the following consequences of a UAS incident or accident:

- **Operational and Reliability:** If the aircraft were to strike power support structures, individuals on the ground, or other important infrastructure, then operational reliability and consistency may be interrupted. The severity would be centralized in location. The only major impact would be to the UAS program at SDG&E, which would be grounded indefinitely until a full investigation by NTSB, FAA, and SDG&E could be concluded. Therefore, a score of 4 (major) was provided, given that such an incident could result in more than 10,000 customers being affected, impacts to a single critical location, or disruption of service greater than one day.
- **Regulatory, Legal, and Compliance:** UAS Incident was scored at a 3 (moderate), as it was determined using empirical data to the extent it is available and/or subject matter expertise that there would be moderate regulatory consequences with respect to an UAS accident which has failed operationally and led to a mid-air collision. The legal issues associated with this risk scenario would primarily focus on civil lawsuits, and operational violations that led to a collision with the manned aircraft. Indirect costs of such a collision would be very high, and are difficult to ascertain ahead of time.
- **Financial:** UAS incident or accident in this risk scenario would likely be moderate to high, but not "very high," and therefore rated as 4 (major), which is defined in SDG&E's 7X7 matrix as between \$10 to \$100 million. Largely the costs would be potential litigation, costs associated with remediation and potential upgrades to the UAS program, training programs, and potential policy/procedure changes. Wrongful death suits, liability, etc. are often results of aviation accidents.[19] The overall costs would largely be a function of the type of aircraft lost as it will

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[17] Donahue, Pete. How Often do Birds Cause Plane Crashes? January 16, 2009. http://www.nydailynews.com/new-york/birds-plane-crashes-article-1.361189.
[18] https://polytechnic.k-state.edu/aviation/uas/research.html.
[19] Scuffham, P.; Chalmers, D.; O'Hare, D.; Wilson, E.; Direct and indirect Cost of General Aviation Crashes. Aviation Space Environment Medicine. September 2002 Pg. 851-858 http://www.ncbi.nlm.nih.gov/pubmed/12234034.

define the number of passengers. As SDG&E operations do not come in contact with large passenger jets, the fatalities are most likely to be between 1 – 4 passengers.

4.5 Explanation of Frequency Score

With relation to the frequency of such an event occurring, there have been no documented cases of a UAS striking a manned aircraft in the non-military sector. The only military mid-air collisions led to significant damage to the manned aircraft, and no injuries or loss to passengers, or crew. While the aircraft may enter into an uncontrollable situation due to communications interference, software bugs, or battery misuse, onboard technologies such as "Return to Home" and Low Battery warnings already provide some risk mitigation. However, given that the use of UAS are increasing, the risk of a UAS-related incident occurring is also increasing. Given this, SDG&E scored this risk a 2 (rare), estimated to occur once every 30-100 years.

5 Baseline Risk Mitigation Plan[20]

As stated above, this risk involves an employee, contractor, subcontractor, third party or parties, or external entities, operating a UAS which results in damage to SDG&E infrastructure. The 2015 baseline mitigations discussed below includes the current evolution of the utilities' risk management of this risk. The baseline mitigations include the amount to comply with laws that were in effect at that time.

In 2015, SDG&E was in the early stages of its UAS operations and risk mitigation, especially given that this is relatively new and emerging technology. The 2015 controls were primarily in a research and development stage, and had not been formalized. Many of the 2015 mitigations relied on industry best practices. Since then, as of January 1, 2016, the ASD department took responsibility of SDG&E's UAS operations and developed formal mitigation activities, discussed in Section 6. Each of the mitigation activities in place in 2015 are described below. The controls were implemented to improve or maintain safety by enacting policies or procedures that reduce the likelihood of an event occurring.

These controls focus on safety-related impacts[21] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[22] as well as controls and mitigations that may address reliability.[23] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various UAS-related events, not just the scenario used for purposes of risk scoring.

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[20] As of 2015, which is the base year for purposes of this Report.
[21] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[22] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[23] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

1. UAS Weight Limitations

SDG&E restricted the acquisition of any UAS with a weight in excess of 55 pounds to lessen the severity of an aircraft accident. Additionally, flight operations in populated areas were restricted to micro UAS only. This is a requirement of 14 CFR Part 107.

2. Pilot in Command (PIC) Experience and Training Requirements

FAA regulations mandated PICs to have been licensed recreational pilots in order to operate a commercial UAS. An FAA licensed pilot has a certain level of aeronautical knowledge, experience, and demonstrated competency that increased the level of safety when operating UASs.

3. UAS Software and Hardware Checked Prior to Flight

For this best practice, SDG&E systematically checked UAS software and hardware for latest upgrades to check the reliability of equipment.

4. Flights Not Conducted Near Aircraft, People or Within Five Miles of an Airport Without Air Traffic Control (ATC) Permission

SDG&E UAS maintained 500 feet from the general public and private property, and suspended flight operations whenever manned aircraft entered within the vicinity of the flight area in accordance with 14 CFR part 107. Additionally, missions within controlled airspace were de-conflicted with local ATC to avoid possible mid-air collisions with manned aircraft.

5. Complied with State and Federal UAS Regulations

SDG&E monitored state and federal rules and regulations concerning UAS and proactively provided guidance to protect Company assets.

While the current level of risk is managed through regulatory compliance, informal training, and hardware management by ASD supervision and approvals, operations continue to expand, improve, and the complexities develop along with it. Therefore, the following characteristics and needs are clear:

- The inherent level of the identified risk is minimal due to the current size of operations, and the extremely low likelihood of a catastrophic event.
- The risk associated with less severe events occurring – such as a collision with a transmission wire or person on the ground, damaging the system or injuring a person – may be much higher than a catastrophic event and, therefore, continued development of training, codifications, oversight, and hardware must be more defined.
- The likelihood of less severe, but still costly, events occurring is quite high as UAS tend to fail at a much higher rate than manned aviation, due to a lack of airworthiness certification, immaturity in the designs and testing of components, and a lack of direct oversight in the materials and production of systems. As such, SDG&E is proposing (as described in the subsequent section) to implement a Safety Management System (SMS). Performance information and flight data will

be better captured, analyzed, and understood, leading to programmatic changes that prevent failures.

- SMEs have been brought in from industries where leaders in the field of Operational Risk Assessment and Mitigation continue to examine operational examples and provide insight to overall risk exposure. Their insight will go directly to the development of mitigations codified in future SMS, AOM, and Training manuals. This is an ongoing effort, and one that requires continuous application in support of third-party input, audit, and inspection.

Input to the evaluation of baseline risk include industry wide reports on incident and accident data, best practices as published by the ASTM Industry Consensus Groups on AOM development, Batteries, Flight Operations, and Expertise, as developed at the University of Southern California Aviation Safety & Security Program.

Through maintaining operational oversight in the early project development of UAS operations, and creating training programs that are rooted in first-hand experience, safety protocols developed through lessons learned in manned and unmanned aviation, and codifying best practices from throughout the industry, SDG&E can integrate UAS operations into all facets of SDG&E's mission safely. However, as these operations become more complex, diverse, and integrated, SDG&E will need to enhance the current operational support structure with a systematic safety approach (Safety Managements Systems), continued effort to promote cutting-edge technology adoption, and an increased use of experienced contractors for missions of greater complexity.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. In addition, SDG&E proposes new mitigations to further address the risk of UAS Incident. The baseline controls were focused on compliance with federal and state mandates and are now addressed through the UAS SMS and UAS Training Program for SDG&E Employees discussed below. The proposed plan focuses on codifying policies, procedures, and plans for the UAS program to continue to scale and operate in support of SDG&E activities.

The benefits associated with SDG&E's proposed plan are many in applying, implementing, and evolving the operational framework envisioned for the UAS program. By adopting industry best practices that touch upon SMS, Crew Resource Management (CRM), and more advanced flight management controls, SDG&E will eliminate the communication errors involved with the majority of aviation accidents.[24] It remains difficult to quantify accident rates in the aviation industry, however unmanned aircraft are prone to very specific incident drivers (hazards), including airworthiness or maintenance problems, situational-awareness reduction, human error due to lack of training or

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[24] Wiegmann, D. et. Al; Federal Aviation Administration. Human Error and General Aviation Accidents: A Comprehensive, Fine-Grained Analysis using HFACS. December 2005. https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/2000s/media/0524.pdf.

environmental knowledge, and problems of non-detailed communications. By adopting the measures above – especially in the codification of manuals, implementation of a robust SMS that captures hazards, analyzes them for risk, and mitigates risk before they become accidents – safety and security of the UAS program, and its tangential operations, will follow. The proposed activities, along with updates about other controls, are described in detail below.

1. UAS SMS

Developing a robust SMS program enables the support and expansion of UAS activity throughout SDG&E strategic operations. The FAA has identified SMS as the main enabling operational approach to aviation operations that provides succinct and successful operations. Without expanding the implementation of UAS operations through the incorporation of data processing, fleet management, and operational training for any and all operations, those operations will not realize the dramatic increase in safety.

According to subject matter experts, Safety Management Systems is the future of Unmanned Aircraft operations, and will likely be required by 2017 by the International Civil Aviation Organization, which FAA is required to follow.[25] SDG&E will be positioned to avoid the risk of costly program overhaul when the proposed requirement becomes reality; it will avoid the need to change the procedures in place that often lead to residual and unidentified risk.

Among the required mitigations are pre-flight checklists, some form of management of flight operations and notice to the public, and a need to operate within the boundaries of regulatory approvals. Without clear procedures and policies, SDG&E will not be able to entrust flight operations to contractors and, therefore, cannot fulfill its obligations.

2. UAS Training Program for SDG&E Employees

Training and operational codifications provide the policy and procedure foundation upon which all operations must be based. It is estimated the training will require constant development in the early and middle phases of program development. The training program consists of an initial training manual for internal use of pilot development, continued training costs for currency and performance development, and case-by-case skills performance development. Training is the core element of the fourth pillar (Safety Promotion) of SMS, and therefore required in an on-going programmatic methodology that goes beyond that required by other operational core competencies of SDG&E.

[25] Wolf, Harrison. AUVSI Presentation 2016 by Randy Willis, FAA ICAO Board Member. May 2016.

3. Contractor Qualification, Oversight and Audit Program

Auditing and third-party oversight and qualification is another portion of the Safety Assurance function within SMS, and is directly related to acquiring feedback and unbiased assessment of any aviation operation. As UAS operations are relatively new, getting unbiased assessment of the operational processes is vitally important and allows external input into an otherwise internal workflow. The FAA and ICAO have identified auditing and third-party inspection as a vital element of a healthy aviation organization. Audits require bringing in external companies for three to four days at a time to examine documentation of policies and procedures, data acquisition, and witness operations both announced and unannounced. The Wyvern Exact certification,[26] Argus Prism certification,[27] and IS-BAO IBAC standard certification,[28] are all examples of possible certification of SMS that will provide insight, approval, and recognition, enabling UAS operations for SDG&E.

4. Flight Management Controls

As the use of UAS continue to grow within the SDG&E mission portfolio, and as a greater number of operations are approved and executed via contractors or internal pilots, fleet management software and support must be included to monitor, track, and maintain aircraft data. These systems come in a variety of software suites, and though the particular software and hardware platforms to use have not been selected, they cost about the same and their continued use is conducted on an enterprise cost structure that requires implantation and training. These fleet management software suites contribute to both the Safety Promotion and Safety Assurance capabilities of the program, and drive hazard identification, documentation, and policy development.

5. Research Best Use Cases for Specific Systems

Technology is rapidly changing and bringing in outside vendors and consultants is an important approach to ensuring that SDG&E includes the latest opportunities for safety, efficiency, and efficacy in its operations. Likewise, SDG&E identified participation in industry conferences and industry discussion groups – often hosted in Colorado, Northern California, Texas, and other areas – to help support SDG&E safety and technological applications for UAS.

7 Summary of Mitigations

4 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) and control addresses, and the 2015 baseline costs for UAS Incident. While control or mitigation activities may address both risk

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[26] https://www.wyvernltd.com/exact-categories-infographic?__hssc=161114082.1.1475544766902&__hstc=161114082.f703e3685ccc957d60cc6d1de3a7ddd2.1475544766901.1475544766901.1475544766901.1&__hsfp=3477367523&hsCtaTracking=a0394b45-4984-4813-967a-32018365d36b%7C309c70ee-e94b-4f22-81bb-a253fb14e06b.
[27] https://www.aviationresearch.com/PRISM2.aspx.
[28] https://www.nbaa.org/admin/sms/is-bao/.

drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

It should be noted that there were no recorded costs associated with these baseline activities in 2015 due to the emerging aspect of the controls. As the mitigation efforts and SDG&E's UAS program improves and evolves, as outlined in the subsequent section describing SDG&E's proposed plan, costs associated with such activities will be realized.

Table 4: 2015 Risk Mitigation Plan Overview
(Direct 2015 $000)[29]

ID	Control	Risk Drivers Addressed	Capital[30]	O&M	Control Total[31]	GRC Total[32]
1	UAS Weight Limitations*	• Deconfliction, knowledge of all missions by ASD dispatch • Limited operational approvals	n/a	n/a	$0	$0
2	Pilot in Command Experience and Training Requirements*	• Pilot Error • Hardware Malfunction • Training Problems	n/a	n/a	0	0
3	UAS Software and Hardware Checked Prior to Flight	• Hardware Malfunction • Communication Issues • Human error	n/a	n/a	0	0
4	Flights Not Conducted Near Aircraft or People or Within Five Miles of an Airport Without Air Traffic Control Permission*	• Midair Collision • Activity of aircraft in vicinity	n/a	n/a	0	0

[29] The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.

[30] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the “baseline” costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.

[31] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).

[32] The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[30]	O&M	Control Total[31]	GRC Total[32]
5	Complied with State and Federal UAS Regulations*	• Communication Issues • Situational Awareness • Human Error	n/a	n/a	0	0
	TOTAL COST		$0	$0	$0	$0

* Includes one or more mandated activities

Table 5 summarizes SDG&E's proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan, and is not requesting funding approval. SDG&E will request approval of funding in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 5 the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

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Table 5: Proposed Risk Mitigation Plan Overview[33]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[34]	2019 O&M	Mitigation Total[35]	GRC Total[36]
1	UAS SMS	• Pilot Error/Inexperience • Inadequate Pre-Flight Risk Assessment • Field Error/Inexperience • Intrusion Into Incorrect Airspace • Improper Software Install • Malicious Third Party Software	n/a	$50 - 80	$50 - 80	$50 – 80
2	UAS Training Program for SDG&E Employees	• Pilot Error/Inexperience • Inadequate pre-flight risk assessment • Field Error/Inexperience Improper Software Install	n/a	16 - 23	16 - 23	16 - 23
3	Contractor Qualification, Oversight and Audit Program	• Pilot Error/Inexperience • Inadequate Pre-Flight Risk Assessment • Field Error/Inexperience • Intrusion Into Incorrect Airspace	n/a	20 - 30	20 - 30	20 - 30

33 Ranges of costs rounded to the nearest $10,000.
34 The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
35 The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
36 The GRC Total column shows costs typically represented in a GRC.

4	Flight Management Controls	• Intrusion Into Incorrect Airspace	n/a	9 - 13	9 - 13	9 - 13
5	Research Best Use Cases for Specific Systems as Technology Advances	• Pilot Error/Inexperience • Inadequate Pre-Flight Risk Assessment • Field Error/Inexperience • Intrusion Into Incorrect Airspace • Improper Software Install • Malicious Third Party Software	n/a	10 - 14	10 - 14	10 - 14
		•				
	TOTAL COST		$0	$110 - 160	$110 - 160	$110 - 160

☐	Status quo is maintained
☐	Expanded or new activity
*	Includes one or more mandated activities

The costs presented in Table 5 were zero-based as these activities are all new or expanding. The subject matter experts utilized their knowledge of how much similar projects and programs cost to implement. The range is needed to provide flexibility as these are new activities involving an emerging technology.

1. UAS SMS

   The costs associated with the development and implementation of a UAS SMS derived as a result of previous work and proposals for work by third-party vendors, and vetted through inter-industry discussions for appropriateness. It is estimated that accident and incident rates will drop in accordance with the above cited paper, leading to significant cost savings.

2. UAS Training Program for SDG&E Employees

   The cost for a UAS Training Program for SDG&E Employees was forecasted based on vendor proposals and industry standard rates, as well as the number of hours for labor expected for SDG&E employees to implement the training.

3. Contractor Qualification, Oversight and Audit Program

As stated in Section 6, because UAS technology is emerging, obtaining an unbiased assessment of the operational processes is vitally important. The cost for this activity includes expert time and travel as well as the certification itself which will provide insight, approval, and recognition, enabling UAS operations for SDG&E.

4. Flight Management Controls

The costs shown above in Table 5 are based upon an industry survey of costs associated with the fleet management software. The software can range from about $6,000 to $18,000 per year.

5. Research Best Use Cases for Specific Systems as Technology Advances

The costs associated with this mitigation include bringing in outside vendors and consultants as well as SDG&E employees participating in various industry conferences. These costs can vary depending on the consultant selected and/or the conference attended. Nonetheless, the basic cost established for conference participation via AUVSI XPONENTIAL 2016 was about $1,400 per person. Including conference participation, industry consultants, and technological trials, the cost of maintaining future oriented solutions all contributed to the forecasted costs.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[37] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[38]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis

[37] D.16-08-018 Ordering Paragraph 8.
[38] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits.

described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[39] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The

[39] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure 3 shows the RSE calculation.

Figure 3: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 5 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the UAS risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

The mitigations consisted of six proposed projects that were organized into one grouping for analysis: an effective UAS safety program. The grouping included:

(a) Effective UAS Safety Program (SMS, asset improvements, public information)

- UAS SMS
- UAS Training Program
- Contractor qualifications, oversight, audit
- Flight management controls, software
- Research drone tech upgrade/replacements
- UAS privacy policy/public awareness

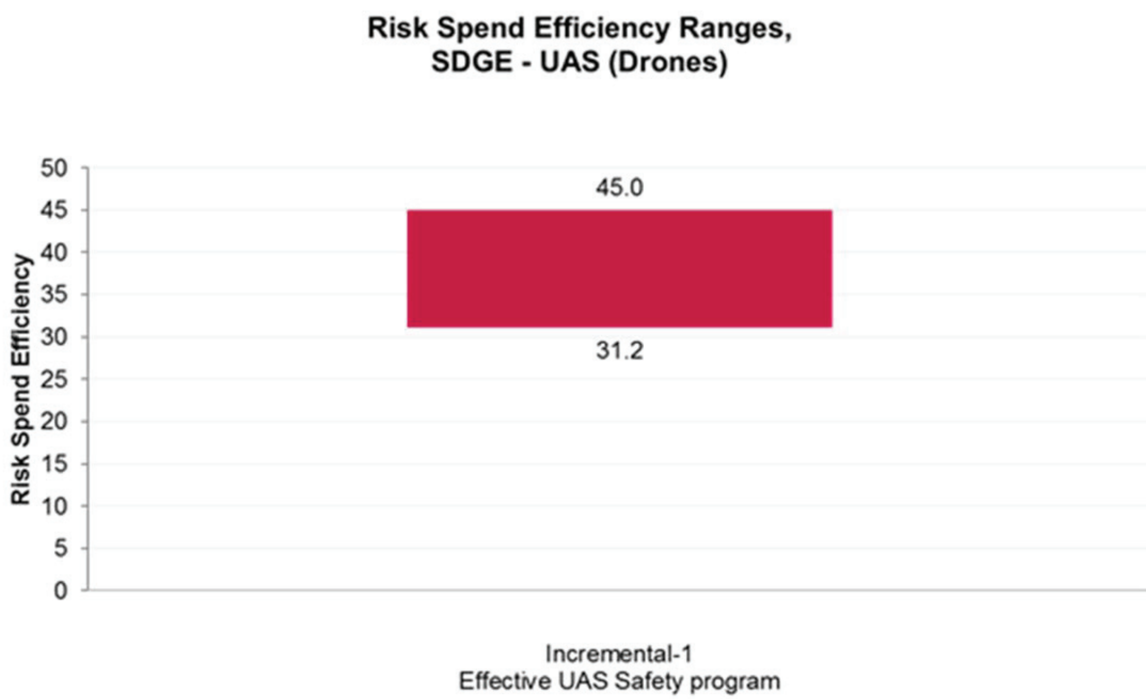
- Effective UAS Safety Program

This incremental mitigation consists of an SMS program, various training, qualifications, oversight, and audits, software and technology, and public awareness. SDG&E's SMEs determined that because there have been no UAS incidents that threatened anyone's life, either in the company or within the industry, research could not indicate the effectiveness of the mitigations at reducing risk. Therefore, the team decided with an effective UAS safety program, the likelihood of a UAS incident involving fatalities would move from a current score of 2 to a score of 1 on SDG&E's 7x7 risk matrix, equivalent to one incident in greater than 100 years.

8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SDG&E calculated the RSE ratio for the proposed mitigation grouping. Figure 4 displays the range[40] of RSEs for the SDG&E UAS risk mitigation grouping.[41]

Figure 4: Risk Spend Efficiency



9 Alternatives Analysis

SDG&E considered alternatives when developing its proposed plan to address this UAS incident risk. These alternatives were dismissed in favor of SDG&E's proposed plan for the reasons described below.

9.1 Alternative 1 – Increase Contractor Responsibility

The first alternative considered was to allow contractors to have full oversight of mission, safety, operations, and decision making in both strategic and tactical approach. Some entities within the inspection industry (particularly flare stack inspections and solar panels) rely solely on contractors. In

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[40] Based on the low and high cost ranges provided in Table 5 of this chapter.
[41] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

this case the application and use of UAS contractors is minimal, as the assets managed are in fewer locations, away from population centers (generally), and therefore offer less risk to organizations than SDG&E. SDG&E would provide tasking to the various contractors, and they would manage their assets, personnel, and application of technology use, in support of those tasks.

The number of operations, the diversity of application, the rapid nature of technology development, as well as the need to standardize and communicate information across all aviation activities, both internally and externally to SDG&E, require a centralized operational risk management scheme. The first alternative puts too much control and oversight with contractors who may operate beyond the oversight and safety expectations of SDG&E. Ultimately, the risk is not reduced, but is simply passed on to a contractor with less personal or reputational risk than SDG&E, and therefore likely to approach the overall mission differently. Further, with no centralized safety mechanisms, coordination between entities is more difficult. As contractors differ in their approach to operations, SDG&E would be placed in a position of constant vigilance over their operations, rather than to act in a proactive top down approach, which increases safety directly. SMS is known to decrease loss and provide extremely high Return on Investment. In a 2011 study, incidents and accidents were directly diminished, and therefore both reputational, financial, and physical damage reduced in the aviation industry participants that implemented SMS.[42]

9.2 Alternative 2 – Continue In-House and Contractor Engagement

The second alternative is to move forward with both in-house and contractor UAS engagement, without a robust safety oversight approach. This would not require training and application of SMS systems that are consistent with ICAO and FAA frameworks. This could be considered a status quo option, as the program is developing, moving forward, and intending to operate in support of SDG&E. However, this also increases the likelihood that risks are not managed to the highest industry consensus standards, and exposes the operation and important state assets to considerable physical and non-physical risk.

While contractor engagement may be a part of the SDG&E UAS strategy, the risk management, leadership, and promotion of lessons learned will be the responsibility of SDG&E leadership. The fundamental difference is that SMS diminishes organizational drift, reduces the normalization of deviance, and ultimately decreases the likelihood of incidents and accidents. It is fundamentally important to approach safety from a top down approach that meets and exceeds all industry best practices of which SMS is one. By not approaching UAS operations with a safety focus that embodies the direction that FAA and ICAO envision moving forward, SDG&E risks putting off investment costs until FAA/ICAO require SMS for UAS activities (estimated to be in 2019).[43] While the investment costs could be required as early as 2019, the FAA is providing approvals and waivers to companies that illustrate a dedication to safety through the safety case approval process.[44] As SDG&E seeks to expand

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[42] Center for Aviation Safety Research. Aviation Safety Management Systems Return on Investment Study. 2011. http://parks.slu.edu/myos/my-uploads/2013/01/03/aviation-safety-management-systems-roi-study.pdf.
[43] Interview with Randy Wyllis – FAA Representative to ICAO. AUVSI XPONENTIAL 2016 New Orleans, LA.
[44] https://www.faa.gov/uas/request_waiver/.

UAS activities into higher risk environments, or operations Beyond Visual Line of Sight, a demonstrated success in SMS will diminish risk to a satisfactory level to enable those operations.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Electric Infrastructure Integrity (Chapter SDG&E-12)

November 30, 2016

310313

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Executive Summary

The risk of Electric Infrastructure Integrity is the occurrence of a safety, environmental, or reliability incident due to equipment failure. This equipment or asset failure could be caused by conditions including, but not exclusive to: degradation, age, operation outside of design criteria due to unexpected events or field conditions (e.g., force of nature), or an asset that is not constructed with the latest engineering standards. SDG&E's 2015 baseline mitigation plan for Electric Infrastructure Integrity consists of four categories of controls:

1. Premature Overhead Failure
2. Premature Underground Failure
3. Premature Substation Failure
4. System Modernization

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018, as well as controls and mitigations that may address reliability. SDG&E will continue the 2015 controls in the proposed plan. In addition, SDG&E proposes to expand and add new mitigations to further address the risk of Electric Infrastructure Integrity. Examples of these incremental mitigation activities include:

- A Wire Correction Program, which will effectively replace or protect the assets most prone to failure.
- A 4 kV Modernization program, which aims to continue and accelerate traditional conversions of the 4 kV systems, including substations and both underground and overhead, to 12 kV standards. These upgrades would enable better protection against risks such as wire down events.
- A Switch Maintenance Program for both underground and overhead switches. This program aims to systematically and thoroughly inspect all distribution switches.
- An acceleration of SDG&E's Advanced SCADA Program across all electric distribution systems.

A risk spend efficiency (RSE) was calculated for Electric Infrastructure Integrity. The RSE is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk.

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Risk: Electric Infrastructure Integrity

1 Purpose

The purpose of this chapter is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of Electric Infrastructure Integrity. SDG&E considers the Electric Infrastructure Integrity risk to be the occurrence of a safety, environmental, or reliability incident due to equipment failure. This equipment or asset failure could be caused by conditions including, but not exclusive to: degradation, age, operation outside of design criteria due to unexpected events or field conditions (e.g., force of nature), or an asset that is not constructed with the latest engineering standards.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.
The risk assessment provided herein addresses both low frequency-high consequence and high frequency-low consequence events. Another potential event associated with Electric Infrastructure Integrity – the inadvertent contact of an energized SDG&E facility by an employee, contractor, or the

[1] Commission Decision (D.) 14-12-025 at p. 31.

public, potentially causing injury – is not covered here, but in the Employee, Contractor and Public Safety risk chapter of this Report. It is important to note that although the consequences of this risk are similar those described in the Public Safety Events – Electric and Employee, Contactor and Public Safety chapters, the drivers and mitigations often differ. While other risk chapters focus on mitigations that address public outreach, education, training, and other internal procedural enhancements, this chapter focuses on infrastructure improvements. This chapter focuses on mitigations that aim to reduce safety risks directly associated with infrastructure failure or mis-operation, limited to equipment owned and operated by SDG&E. Also, this chapter primarily focuses on risks and mitigations outside of the Fire Threat Zone (FTZ). FTZ-related risks and mitigations are covered in the Wildfire Caused by SDG&E Equipment risk chapter of this Report.

Further, SDG&E is addressing the risk drivers of which it is aware. Potential drivers that are unknown to SDG&E are outside the scope of this risk.

2 Background

SDG&E's electric service territory is 4,100 square miles spanning two counties and 25 communities. It covers the southern portion of Orange County to the U.S.-Mexico Border, and San Diego County from the coast to the western borders of Riverside and Imperial Counties. SDG&E's 1.4 million electric consumers comprise predominantly residential customers, along with a smaller number of commercial and industrial customers. Table 1 below provides an overview of SDG&E's electric system.

Table 1: SDG&E Electric Infrastructure Overview

Transmission	Distribution	Substation
Circuits (Tie lines): 500 kV: 6 230 kV: 47 138 kV: 36 69 kV: 155	Circuits: 12 kV: 808 4 kV: 225	Distribution Substations 12 kV: 112 (no 4 kV) 4 kV (step downs and substations): 195
Overhead Miles: 1,830	Overhead Miles: 6,523	Transmission Substations: 26
Underground Miles: 136	Underground Miles: 10,464	

SDG&E aims to build and maintain a safe and reliable electric infrastructure. To do so, SDG&E employs both conventional and innovative approaches to engineering, designing, constructing, maintaining, and operating its electric infrastructure. The Company creates and maintains construction standards and practices that help to maintain safe operations for electrical workers and the public.

These are challenging tasks given the varying terrain, weather patterns, aging infrastructure, continually and changing load patterns, and the resulting impacts to the safety and reliability of electric infrastructure, across the service territory.

SDG&E is an industry leader in the development of innovative engineering, construction, and operational techniques, having experienced a variety of operational challenges over the years. SDG&E invests in the continual improvement of electric transmission, substation, and distribution infrastructure, as well as in technology to safely monitor and control those assets. SDG&E routinely collaborates with several manufacturers, consultants, and various consortiums of utilities to recognize and continually pursue best practices for the purpose of enhancing employee and public safety.

These investments and practices have contributed, in large part, to SDG&E's maintenance of a consistent trend of industry-leading reliability indices (e.g., Sustained Average Interruption Duration Index, commonly known as SAIDI). These achievements are a result of implementing long-term infrastructure improvements and responding to unplanned outages with urgency. Despite these successful efforts, not all electric reliability risks can be fully mitigated and, therefore some residual risks will remain.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[2] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks.[3] This includes identifying leading indicators of risk. Sections 3 – 8 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Electric Infrastructure Integrity risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as an electric, operational risk, associated with transmission, distribution and substation assets, as shown in Table 2.

[2] A.15-05-002, filed May 1, 2015, at p. JMD-7.
[3] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.

Table 2: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	ELECTRIC	TRANSMISSION/DISTRIBUTION/SUBSTATION

3.2 Potential Drivers[4]

When performing the risk assessment for Electric Infrastructure Integrity subject matter experts identified potential indicators of risk, referred to as drivers. These include, but are not limited to:

- **In-service equipment has passed its useful life, becomes obsolete, or does not operate in accordance with modern safety standards**:

  Electric assets are usually in service for several decades, and, possibly for several years beyond the book life of the asset. Based on an assessment of age, one of the most common key indicators of failure, such assets are more prone to failure. These assets can also be considered obsolete when new safety, construction, and operational standards have been established in the industry or within the Company.

- **In-service equipment overloaded beyond specifications**:

  Electric assets are designed and constructed per SDG&E standards and in accordance with CPUC General Orders and other local or national requirements. Assets often are designed and constructed to exceed the requirements set forth by these standards; however, field conditions, such as excessive forces exerted on poles due to acute natural forces (e.g., high winds), may stress the infrastructure and cause failures.

- **In-service equipment failing prematurely**:

  SDG&E's electric assets such as underground cables, substation transformers, and overhead connectors are supplied by various manufacturers. These assets undergo routine quality testing from their respective manufacturers and operate within their design criteria; however, it is reasonable to expect some subsets to fail over time, under conditions near the upper limits of their ratings, or for reasons unknown to SDG&E.

- **In-service equipment designed to protect other assets failing to operate as designed**:

  Due to their sensitive nature, protective relaying devices, along with their associated telecommunication systems (e.g., Energy Management System [EMS], Supervisory Control and Data Acquisition [SCADA]), can be expected to fail periodically. These failures may cause the assets they are designed to protect to experience more damage or potentially fail prematurely

[4] An indication that a risk could occur. It does not reflect actual or threatened conditions.

under faulted conditions. Relays themselves also may fail prematurely, potentially causing adverse impacts to reliability and safety.

- **In-service equipment failing with lack of or delayed utility awareness**:
  Protective relaying devices and their associated telecommunication systems are designed to provide utility operators with real-time insights regarding the state of electric assets, including which assets pose risks to electric workers and the public. Failure of these systems may cause prolonged or undetected risk exposure to the public.

- **In-service equipment failing in excessive volumes:**
  Although it is reasonable to expect some subsets of in-service electric assets to fail, acute weather events or environmental conditions may pose added risks to SDG&E's operations. In particular, storm events may lead to large volumes of failures that extend the normal outage response time, due to limited resources to assess and mitigate damage, and unsafe field conditions.

- **Force of Nature and Climate Change**
  The SDG&E service territory features a diverse range of micro-climates and weather conditions. Customers and electric infrastructure are dispersed among sparsely populated lower deserts and mountainous regions, as well as in densely populated load centers along the coastal and inland regions of San Diego and south Orange County. Climate conditions include: sunny skies and mild temperatures, Santa Ana and elevated wind conditions that can exceed 100 miles per hour (MPH) gusts near transmission and distribution infrastructure, heat waves and peak loads in spring, summer and fall months causing unexpected volumes of transformer overloads, heavy rainfall across all regions of the service territory resulting in flash floods, landslides, and the resulting electric infrastructure failures, and ice loading causing pole failures in the inland regions.

  Various combinations of these regional and seasonal conditions call for corresponding operating procedures, several types of advanced protective equipment, and strategic hardening of infrastructure. The intermittency of distributed and bulk renewable generation also introduces added variability in the operating status on any given day.

  Other natural forces that could have an adverse impact on SDG&E's electric infrastructure could include earthquakes and aftershocks, tsunamis causing the destruction of local generation, transmission, and distribution infrastructure, and 100-year floods, and sea level rise. While climatologists have projected sea level rise along SDG&E's coastal region to occur steadily over the course of the next 50-100 years, an unexpected acceleration of this schedule could cause extensive damage to coastal infrastructure, including generation, transmission, and distribution systems. The corrosive nature of the salt contained in sea water could cause extensive underground cable system failures, and the standing water along the base of wooden pole structures could significantly accelerate the deterioration cycle if these types of infrastructure are not fortified or otherwise reconfigured.

Current climate science is indicating that the extreme risk scenarios that SDG&E has been subjected to will continue to change in the years and decades to come. The most recent science and vulnerability assessments completed by SDG&E indicate that the SDG&E electric system more likely will be exposed to the following events:

- Increased number of planned work cancellations due to high fire concerns
  - Includes government-issued restrictions in national forestland
- Acceleration of sea level rise:
  - Low-lying substations and underground facilities susceptible to flooding
  - Potential for prolonged outages due to accessibility issues during flood events
  - Salt water inundation may increase corrosion
- Increase in temperature :
  - Increase in peak electricity demand, despite renewable resources
  - Less efficient power production and reduced substation capacity due to warmer nights
  - Shortened lifespan of transformers due to accelerated break-down of insulation
  - Sagging lines and additional damages due to thermal expansion of electric infrastructure
  - Potential for policy revisions and need to adapt to evolving regulations and standards set by the government and CPUC
    - Planned outage programs to perform needed work and upgrades become susceptible to more frequent cancellations
    - Statewide emissions regulations and restrictions on water use may impact availability of power imports during summer
- Change in rainfall patterns:
  - Reduced efficiency due to less water availability
  - Inundation of, or erosion around, underground electric facilities during flood events
  - Delays in repair/maintenance due to storms

SDG&E will continue to study the effects of climate change on its service territory. See the Climate Change Adaptation risk chapter in this Report for additional details regarding SDG&E's baseline and proposed measures for mitigating this risk.

Table 3 maps the specific drivers of Electric Infrastructure Integrity to SDG&E's risk taxonomy.

SDGE
A Sempra Energy utility

Table 3: Operational Risk Drivers

Driver Category	Electric Infrastructure Integrity Driver(s)
Asset Failure	• In-service equipment past its useful life, becomes obsolete (i.e., aging electric infrastructure), or does not operate in accordance with modern safety standards • In-service equipment overloaded beyond specifications • In-service equipment failing prematurely • In-service equipment designed to protect other assets failing to operate as designed (e.g., switch/relay) failing to operate as designed • In-service equipment failing with lack of or delayed utility awareness • In-service equipment failing in excessive volumes
Asset-Related Information Technology Failure	• Failure of Energy Management Systems (EMS), SCADA, or other critical operational systems that could prevent timely control of power flow
Employee Incident	• In-service equipment not designed for operation in accordance with modern safety standards
Contractor Incident	
Public Incident	Not applicable
Force of Nature	• In-service equipment failing due to acute climates

3.3 Potential Consequences

If one or more of the risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

- Major incident resulting in serious injuries;[5]
- Major incident causing significant, short-term environmental impacts;
- Operational impacts, such as prolonged outages;
- Finding(s) of non-compliance;
- Adverse litigation and related financial impacts; and/or
- Erosion of public confidence.

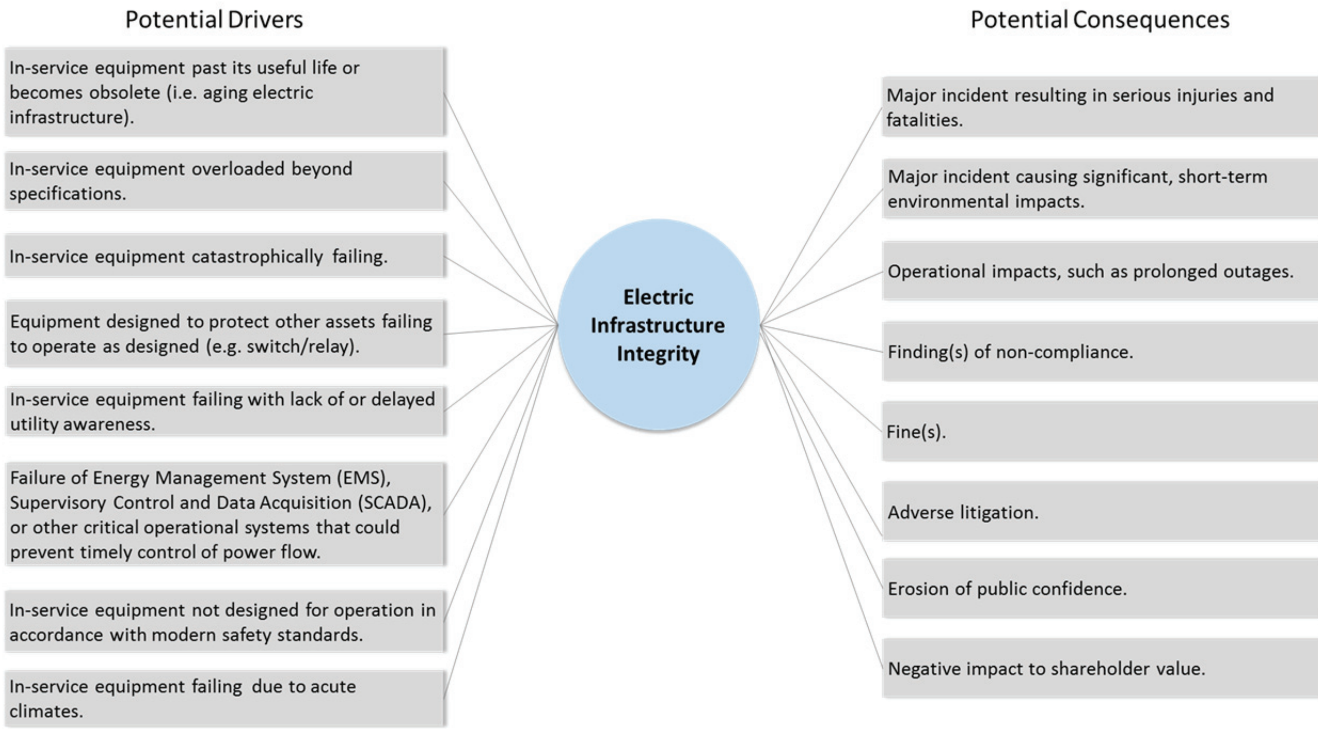
These potential consequences were used in the scoring of Electric Infrastructure Integrity that occurred during the SDG&E's 2015 risk registry process. See Section 4 for more detail.

[5] During the 2015 risk registry process, the consequences associated with this risk were scored to be limited to serious injuries. Following the 2015 risk registry, subject matter experts determined that a consequence could be a fatality.

3.4 Risk Bow Tie

The risk "bow tie," shown in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Electric Infrastructure Integrity as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which an electric infrastructure integrity incident can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Electric Infrastructure Integrity:

- An energized wire down event occurs due to overhead electric infrastructure failure. While energized, the downed wire caused arcing, fires, and damage to structures, causing serious injuries to anyone within the ground vicinity. This event also results in claims, litigation and associated financial impacts.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[6] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 4 provides a summary of the Electric Infrastructure Integrity risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 4: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
4	4	5	4	4	5,112

[6] D.16-08-018 Ordering Paragraph 9.

4.3 Explanation of Health, Safety, and Environmental Impact Score

An energized wire down event could lead to a few serious injuries to the public or employees, and/or significant and short-term impacts to the environment. Subject matter experts gave this potential Health, Safety, and Environmental impact a score of 4 (major) in 2015. Following the 2015 scoring, SDG&E realized that a Safety Score to a 6 (extensive) is more representative of the risk scenario due to the fact that a fatality or serious injury also could occur as a result of inadvertent electrical contact involving an energized wire down.

Overhead conductors in SDG&E's service territory are of various vintages and sizes with various corresponding types of connectors. Design and construction considerations include load growth, General Order (GO) 95 and other mandated construction requirements, and other traditional planning guidelines. Other design considerations, such as latest known local weather conditions, civil/structural and environmental conditions, communication infrastructure provider (CIP) attachments, vegetation, and third party incidents (e.g., car-pole contact), are also be considered.

Initial data analysis results suggest wire down events occur more often in smaller, older electric infrastructure, most notably #4 and #6 conductors, in areas with potentially elevated winds. Conductor sizes #4 and #6 make up 22% and 21% of SDG&E's installed overhead circuit miles, respectively; however, together make up over 70% of wire down events in the last five years. Modern system protection devices on the electric transmission and distribution systems often adequately safeguard against these risks as these wire down events occur. Some events, however, are not easily detectable, such as when the load side of a fallen conductor contacts the ground (as opposed to the line side, connected to the energy source). In these types of events, a fallen wire may potentially remain energized until utility personnel arrive on scene. This situation could cause a safety hazard for both the public and utility personnel, due to risk of electrocution.

Notable baseline mitigation activities are in place to address the concerns associated with wire down events, which are reflected in the risk score. These baseline controls are discussed in more detail in Section 5.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, the following scores were assigned to the remaining residual risk categories.

- **Operational and Reliability:** A score of 4 (major) was given to this risk impact area. The occurrence of a local transmission, substation, or distribution outage has the potential to affect more than 10,000 customers (not more than 50,000), impact a critical location, or disrupt electrical service greater than one day. For example, if a single 69/12 kV transformer were to fail during a peak load period, resulting in a 12 kV bus outage, subject matter experts estimated that over 10,000 customers could be affected for several hours while crews work to reroute power from other sources.

- **Regulatory, Legal, and Compliance:** A score of 5 (extensive) was given to this risk impact area. The occurrence of an event resulting in notably adverse impacts to public or employee safety and reliability may result in governmental or regulatory investigations and enforcement actions lasting longer than one year.
- **Financial:** A score of 4 (major) was given to this risk in the Financial impact area because the occurrence of an event may result in potential financial losses between $10 million and $100 million, attributable to litigation (as discussion in the Regulatory, Legal, and Compliance impact area) or other causes.

4.5 Explanation of Frequency Score

Subject matter experts used empirical data to the extent available and/or their expertise to give a score of 4 (occasional) to the likelihood of a downed wire causing arcing, fires, and damage to structures, and causing serious injuries to anyone within the ground vicinity. This is defined in SDG&E's 7X7 risk matrix as having the potential to occur once every 3-10 years in the service territory. This is reasonable, in large part, because of the mitigations and controls that have been implemented to help prevent injuries as a result of asset failures.

5 Baseline Risk Mitigation Plan[7]

As stated above, Electric Infrastructure Integrity risk is the occurrence of a safety, environmental, or reliability incident due to equipment or asset failure caused by a variety of conditions. The 2015 baseline mitigations discussed below include the current evolution of the utilities' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time.

The risk of Electric Infrastructure Integrity can also be characterized by several possible scenarios, including the wire down event used for risk impact and frequency scoring that involves asset failures. Asset age remains the single most predictable and impactful attribute leading to the natural decline of electric infrastructure integrity. Aged assets not only can demonstrate severe wearing due to weathering and electrical or mechanical use, but also may not reflect the benefit of various improvements made to technology over time with regard to safe design, installation techniques, material quality, and function. Also, it may be more difficult to maintain and operated aged assets due to lack of spare parts and vendors support. Given these conditions, aged infrastructure generally is operated with heightened caution, sometimes using special procedures, for the safety of workers and the public.

SDG&E's baseline mitigation plan consists of four categories of controls: (1) Premature Overhead Failure, (2) Premature Underground Failure, (3) Premature Substation Failure, and (4) System Modernization. Subject matter experts from the Electric Transmission and Distribution Engineering

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[7] As of 2015, which is the base year for purposes of this Report.

Department collaborated to identify and document them. This section provides an overview of the controls and examples of the projects and/or programs included in the mitigation.

These controls focus on safety-related impacts[8] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018,[9] as well as controls and mitigations that may address reliability.[10] Accordingly, the controls and mitigations described in Sections 4 and 5 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various events related to Electric Infrastructure Integrity, not just the scenario used for purposes of risk scoring.

1. Premature Overhead Failure

SDG&E considers the overhead electrical system to be its primary concern, from a risk perspective, because of public safety and its susceptibility to weather. SDG&E is aware, and tracks the age, of its infrastructure; however, it is the premature failure of assets that potentially leads to the most significant issues. SDG&E addressed such concerns with various mitigation projects and programs in 2015.

An example of a control in this category is SDG&E's Corrective Maintenance Program (CMP). In accordance with General Order 165, SDG&E performs routine inspections of overhead electric infrastructure to assess the condition of its equipment and to proactively identify potential safety risks and reliability issues associated with poles, crossarms, conductors, connectors, and other equipment. The program also entails proactive replacement of major assets such as poles, in order to prevent forced interruptions and the resulting public safety hazards. CMP is a reasonable and effective control for electric infrastructure risks because it implements comprehensive, routine inspections of various components of overhead and underground electric infrastructure, supplemented with timely corrective actions to replace assets prone to premature failure.

2. Premature Underground Failure

The underground electrical system poses operational and public safety risks. The underground infrastructure represents the majority of SDG&E's electric distribution infrastructure, is often significantly aged, and is naturally subject to several environmental factors that may accelerate premature failures, such as soil conditions, flooding, and dig-ins by third parties. In 2015, SDG&E continued to implement longstanding programs to remove known vintages of poor performing cable (e.g., unjacketed cables) and utilized predictive analytical methods to identify cables most prone to

[8] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[9] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[10] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

failure. In addition, in contrast to the overhead electric distribution system, underground connections and terminations are significantly larger pieces of equipment and may often pose additional safety risks to the public and workers. Also in 2015, SDG&E continued to implement the routine removal of "live front" terminators and transformers, which are devices not designed in accordance with modern safety protocols. These devices were generally replaced with "dead front" devices, which enable workers to operate the devices in a safer manner that limits the exposure to energized equipment. These mitigation actions are reasonable and effective because they systematically reduce or eliminate underground electric risks known to be among the greatest historical concerns to electric workers and/or contractors who build and maintain these assets.

3. Premature Substation Failure

There are unique complexities associated with substation infrastructure, including heavy reliance on protective relaying devices, and antiquated assets as old as 70-80 years with limited operational flexibility. Electric substation infrastructure is generally isolated from public view or contact. Electric workers, however, may be subject to electric safety hazards such as arcing, high voltage induction stray voltages, and mechanical safety hazards associated with working with heavy equipment (e.g. cables) and in confined spaces, such as in metalclad switchgear.

In 2015, SDG&E continued to expand the deployment of the Condition Based Maintenance (CBM) program, which installed monitoring devices that help to provide foresight on substation asset health such as transformers. This information is key to appropriately planning and implementing maintenance schedules that help to prevent prolonged, forced interruptions due to equipment failures, and the safety concerns associated with working around these risk-prone assets. This mitigation directly addresses the premature nature of substation asset failures in a manner that is prudent: it avoids and reduces safety risk, optimizes capital investment while reducing maintenance costs, and empowers the organization with data to help experts understand the long-term causes of substation asset failure.

4. System Modernization

Modern electric infrastructure uses technology that leverages recent engineering techniques that conform to the latest environmental and physical standards, and advanced monitoring and telecommunications to increase situational awareness. SDG&E works continuously to modernize its electric infrastructure to mitigate and control risks of antiquated equipment. It uses advanced technologies to detect and respond timely to risks as well as to maintain situational awareness of electric infrastructure at all times, especially when there is potential for accidental public or worker contact with energized equipment. Proactively deployed technologies aid in SDG&E's 24-hour monitoring; however, failures or limitations of the systems may inhibit the safe isolation or restoration of inevitable asset failures. Protective systems (e.g., switches with protective relays) help to address this as they are designed to quickly isolate and de-energize damaged equipment, minimizing customer outage and other risk exposure. These protection systems are tailored to specific scenarios and also may fail to operate (mechanical or communication failure), mis-operate (e.g., under or over-sensitivities), or not operate effectively due to an unforeseen circumstance that exceeded design criteria.

In 2015, SDG&E continued to expand the deployment of advanced SCADA systems, featuring switching and communication infrastructure with phasor measurement units (PMU). These PMUs sample and measure data with exceptional granularity, capturing 30 samples of voltage and other data per second, and transmitting the data back to a central logic and control unit at the substation. This enhances situational awareness and enables real-time analysis of potentially energized wire down events. These capabilities provide SDG&E with an intelligent, wire down risk mitigation option to compare with more conventional methods of undergrounding, upgrading conductors, or redesigning an overhead circuit's configuration. SDG&E believes Advanced SCADA systems can play an increasingly important role in ensuring the availability of expedient, effective, and cost-conscious solutions wire down risk mitigation.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level, along with the incremental (expanded and new) mitigations being proposed in the years 2017, 2018 and 2019. These are described below.

1. <u>Premature Overhead Failure</u>

One of the primary concerns of SDG&E with respect to its overhead equipment is when a piece of overhead equipment (e.g., wires) that falls to the ground remains energized, also referred to as a wire down event. If an employee, contractor or the public comes into contact with an energized wire, the results can be fatal. Accordingly, SDG&E is continuing to take proactive measures to determine the cause of such events.

Data analysis suggests there are various drivers of wire down events, such as third-party contact, acute weather causing vegetation and foreign object contact, aged infrastructure, and degradation of connectors. The most notable and consistently contributing driver of wire down events is the failure of small wire on three phase systems. In evaluating the overall safety risk of these wire down events, it was determined that the highest safety risks exist where one wire and one span from the load side on a three phase system falls and makes contact with the ground. In this situation, the conductor can remain energized even though upstream protection devices, such as single phase fuses, have operated as designed. After the wire makes contact with the ground, although the circuit is considered "open" from the source side, backfeed from adjacent phases connected to downstream transformers, as well as customer generation sources, that remain online, may cause the downed wire to remain or become energized. If a customer or worker were to come in contact with this downed wire prior to the creation of further isolation points (such as opening a 3-phase switch upstream) serious injury or death may occur due to electrical contact.

SDG&E is proposing a Wire Correction Program, which will effectively replace or protect the assets most prone to failure. The Wire Correction Program uses historical data collected from actual wire down events to estimate failure rates of overhead infrastructure as they may relate to causing wire down events. Applying these failure rates to all non-FTZ circuits provides SDG&E subject matter experts with an estimate of an individual circuit's expected likelihood of a wire down event over a given period.

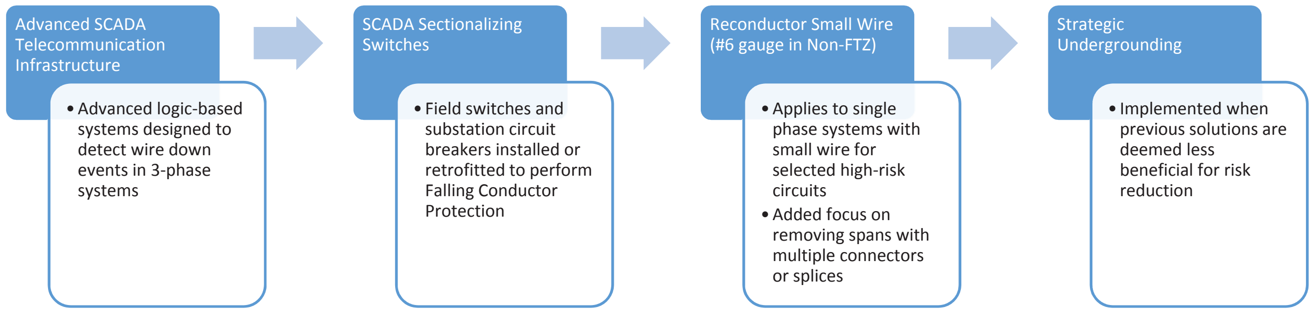
SDG&E ranks these individual circuits by the total expected number of wire down events to identify the top quartile where risk reductions may be concentrated. This top quartile of potential wire down events encompasses the circuits with the most exposure of high-risk assets, primarily #6 gauge small wire, and most notably to address spans greater than 500 feet in length. Also, other environmental factors including high winds, accelerated corrosion in coastal areas, likelihood of public contact, and areas where wire down events have occurred more than usual, are considered when estimating failure rates.

The proposed strategy to mitigate the risk of energized wire down events caused by overhead infrastructure failures involves deploying Falling Conductor Protection (FCP) in non-FTZ areas where several contiguous spans of three-phase #6 small wire exist. FCP, an SDG&E developed technology, enables the fastest-known detection and isolation (switching) available. By sensing the wire down event and de-energizing the wire while the conductor is falling to the ground, this technology is expected to significantly reduce the risk of energized conductor making contact with the ground. Several additions or upgrades to the infrastructure are needed to support FCP:

- Addition of line monitoring infrastructure in strategic areas where communication is available or otherwise can be made available.
- Addition or upgrade of existing sectionalizing switches equipped with Phasor Measurement Unit (PMU) technology. Due to the nature of the design, FCP may operate successfully to reduce the risk of energized down wires; however, with some potential reduction in local electric reliability. As designed, when a falling conductor is detected by the FCP system, the nearest upstream FCP-enabled switch will trip open to isolate the damage. The switch may or may not be the nearest isolating device, such as a fuse, which would limit the outage exposure to fewer customers. The PMU technology would help limit potential degradation in reliability.
- Control and communication upgrades consisting of a Phasor Data Concentrator (PDC), RTAC, GPS, advanced relays, and other related components. The substation needs to have these upgrades to control the complexed series of added protection systems, which will operate in parallel to other existing protection systems.

Where FCP cannot be deployed to protect at-risk small wire, the alternative is to replace remaining small wire with larger conductor that is known to be statistically less prone to failure, such as #2 5/2 AWAC conductor. In other areas, where small wire may not feasibly be replaced, at-risk connectors, sleeves, and single phase spans of small wire (commonly known failure points) will be replaced as needed. Where appropriate, at-risk overhead facilities also may be undergrounded. Figure 2 depicts the proposed Wire Correction Program:

Figure 2: Summary of Proposed Wire Correction Program



The proposed Wire Correction Program aims to address the top 25% of projected wire down risks over a 10-year period.

Additionally, SDG&E is proposing a program that focuses on pole loading. With nearly 240,000 distribution poles, it is imperative that SDG&E maintains accurate data pertaining to the structural integrity and safety of each structure. Current, detailed, and accurate pole loading calculations and as-built documentation identifying the condition of poles are important for SDG&E to be able to assess the safety of assets. Major pole-related events, including fire ignition, causing injury or death to public and/or Company personnel, and damage to infrastructure or homes, may be driven by severe weather conditions or other third-party events. It is important to note that while SDG&E strives to maintain up-to-date information for pole integrity, a large share of SDG&E's distribution poles also have attachments owned and maintained by other utilities, such as communication infrastructure providers (CIP). Major failures of this third-party infrastructure, could cause substantial adverse safety, environmental, operational, reliability, regulatory, and financial implications to the Company as experienced by other similar utilities.

The proposed Post-Construction True-Up Quality Assurance and Quality Control (QA/QC) program provides dedicated personnel, activities, and tools to proactively identify and correct pole loading issues through activities including data analytics, engineering, training, and validation or improvement of construction standards and work methods. The proposed program would supplement the existing Corrective Maintenance Program (CMP) by steadily improving construction quality, as well as placing greater emphasis (identification and timeliness of mitigation) on field follow-up for poles with high risk of failure. The program would implement routine inspections to capture data to further evaluate if poles meet safety standards. Upon the discovery of potentially unsafe conditions, timely reinforcements or replacements would be implemented to achieve risk reduction and improve safety.

Another area of concern is the 4 kV distribution system as a whole. This is because an aged system requires significant efforts to upgrade to a 12 kV voltage level. While the 4 kV system collectively serves approximately 5% of SDG&E's customer load, this system represents a much more significant share, 22%, of the number of distribution circuits. These 4 kV circuits are operated with older system protection and control technologies, making them far more susceptible to certain reliability issues for longer periods of time. Additionally, wire down occurrences, as a proportion of the amount of infrastructure currently installed (downed spans per 100 miles conductor), are up to twice as frequent on the 4 kV system when compared to 12 kV over the last five years.

Over the last several years, SDG&E has worked to modernize the 4 kV distribution system by converting or rebuilding the infrastructure to 12 kV, which provides additional technological flexibility such as advanced system protection, stronger conductors and hardware, and structural improvements due to new pole sets or undergrounding. SDG&E routinely upgrades 4 kV distribution to 12 kV through various planning channels, such as through undergrounding programs coordinated with local cities, and capacity-based upgrades and rearrangements.

4 kV generally serves fewer customers when compared to 12 kV due to natural capacity limitations. Because 4 kV operates at a higher current than 12 kV by an approximate factor of three, fewer customers can be served by the same volume of infrastructure on 4 kV compared to 12 kV. For example, a 12 kV distribution circuit typically provides up to 600 amps of load, which can equate to over 2,000 homes. A 4 kV distribution circuit typically provides up to 200 amps of load, which can equate to approximately 200-300 homes. For comparison, a total of three 4 kV circuits would be required to operate at the same 600-amp conductor rating, which would equate to these three 4 kV circuits serving approximately 600-900 homes for the same current rating as 12 kV, which can serve over three times more customers. Due to the age of 4 kV infrastructure, SDG&E must perform the inspection and maintenance procedures more closely, and with more caution. An upgrade to 12 kV would reduce the effort and time to perform this work.

SDG&E is proposing a 4 kV Modernization program, which aims to continue traditional conversions of the 4 kV systems, including substations and both underground and overhead, to 12 kV standards. These upgrades would enable better protection against risks such as wire down events. Replacement of these 4 kV facilities also inherently adds resilience to the distribution infrastructure as the majority of these assets are severely aged and naturally prone to failure and the consequential forced outages.

2. <u>Premature Underground Failure</u>

Aged and/or corroded overhead and underground (padmount or subsurface) distribution switches have a higher propensity for failure and/or inoperability during an outage (or for extending the impact of an outage to the next upstream protection device), causing a prolonged forced outage as crews are required to install additional jumpers or other workarounds. Switches that are constantly ("normally") closed or constantly opened (e.g., tie switches) are at increased risk of being inoperable when needed. The inoperable state of the switch poses safety risks to field operating personnel due to potential flash or overexertion by the employee.

SDG&E is proposing a Switch Maintenance Program for both underground and overhead switches. This program aims to systematically and thoroughly inspect all distribution switches. These inspections are expected to include visual inspections, infrared (IR) inspection to detect points of potential overheating, switch lubrication, and physical exercising. Upon inspection, if a switch is found to not be safe for continued operation, field experts will make the determination to replace the switch with an appropriately superior or equivalent asset, depending on field conditions. This program supplements existing programs to replace SF6 and DOE switches, which were previously identified to be at-risk due to their environmental and potential arcing hazards, respectively. This program is expected to significantly improve worker safety while operating these switches, and prevent premature failures of these assets, avoiding potential for injuries and damages to adjacent facilities.

Also, SDG&E is also proposing to continue and expand its Proactive Cable Replacement program. This program aims to identify underground cables that are aged or otherwise prone to failure according to data trends. Along with these cable replacements, other related assets, such as 600-amp tee connectors, will be replaced.

To supplement the Wire Correction Program addressing Premature Overhead Failures, strategic overhead-to-underground conversions also are proposed as a mitigation program in areas where Falling Conductor Protection and replacement of small conductor are not sufficient to mitigate wire down risks.

3. Premature Substation Failure

The adverse impact of aging electric infrastructure is illustrated by a failure (internal fault) of a 4 kV package substation. These aged units feature an integrated 12/4 kV transformer, circuit breaker, and associated electromechanical controls and relaying. As compared to current distribution substation operations, where such assets are physically separated and operated/maintained independently, these package substations operate and fail as a unit. These package substations are no longer an SDG&E standard due to their limited flexibility and potential safety concerns.

The customers these substations support, may be susceptible to a multi-day outage, should an emergency occur, as few flexible tie switches to adjacent circuits are available, and SDG&E works to build customized, temporary primary feeds for the area. SDG&E would be faced with constructing facilities in a relatively small workspace, as the existing package substation currently is constructed per older design standards.

SDG&E's Substation Equipment Assessment (SEA) team routinely reviews all major substation assets, including the units described above, and works to remove and/or upgrade substation infrastructure. While SDG&E has removed a substantial share of 4 kV substations to date, 4 kV substation assets often were replaced with 12/4 kV step-down transformers as semi-permanent solutions. These step-down units do not provide electric isolation points for as safe and reliable an operation as the modern 12 kV system.

The proposed 4 kV Modernization program aims to remove these aged substation assets. Load served by the connected 4 kV distribution circuits would be cutover to 12 kV circuits as part of the 4 kV distribution risk mitigation efforts previously described. Removal of the substation assets alleviates operational and safety risks by no longer requiring electric workers to work with equipment not designed to SDG&E's current safety requirements. Where replacement substation assets are required to serve the load cutover from 4 kV to 12 KV, such as circuit breakers and relays, this upgrade program will provide the opportunity to modernize the equipment to perform added functions that support safe and risk-mitigating operations such as the detection and prevention of energized wire down events.

Also, SDG&E is proposing to expand Condition Based Maintenance (CBM) infrastructure to include Transmission and Substation Battery assets. These programs will enable data gathering to better predict future failures and understand how to develop and maintain best safety practices when operating these devices. These systems also enable timely maintenance practices to better assess asset health.

4. System Modernization

SDG&E's service territory features electric infrastructure of various vintages, some dating back to the 1920s. Associated with older infrastructure are classic techniques for managing the assets categorized by common failure modes and generally known life expectancies for the general population. In contrast, associated with infrastructure constructed in recent decades are techniques, equipment, and tools to operate infrastructure more safely and effectively. The proposed System Modernization mitigations aim to address the replacement or improvement of infrastructure that, to SDG&E's knowledge, are expected to fail or otherwise cause potential safety risks in the near to medium term; within 1-10 years. Infrastructure expected to fail in a shorter timeframe are replaced or otherwise isolated for safety as soon as practical.

Modern infrastructure is expected to operate under much different conditions than older infrastructure. The conventional "centralized station" uni-directional power delivery model is now commonly transformed to the distributed generation model to accommodate reverse power flow caused, for example, by rooftop solar systems. As these are intermittent generation systems, the Company is now faced with challenges associated with load and generation resource forecasting at the community, circuit, substation, and transmission levels. Until the systems are modernized, SDG&E's data analytics capability is limited. As an abundance of modern operational (e.g., SCADA, Synchrophasors, Advanced Meter Infrastructure [AMI]) and customer (e.g., AMI) data becomes available, the Company could potentially safeguard against future widespread asset failures by identifying trends years before the expected date of failure. It is important for engineers and operators to identify common causes for failures that may not be inherently obvious due to the shift from the conventional power delivery system to the distributed generation system, to properly invest in and plan for deployment of future technologies. Failure to adapt to new data analytics methods may result in SDG&E's inability to diagnose failures, develop and implement permanent solutions, and lead to unnecessary capital and operational expenses associated with temporary solutions.

SDG&E is proposing to expand and accelerate the implementation of its Advanced SCADA Program across all electric distribution systems. The Advanced SCADA systems will improve safety and reliability by increasing situational awareness through the use of highly granular, real-time monitoring, enabling advanced, logic-based automation and control, and further enabling long-term data gathering for advanced analytics and predictive asset failure modeling. This program also provides a platform for SDG&E to continue its work in developing new risk identification and mitigation techniques, similar to Falling Conductor Protection.

7 Summary of Mitigations

Table 5 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for Electric Infrastructure Integrity. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 5 were estimated using assumptions provided by SMEs and available accounting data.

Table 5: Baseline Risk Mitigation Plan[11]
(Direct 2015 $000) [12]

ID	Control	Risk Drivers Addressed	Capital[13]	O&M	Control Total[14]	GRC Total[15]
1	Premature Overhead Failure*	• Asset Failure	$16,040	$1,180	$17,220	$16,460
2	Premature Underground Failure*	• Asset Failure	33,110	n/a	33,110	33,110

[11] Recorded costs were rounded to the nearest $10,000.
[12] The figures provided in Tables 5 and 6 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[13] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[14] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[15] The GRC Total column shows costs typically presented in a GRC.

ID	Control	Risk Drivers Addressed	Capital[13]	O&M	Control Total[14]	GRC Total[15]
3	Premature Substation Failure	• Asset Failure	4,190	n/a	4,190	1,450
4	System Modernization	• Asset Failure	570	50	620	620
	TOTAL COST		$53,910	$1,230	$55,140	$51,640

* Includes one or more mandated activities

While all the controls and baseline costs presented in Table 5 contribute to mitigating this risk, some of the controls also may contribute to mitigating other risks presented in this RAMP Report. The potential drivers for this risk are similar to those described in other risk chapters: Employee, Contractor, and Public Safety, Climate Change Adaptation, Wildfire Caused by SDG&E Equipment, and Public Safety Event – Electric. The respective risk chapters aim to address distinctions among these risks' consequences and resulting mitigation plans. For example, the Wildfire chapter focuses on risk mitigations addressing *fire risks* caused by electric infrastructure, but not necessarily injuries caused by failed electric infrastructure. Similarly, the Employee, Contractor, and Public Safety risk chapter focuses on training and public awareness campaigns to prevent avoidable electric safety incidents. Nonetheless, because the mitigation activities mitigate multiple risks in this Report, SDG&E is presenting both the costs and risk reduction benefits in this chapter as well as the aforementioned risks.

Table 6 summarizes SDG&E's proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan, and is not requesting funding approval. SDG&E will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 6, the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 6: Proposed Risk Mitigation Plan[16]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[17]	2019 O&M	Mitigation Total[18]	GRC Total[19]
1	Premature Overhead Failure*	• Asset Failure	$177,340 - 230,540	$8,320 - 10,810	$185,660 - 241,350	$183,820 - 238,970
2	Premature Underground Failure*	• Asset Failure	215,140 - 279,680	1,280 - 1,660	216,420 - 281,340	216,420 - 281,350
3	Premature Substation Failure	• Asset Failure	37,550 - 48,810	260 – 340	37,810 - 49,150	28,820 - 37,470
4	System Modernization	• Asset Failure	26,170 - 34,020	680 - 890	26,850 - 34,910	26,850 - 34,910
	TOTAL COST		$456,200 - 593,050	$10,540 - 13,700	466,740 - 606,750	$455,910 - 592,680

☐	Status quo is maintained
☐	Expanded or new activity
*	Includes one or more mandated activities

1. .Premature Overhead Failure

The costs associated with the incremental activities were developed based on historical data of similar programs as well as SME judgement. SDG&E also used high level assumptions regarding the work to be completed as part of these programs. For example, to develop the forecasted costs for the Wire Correction Program, SDG&E assumed that a percentage of the scope would be the implementation of FCP technology, while another percentage would be the undergrounding activities. A range of costs is provided to accommodate the refinement of scope and work plans for each wire, circuit, pole, etc., that will occur according to the findings of the inspection process.

2. Premature Underground Failure

The costs associated with the incremental activities were developed based on historical data of similar programs, as well as SME judgment. SDG&E also used high level assumptions regarding the work to be

[16] Ranges of costs were rounded to the neared $10,000.
[17] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
[18] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[19] The GRC Total column shows costs typically represented in a GRC.

completed as part of these programs. For example, to develop the forecasted costs for the Switch Maintenance Program, SDG&E assumed that a percentage of the maintenance inspections would result in recommended capital replacements; the actual number of replacements will only be known after a thorough inspection is completed as part of the program. A range of costs is provided to accommodate the refinement of scope and plan for each switch that will occur during the inspection process.

3. Premature Substation Failure

The costs associated with the incremental activities were developed based on historical data of similar programs as well as SME judgment. SDG&E also used high level assumptions regarding the work to be completed as part of these programs. For example, SDG&E assumed two 4 kV substation removals/conversions will be designed, engineered, and [de]constructed per year utilizing existing resources, taking into account similar resource limitations for converting the distribution assets to 12 kV. A range of costs is provided to accommodate the refinement of scope and plan for each substation that will occur during the design process.

4. System Modernization

The costs associated with the incremental activities were developed based on historical data of similar programs as well as SME judgment. SDG&E also used high level assumptions regarding the work to be completed as part of these programs. For example, to develop the forecasted costs for the Advanced SCADA Program, SDG&E projected costs using a 4-year average for similar programs. As SDG&E's design of these systems employs various technologies suited for diverse field conditions, the actual required equipment is not yet identified, and will be determined upon field surveying and project development.

For each of the mitigations, SDG&E is proposing to continue its baseline work and forecasted such costs using mostly five-year averages, which is most representative because the amount and complexity of work can vary on an annual basis. The future scope of work is largely consistent with the baseline. In some cases, where the future scope of baseline work is proposed to expand or accelerate, zero-based forecasts were used to estimate costs.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[20] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the

[20] D.16-08-018 Ordering Paragraph 8.

effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[21]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score).** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the

[21] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 4 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[22] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another.

Figure 3 shows the RSE calculation.

Figure 3: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 6 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the EII risk. The RAMP Approach chapter in this Report, provides a more detailed example of the calculation used by the Company.

SDG&E used the following approach to assess the RSE of the mitigations:

(1) Current and Incremental activities were grouped according to asset type, resulting in four asset classes: OH, UG, Subs, and Systems. A single representative asset type was then used to evaluate each of the bundled proposals. Consequently, four current controls and four incremental mitigations were analyzed.
(2) Weights were applied to each of the asset classes according to potential safety impact to account for their contributions to the risk:

[22] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

a. OH is assigned the highest weight (greater than 50%) as it is considered a larger contributor to this risk due to the public accessibility of this asset class.
b. Underground assets were assigned the next highest weight (between 25 and 50%) as they are not as easily accessible by the public.
c. Substation and Systems were assigned a low weight (less than 5%) since these assets are fenced in and/or have not been a significant cause of safety incidents in the industry.

(3) The risk reduction of each mitigation was calculated and the current and incremental programs were unbundled, with slightly more benefit allocated to the baseline programs as they are ongoing and therefore generally address higher priority risks.

The resulting risk to the system should all the mitigations NOT be funded was estimated to occur Regularly (Frequency at level 5 to 6), potentially causing serious injuries or even fatalities (safety impact at level 6). The corresponding risk score could then potentially reach approximatively 800,000 in the long term. This is based on SME projected degradation and system aging. Lack of aggressive maintenance procedures would cause the electric system to become more susceptible to failures and it is important to note the fact that some similar risk events have caused fatalities within the industry. While eliminating all risk is not achievable, the Company is proposing to continue, expand, accelerate, and implement new mitigations to keep the risk level from increasing. While data models for some electric assets are mature, the company recognizes that it does not have an analytical basis for the resulting risk of all electric assets and will be pursuing an analytical approach and models to better quantify the risk of Electric Infrastructure Integrity.

- **Overhead assets**

Circuits prone to wire down events were used as a proxy for the OH asset class. OH is assigned the highest weight (greater than 50%) as it is considered a larger contributor to this risk due to the public accessibility of this asset class. Since not all targeted circuits prone to wire down events are being addressed by this mitigation over the time period of interest (2017-2019), it was necessary to pro-rate in the risk reduction the amount of the percentage being addressed or approximately 10%. There is also an adjustment for the relative effectiveness of these wire down remedial actions that is applied in the risk reduction calculation. The number used is two times the average, meaning that the assets targeted by the program have been shown to contribute two times as much per unit to this risk than the average asset.

- **Underground equipment**

For this asset class, underground cable information was used as a proxy due to the availability of data for this asset, even though most of the safety risk is caused by the associated equipment. This risk represents an estimate of potential electrical contact incidents from working with live front transformers, “do not operate energized” (DOE) switches, in confined spaces, and other underground electric assets. Underground assets were assigned the next highest weight (between 25% and 50%) as they are not as easily accessible by the public; however, they make up the majority (greater than 60%) of SDG&E’s electric facilities.

The percentage of poor performing assets slated to be replaced in the UG group is very small, less than 0.5%, and this percentage is used to prorate the program’s benefits. From all Company underground assets, almost 25% were deemed poor performing, and this percentage is used as an additional factor to prorate the benefit of the program. Even though the percent slated for replacement is very small, the effectiveness of these reconstruction measures is estimated to be much larger than represented by the average condition; the effectiveness factor was estimated at 10 times the average.

- **Substation assets**

For this grouping, 4 kV substation data was used as a proxy. Note that because of access restrictions in substations, it is much less likely that inadvertent electrical contact can occur and therefore a small weight (less than 5%) was assigned to this asset class.

Substations with 4 kV voltage on the low side were used as the proxy for the asset class percentage being remediated. The number proposed is 6 out of 29 substations slated for remediation activities, and this ratio is used as a benefit deflator. However, it should be noted that there are over 150 step-down transformers that are in the 4 kV transformer fleet and that are not located in a traditional enclosed substation facility.

Severely aged substation infrastructure across all voltage levels are replaced based on operational significance and SDG&E reliability standards. Targeted programs also include obsolete equipment and relay replacements. Approximately 10-20 substations are targeted each year for this type of work.

- **System Modernization**

For this grouping, a percentage of switches targeted for remediation was used as a proxy. The assigned weight of this asset class is very small (less than 5%).

The proposed number of switches targeted for inspection and remediation and used as the proxy for the percentage of poor performing assets being remediated is more than half of the targeted population. This percentage is used as a risk deflator.

The risk mitigation strategy for System Modernization includes expanding and maintaining distribution Advanced SCADA infrastructure. This project deploys switches and other devices equipped with Advanced SCADA capabilities; using high speed broadband radios and logic-based controls to reduce safety risks by quickly and more accurately identifying infrastructure failures. The devices feature advanced high impedance fault detection and falling conductor detection in addition to traditional protection such as overcurrent protection. In lieu of these systems, electric infrastructure failures and their associated outages and safety risks could remain undetected or unconfirmed for extended periods of time while first responders are en route. Approximately twenty-five circuits per year are targeted for Advanced SCADA expansion.

<u>Qualitative Ranking of Mitigation Groupings</u>

Table 7 below shows the ranking of mitigation classes based on safety impacts:

Table 7: Qualitative Risk Ranking

Class	Assets	SME Rank
Current OH	Conductors/Connectors (impacting wire down), pole loading	**1**
Incremental OH	True up QA/QC, 4kV modernization, distribution rebuild, long spans, small wire and connectors, coastal infrastructure, anchor rods, UAV switches	**2**
Current Systems	Advanced SCADA	**3**
Current UG	Cable, live front transformers, DOE switches, services, CMP switches and manholes	**4**
Incremental Systems	SCADA RTUs, bridged cutout switches	**5**
Current Subs	Aged infrastructure, CBM	**6**
Incremental Subs	CBM expansion, 4kV modernization	**7**
Incremental UG	Undergrounding, tee connectors	**8**

The above rankings are believed to be reasonable because they aim to address risks in order of highest safety risk to the public, contractors, or employees. Current OH mitigations implement critical routine maintenance and inspections of overhead infrastructure, which are most prone to safety incidents due to their physical exposure to outside forces (e.g. wind, storms) and collocation with the public. The Incremental OH mitigations aim to expand and accelerate these practices, however systematically address mostly medium-to long-term risks as projected by data models based on known failure rates. Technological advancements and modernization efforts such as Advanced SCADA are valuable because they support fast, real-time operations for other risk-mitigating activities across all asset classes. The Current Systems mitigations address highest risk areas whereas the Incremental Systems mitigations address areas of growing concern.

Subs and UG mitigations are ranked lower due to the assets' limited physical exposure to the public. Substations are typically located in areas not generally traversed by the public and are also enclosed by a secured wall or fence. For utility workers in substations, various safety protocols are strictly enforced to help ensure safety, such as the utilization of visual disconnect switches and gauges to identify open or de-energized circuits. Underground facilities, which include subsurface (e.g., vault, manhole, conduit) structures and above-ground pad-mounted structures, are relatively less susceptible to public or worker safety due to the modern design of these systems. In the event of a cable fault or public contact of a pad-mounted transformer station, damaged assets are often effectively automatically isolated from inadvertent electrical contact or are otherwise away from public contact. Current UG and Subs activities are ranked higher than Incremental UG and Subs because the existing programs aim to address infrastructure with the highest rate of failure primarily due to age. The Incremental UG and Subs mitigations aim to expand and accelerate these efforts to ensure safety is steadily maintained in proportion to the rate of failure.

Quantitative Ranking of Mitigation Groupings

With the unbundling of the risk reduction benefits into proposed and baseline portions, the various programs can be re-ranked. The Quantitative Rank column in Table 8 shows the re-ranked sequence based on the quantitative analyses that were performed.

Table 8: Quantitative Risk Ranking

Class	Assets	SME Rank	Quantitative Rank
Current OH	Conductors/Connectors (impacting wire down), pole loading	**1**	**1**
Incremental OH	True up QA/QC, 4kV modernization, distribution rebuild, long spans, small wire and connectors, coastal infrastructure, anchor rods, UAV switches	**2**	**2**
Current Systems	Advanced SCADA	**3**	**3**
Current UG	Cable, live front transformers, DOE switches, services, CMP switches and manholes	**4**	**7**[23]
Incremental Systems	SCADA RTUs, bridged cutout switches	**5**	**4**

[23] The difference in ranking is due to the use of underground cable data as a proxy which may under represent the UG class safety risk.

Current Subs	Aged infrastructure, CBM	**6**	**5**
Incremental Subs	CBM expansion, 4kV modernization	**7**	**6**
Incremental UG	Undergrounding, tee connectors	**8**	**8**

It is important to note that the electric infrastructure programs are intended to maintain current performance and to address potential adverse impacts from system aging and degradation.

8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

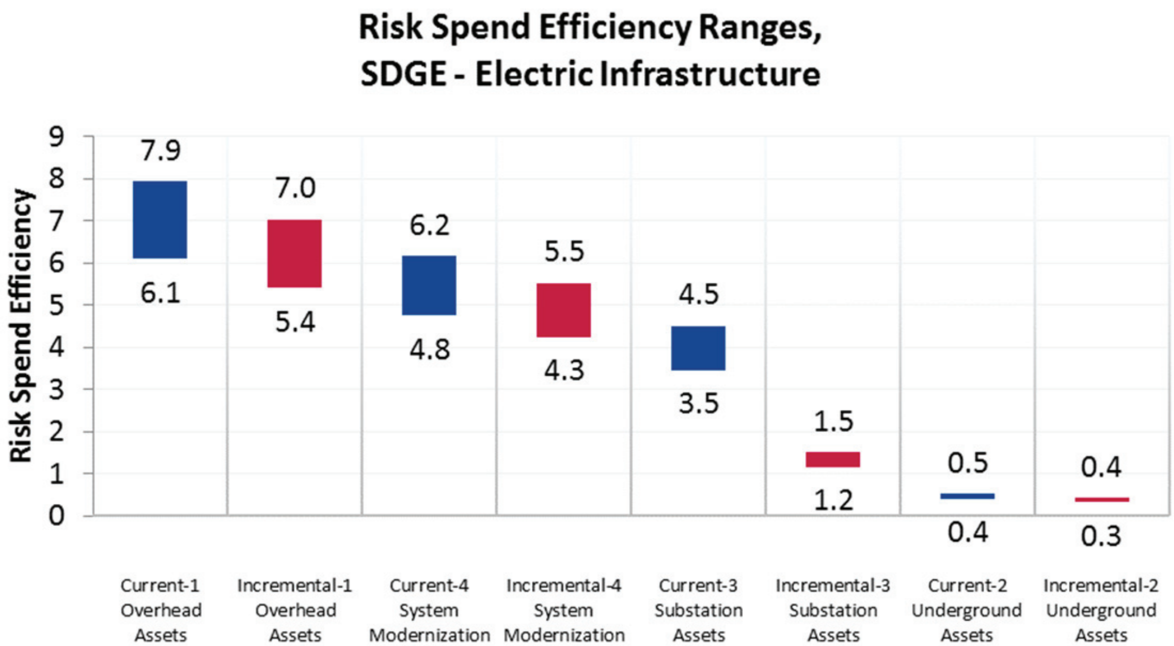
1. Overhead Assets (current controls)
2. Overhead Assets (incremental mitigations)
3. System Modernization (current controls)
4. System Modernization (incremental mitigations)
5. Substation Assets (current controls)
6. Substation Assets (incremental mitigations)
7. Underground Assets (current controls)
8. Underground Assets (incremental mitigations)

Figure 4 displays the range[24] of RSEs for each of the SDG&E EII risk mitigation groupings, arrayed in descending order.[25] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

[24] Based on the low and high cost ranges provided in Table 6 of this chapter.

[25] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 4: Risk Spend Efficiency



9 Alternatives Analysis

SDG&E considered alternatives to the proposed mitigations as it developed the proposed mitigation plan for the Electric Infrastructure Integrity risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources.

9.1 Alternative 1 – Comprehensive Replacements

SDG&E considered comprehensive replacements as an alternative to the proposed plan. This would include replacing entire classifications of risk-prone assets with assets less impacted by the same risk drivers. For example, a comprehensive replacement of all #6 conductor in the SDG&E service territory with #2 conductor could be very costly, while not eliminating an incremental amount of risk that is proportional to those costs when compared to the proposed mitigation strategy, which incorporates a hybrid solution involving Advanced SCADA. While there are benefits to this alternative, such as a greater amount of enterprise risk reduction, they do not seem to justify the anticipated high cost of implementing comprehensive replacements. Therefore, this alternative was dismissed in favor of SDG&E's proposed plan, due to the affordability and feasibility constraints.

9.2 Alternative 2 – Extended Period of Replacements

Another alternative considered was to extend the period by which SDG&E replaces aging infrastructure. This would reduce the cost in the short term due to less work being completed in a given year, but it also would increase the risk exposure for an extended period of time. SDG&E does not believe this is a feasible alternative as these aging assets already have been deemed as needing to be replaced. If adopted, this alternative could potentially cause SDG&E to reduce system reliability, as these aging assets begin to fail in larger volumes than currently experienced; disproportionate to workforce and logistical capacity. Accordingly, this alternative was rejected. SDG&E's proposed plan is preferred as it better balances affordability, timeliness, and the resulting risk reduction.

9.3 Alternative 3 – Expedited Undergrounding and Reconductoring

This alternative involves expediting undergrounding and reconductoring plans to reduce the amount of overhead wire exposure. This acceleration could provide more immediate safety and reliability benefits as it would replace equipment that is more prone to failure; but would do so at a high cost (based on historical costs to underground distribution lines). Regarding the reconductoring approach, risks may not be fully mitigated, as the overhead infrastructure still would be susceptible to energized wire down events due to foreign object contact (e.g., car-pole contact). SDG&E's proposed plan is preferred as it is less costly and directly addresses the safety risk associated with wire down events.

9.4 Alternative 4 – Work-Around Switching Procedures and Status Quo

This alternative maintains the status quo, which comprises work-around switching procedures, enabling electric workers to avoid directly operating equipment that is suspected to be unsafe, at the cost of prolonged outages. While the projects and programs currently administered allow SDG&E to provide safe and reliable service today, every day SDG&E's assets are getting older, which again is a potential leading indicator of the likelihood of failure. This alternative is more cost -effective than SDG&E's proposed plan. However, deferring asset replacements increases the risk exposure. SDG&E's proposed plan is preferred as it is expected to reduce risk.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Records Management
(Chapter SDG&E-13)

November 30, 2016

310316

A Sempra Energy utility

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SDGE

A Sempra Energy utility

Executive Summary

The Records Management risk relates to the potential public safety, property, reliability, regulatory, or financial impacts that result from the use of inaccurate or incomplete records.

To assess this risk, SDG&E first identified a reasonable worst case scenario and scored the scenario against five residual impact categories (e.g., Health, Safety, Environmental; Operational & Reliability, etc., discussed in Section 3). Then, SDG&E considered as a baseline, the SDG&E mitigation in place for Records Management in 2015 and estimated the costs (costs are discussed in Section 7). SDG&E identified the following controls as of 2015:

1. Administrative: adherence to existing records management policies and practices, including audits;
2. Training: biennial training for records management and compliance team meetings;
3. Operational Compliance and Oversight: records management within each business group; and
4. Information Management Systems: existing IT applications, including but not limited to Geographic Information Systems (GIS).

The current records management controls focus on safety-related impacts (e.g., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 and may address reliability and regulatory impacts as well.

Based on the foregoing assessment, SDG&E proposed future mitigations. For Records Management, SDG&E proposed to continue the four control categories identified above with enhancements in each category. The proposed enhancements include:

1. Administrative: SDG&E proposes to hire a third-party records management expert to provide recommendations on its records management policies and practices.
2. Training: SDG&E proposes to increase the frequency of training from biennial to annual and provide additional training specific to operational personnel.
3. Operational Compliance and Oversight: SDG&E proposes to launch a centralized records management organization.
4. Information Management Systems: SDG&E proposes to continue with application and system enhancements supporting records management.

Finally, SDG&E developed the risk spend efficiency (RSE). The risk spend efficiency is a new tool that SDG&E developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The metric used to determine the risk spend efficiency of the mitigations was based on records management data, which evaluates the vulnerabilities facing SDG&E's records management practices and policies.

Risk: Records Management

1 Purpose

The purpose of this chapter is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of records management,[1] with a focus on electric operational records that potentially implicate safety. The records management risk involves the use of inaccurate or incomplete information that could result in the failure to (1) construct, operate and maintain SDG&E's system safely and prudently; or, (2) to satisfy regulatory compliance requirements. Due to the breadth of tasks associated with the management of records for the entire enterprise, this risk chapter focuses on the enterprise-wide systems and processes for the management of operational records and is not intended to be a comprehensive discussion of all records.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment in preparation for this Report. While 2015 is used as a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of action taken to mitigate each risk. This is the first time, however, that the utilities have presented a RAMP Report, so it is important to consider the data presented in this plan in that context. Expenditures during 2015 for the baseline mitigations are provided; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety-related risks and mitigating those risks.[2] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

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[1] SDG&E considers records management as the practice of managing the records of an organization throughout the records' life cycle; from the time of creation to their eventual disposal. This includes identifying, classifying, storing, securing, retrieving, tracking and destroying or permanently preserving records, and recently, includes traceability, verifiability, completeness and ready availability (*See, e.g.,* Decision (D.)11-06-017 at p. 19).
[2] D.14-12-025 at p. 31.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

In addition, the risk assessment provided herein focuses on records pertaining to SDG&E's electric operational assets. SDG&E's gas operational records are addressed in the corresponding RAMP Records Management chapter for SoCalGas. This is primarily because many of the electronic applications for managing gas records, as well as some of the gas record-related initiatives, are implemented and maintained by SoCalGas. However, this chapter will capture SDG&E gas costs directly funded at SDG&E.

2 Background[3]

For safety and compliance purposes, SDG&E has implemented various recordkeeping controls for its system in accordance with, for example, the following:

- General Order (G.O.) 95 – Rules For Overhead Electric Line Construction
  - Rule 80.1 defines the record keeping requirement for the required inspection of joint-use poles.
  - Rule 44.2 defines the requirements for pole loading calculations and the records documenting the analysis. This directly influenced the creation of the current Pole Information Data System (PIDS) portal to SAP-Plant Maintenance (SAP-PM) for storing these records, and the link provided within the Geographical Information System (GIS) mapping system for accessing these records.
  - Rule 18 provides records requirements related to the resolution of safety hazards and G.O. 95 nonconformances, also referred to as corrective maintenance. These records were initially stored within the Distribution Inspection and Maintenance System (DIMS) system, which was recently replaced by the more robust SAP-PM system. The inclusion of Communication Infrastructure Providers (CIPs) to Rule 18 following the 2007 wildfires prompted the creation of the Telecommunications Equipment Asset Management System (TEAMS) portal to SAP-PM, providing CIPs with the pole information and data required for joint use applications.

[3] The records management risk and associated scores were originally determined by the Financial Systems and Compliance department (Financial Systems) within the Controller's organization, because this organizational unit provides general policy oversight over all company records, including administrative records. During the evaluation and development of this risk discussion, however, SDG&E determined that operational and asset records are more likely to implicate safety than other records, such as administrative records, and shifted its focus to these operational records. Keeping in line with this focus, the risk was transitioned to the Electric Distribution organization, which has greater visibility and knowledge of operational or asset records. This narrative, mitigations and proposals focus primarily on records management as it pertains to key activities in the electric operations organization.

- G.O. 128 – Rules For Construction of Underground Electric Supply and Communication Systems
  - Rule 17.7 provides requirements and responsibility for records pertaining to the location of underground facilities.
- G.O. 165 – Inspection Requirements For Electric Distribution and Transmission Facilities
  - Section III and Section IV provide the records management requirements for the inspection and maintenance of electrical assets for distribution and transmission facilities, respectively. Additionally, Section III.D requires submittal of an annual report identifying the asset inspection work completed. Given the large amount of data records required to compile an accurate and comprehensive annual report, recent IT improvement projects have been completed or are in progress to facilitate the process.
- G.O. 166 – Standards for Operation, Reliability, and Safety During Emergencies and Disasters
  - Standard 11 requires annual reporting reflecting compliance with the G.O. and any modifications to the emergency plan.
- G.O. 174 – Rules for Electric Utility Substations
  - Section III provides requirements for substation inspection program records and reporting requirements.

There are also many CPUC decisions (e.g. D.16-01-008) and additional requirements around data and records management result from various CPUC directives and laws (e.g. Assembly Bill [AB] 1650). In addition to the existing rules, SDG&E must also comply with new or developing records management rules.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand, analyze and categorize risks." The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks. This includes identifying leading indicators of risk. Sections 3 through 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, Section 3 describes the risk classification, possible drivers and potential consequences of the Records Management risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this as a cross-cutting risk as shown in Table 1. This risk affects people and regulatory, and is a function of employee conduct and compliance.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
CROSS-CUTTING	PEOPLE REGULATORY	EMPLOYEE CONDUCT COMPLIANCE

3.2 Potential Drivers[4]

When performing the risk assessment for Records Management, SDG&E identified potential indicators of risk, referred to as drivers. These include but are not limited to:

- Insufficient training of employees
- Insufficient time or resources to devote to the appropriate records management practices
- Insufficient data back-up policies, procedures or processes

Subcategories of these potential drivers can include, for example, incomplete or incorrect records, delays in capturing asset data into records systems, enterprise systems issues, and failure of employees to follow procedures, processes or practices.

3.3 Potential Consequences

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences of a reasonable worst case scenario could include:

- Severe harm to life and/or property;
- Regulatory fines / penalties; and
- Erosion of public confidence.

These potential consequences were used in the scoring of Records Management risk that occurred during SDG&E's 2015 risk registry process. See Section 4 for more detail.

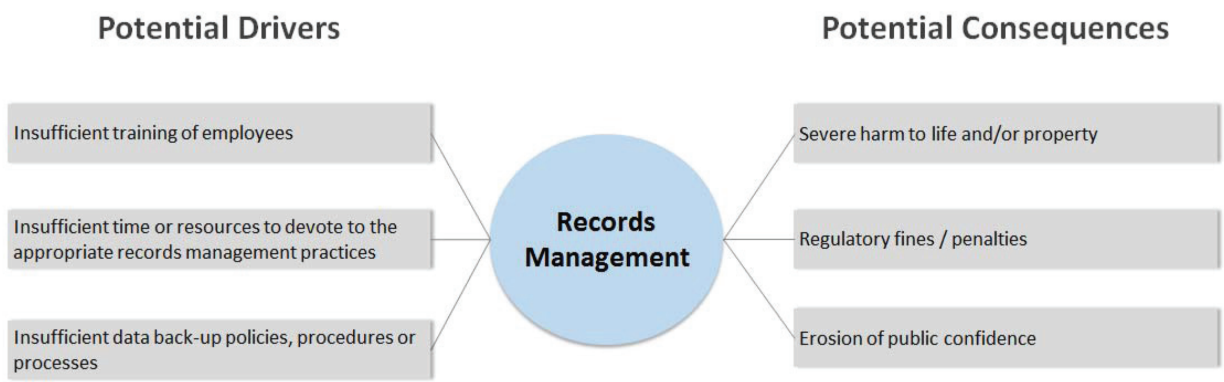
3.4 Risk Bow Tie

The risk "bow tie," shown below in Figure 1, is a commonly used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event, and the right side shows the potential

[4] An indication that a risk could occur. It does not reflect actual or threatened conditions.

consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Records Management as one of the enterprise risks. During the development of the risk register, subject matter experts (SMEs) assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.[5]

4.1 Risk Scenario - Reasonable Worst Case

There are many possible ways in which a records management related event can occur. For purposes of scoring this risk, SMEs used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Records Management:

- Employees, relying on inadequate records, mismark the location of a natural gas pipeline, which ultimately leads to a pipeline failure. While this scenario relates to the potential failure of a gas facility, a similar scenario and consequences could occur with an electric facility, where inadequate records could lead to mismarking the location of a power pole or underground structure, ultimately leading to failure of the electrical equipment or structure. Both scenarios result in severe injuries and disruption of service for an extended period. This also results in a legal consequences including regulatory investigation with financial impacts.

[5] SMEs from the Financial Systems as well as Gas and Electric Operations scored the Records Management risk.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using the scenario in 4.1, SMEs then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[6] Using the levels defined in the REF, the SMEs applied empirical data to the extent it is available and/or their expertise to determine a score for each of the four residual impact areas and the frequency of occurrence of the risk.

Table 2 provides a summary of the Records Management risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 2: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
5	5	5	4	3	4,734

4.3 Explanation of Health, Safety, Environmental Impact Score

Applying the risk scenario of a pipeline, power pole, or underground equipment or structure failure (described in Section 4.1), SDG&E anticipated that such an incident could result in many permanent or serious injuries to employees or the public. Accordingly, SDG&E scored Records Management a 5 (extensive) in the Health, Safety, and Environmental impact in 2015.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SDG&E gave the other residual impact areas:

[6] D.16-08-018 Ordering Paragraph 9.

- **Operational and Reliability:** SDG&E rated the Operational and Reliability impact area a 5 (extensive). A serious incident could result in an interruption of service for greater than 10 days and may impact a large number of customers.
- **Regulatory, Legal, and Compliance:** SDG&E rated the Regulatory, Legal, and Compliance impact area a 5 (extensive) because of the potential for investigations and enforcement actions by the Commission and/or other local, state and federal government agencies that could result in fines and penalties, restricted operations, or other potential remedies.
- **Financial:** SDG&E rated the Financial impact area a 4 (major) because SDG&E reasoned that the primary financial impact would be a result of potential litigation and/or penalties, followed by costs associated with injuries and property damage. SDG&E estimated a potential financial impact range between $10 million to $100 million resulting in SDG&E's score of 4.

4.5 Explanation of Frequency Score

SMEs used empirical data to the extent available and/or their expertise to determine that the likelihood of a records management related incident occurring that would result in many severe injuries to the public or employees was considered to be 3 (infrequent), which is defined in SDG&E's 7X7 matrix as having the potential to occur every 10-30 years in its service territory. SDG&E scored this as a 3 because Records Management incidents involving SDG&E's operational asset records are rare and are further mitigated by the Company's existing controls; at the same time, SDG&E recognizes that enhancements to the existing program can be employed.

5 Baseline Risk Mitigation Plan[7]

As stated above, Records Management risk has potential public safety, property, reliability, regulatory, and financial impacts. The 2015 baseline mitigations discussed below include the current evolution of the utilities' management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time. SDG&E's baseline mitigation plan for this risk consists of four controls: (1) Administrative, (2) Training, (3) Operational Compliance and Oversight; and (4) Information Management Systems.

SMEs from Financial Systems, Enterprise Risk Management, Electric Transmission and System Engineering, Electric Distribution, and Gas Operations departments collaborated to identify and document the controls. These controls focus on safety-related impacts[8] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[9] as well as controls and

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[7] As of 2015, which is the base year for purposes of this Report.

[8] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.

[9] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."

mitigations that may address reliability.[10] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily, which for the Records Management risk focuses on records management of operational assets. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Records Management risks, not just the scenario used for purposes of risk scoring.

1. Administrative

For this risk, the Administrative mitigation activities include SDG&E's administration of and adherence to its record management policy and practices, resources to manage records, internal audits, and records storage (retention).

SDG&E's records management policies include, but are not limited to, processes and systems containing records, definition and identification of records, organizational records (both paper and electronic) and document retention and disposal policy. The goal of records management policies and practices is to provide consistent responsibilities for records management, and to require the assignment of specific accountability for oversight and administration of records management.

SDG&E also has record coordinators across the company. These record coordinators manage records and related issues, and are based within each of their respective business areas. The purpose is to give each operational area day-to-day control over records for which it has responsibility and knowledge. While not their primary job function, the record coordinators work closely with Financial Systems to promote and support the Company's records policies and procedures. In effect, this means that the management of operational asset records is decentralized.

Sempra Energy's Audit Services (Internal Audit) group performs periodic audits to verify compliance with policies related to records management and retention. Historically, these audits have occurred approximately every three years.

Lastly, SDG&E uses physical storage space, both on-site and off-site, for records. SDG&E manages the records storage so that it complies with SDG&E's policies related to retention and disposal.

2. Training

SDG&E currently provides training on general records management concepts to all employees biennially. Because every employee has a part in records management for the Company,

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[10] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

including administrative records, this training helps to provide guidance and reminders about SDG&E's policies and procedures. Additionally, throughout the year, the records management compliance team holds meetings with records management coordinators within the operational areas to provide additional guidance on records management activities. The training requirements include mandatory periodic training on the SDG&E record management policies and systems containing records, definition and identification of records, organizing records (both paper and electronic), among other topics.

3. Operational Compliance and Oversight

Within operations, SDG&E resources are specifically tasked with collecting, inputting, and managing data. For example, in the Electric Regional Operations (ERO) Department, daily asset inspection and maintenance, as part of the Corrective Maintenance Program (CMP), is one of the primary functions of the group and is required through CPUC General Order 165. Through the CMP, employees within ERO perform and document the inspection of thousands of overhead and underground electric assets, utilizing the appropriate work management and plant maintenance systems. Employees within ERO also generate and complete maintenance orders for any corrective maintenance work. These orders are created, managed, and completed within the respective work management systems, which in-turn are digitized within the electric GIS mapping system, based on the as-built documentation submitted. Projects and programs, including replacement and inspection programs (e.g. CMP), and their associated costs are largely captured in the RAMP risk chapter of Electric Infrastructure Integrity and Wildfire Caused by SDG&E Equipment (Including Third Party Pole Attachments). This chapter is focused instead on the compliance with records policy requirements.

The operational and procedural processes to comply with records retention and management policies are managed by each individual operational organization. In other words, currently, management of operational asset records is decentralized in order to give each operational department day-to-day control over records for which it has responsibility and expertise.

4. Information Management Systems

Information Management Systems (IMS) are the IT applications that support the management of information and, for purposes of this risk, the IT applications that support operational asset records management.

IMS provide employees and contractors system-attribute information. These attributes include, but are not limited to, design, materials, construction methods, equipment or structure condition, and past and present operations and maintenance. This system information allows employees and contractors to complete their operational work safely and accurately. The IT applications

SDG&E uses to support records management include GIS, work management, document management, and operational monitoring systems among others.

6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. In addition, SDG&E proposes to enhance each of these mitigations as discussed below.

1. Administrative

As SDG&E continues to refine its records management program, SDG&E is proposing to hire third-parties or records management experts to provide feedback on its records management policies and practices. Specifically, as SDG&E attempts to benchmark against Generally Accepted Recordkeeping Principles (GARP) best practices, consultants may be able to assist SDG&E in determining common records management pitfalls or assist with best practices roadmaps. While the proposal for consultants is included in the administrative category, consultants may assist with any or all of the mitigation categories listed below.

2. Training

The current records management training occurs biennially. With increased focus on records management within the utility industry and a desire to further minimize risk exposure associated with safety, reliability, and other impacts, SDG&E proposes to provide annual training company-wide. Annual training will allow key records management concepts to be communicated to employees more frequently, to refresh employee knowledge and enhance employees' ability to more adequately prepare to manage records.

Due to industry incidents over the past several years, there is increased focus on operational asset records, specifically in the areas of accuracy, completeness, searchability, and traceability. While operating groups provide task-specific training internally as well as in areas such as design, asset inspection, maintenance, construction, and mapping, SDG&E believes additional training specific to operational asset records is a necessary mitigation to improve future risk reduction. The additional training specific to operational asset records management would be explicitly for those individuals within the operational organizations and is meant to be between 4-12 hours of additional training.

3. Operational Compliance and Oversight

SDG&E proposes to launch a centralized records management organization. This organization would provide operational oversight for records management processes in specific operational areas and would provide dedicated full-time records management over the daily tasks and activities performed. In essence, records management specialists representing each functional area within the electric engineering and operations groups would serve as eyes and ears of the centralized operational records management organization and be a bridge to provide real-time feedback on continual improvement of SDG&E's records-related programs. The centralized records management organization proposed would also allow SDG&E to further review modernization of records while additionally identifying other potential opportunities to improve its records management program and oversight on day-to-day activities. With a centralized organization, SDG&E could more nimbly respond to and implement new and proposed regulations related to records management.

In order to launch this records management organization, SDG&E anticipates needing an additional 5 to 15 employees who would effectively be records management specialists; at a minimum, one manager to oversee the team and 1-3 individuals for each functional area (planning, engineering, design, construction, field operations, switching, mapping, etc.). These resources would be in addition to Financial Systems.

4. Information Management Systems

While there are several current and planned IT applications and enhancements to support records management, SDG&E proposes an initiative to further digitize its records. SDG&E's records have evolved over the life of the operational assets, and transferring existing paper records to an electronic format (digitization) is one aspect of modernizing SDG&E's records. In addition to digitization, SDG&E's initiative will also add searchability and traceability functionality. Regulatory compliance standards increasingly require that utilities be able to efficiently and effectively identify specific attributes related to operational assets. As a result, having IT applications for records management that enable searchability and traceability functionality are important.

SDG&E has identified IT solutions to support the modernization effort. The intent of these projects is to leverage existing investments in information technology while providing improved functionality to address operational needs in the records management area.

7 Summary of Mitigations

Table 3 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for records management. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 3 were estimated using assumptions provided by SMEs and available accounting data.

Table 3: 2015 Risk Mitigation Plan[11]
(Direct 2015 $000)[12]

ID	Control	Risk Drivers Addressed	Capital (Electric)[13]	O&M (Electric)	Capital (Gas)[14]	O&M (Gas)	Control Total[15]	GRC Total[16]
1	Administrative	• Insufficient training of employees • Insufficient data back-up policies, procedures or processes	n/a	$580	n/a	n/a	$580	$580
2	Training*	• Insufficient training of employees	n/a	30	n/a	0	30	30
3	Operational Compliance and Oversight*	• Insufficient training of employees • Insufficient data back-up policies, procedures or	6,250 (GRC) 1,110 (FERC)	4,710 (GRC) 350 (FERC)	n/a	600	13,020	11,560

[11] Recorded costs were rounded to the nearest $10,000.
[12] The figures provided in Table 3 and 4 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. These costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[13] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[14] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[15] The Control Total column represents the total amount, which includes GRC items as well as any applicable non-GRC items.
[16] The GRC Total column is only presenting those costs which are typically represented in a GRC.

ID	Control	Risk Drivers Addressed	Capital (Electric)[13]	O&M (Electric)	Capital (Gas)[14]	O&M (Gas)	Control Total[15]	GRC Total[16]
		processes						
4	Information Management Systems*	• Insufficient data back-up policies, procedures or processes	16,830	n/a	2,730	n/a	19,560	19,560
	TOTAL COST		$24,190	$5,670	$2,730	$600	$33,190	$31,730

* Includes one or more mandated activities

Table 4 summarizes SDG&E's proposed mitigation plan and associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan and is not requesting funding approval. SDG&E will request approval of funding in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC.

Table 4: Proposed Risk Mitigation Plan[17]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital (Electric)[18]	2019 O&M (Electric)	2017-2019 Capital (Gas)[19]	2019 O&M (Gas)	Mitigation Total[20]	GRC Total[21]
1	Administrative	• Insufficient training of employees • Insufficient data back-up policies, procedures or processes	n/a	$700 - 990	n/a	n/a	$700 - 990	$700 - 990
2	Training*	• Insufficient training of employees	n/a	400 - 1,200	n/a	40 - 110	440 - 1,310	440 - 1,310
3	Operational Compliance and Oversight*	• Insufficient training of employees • Insufficient data back-up policies, procedures or processes	18,860 - 22,630 (GRC) 4,060 - 4,880 (FERC)	6,210 - 7,450 (GRC) 350 - 420 (FERC)	n/a	910 - 1,100	30,390 - 36,480	24,980 - 31,170
4	Information Management Systems	• Insufficient data back-up policies, procedures or processes	63,350 - 76,020	n/a	5,960 - 7,150	n/a	69,310 - 83,170	69,310 - 83,170

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17 Ranges of costs rounded to the nearest $10,000.
18 The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
19 The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
20 The Mitigation Total column represents the total amount, which includes GRC items as well as any applicable non-GRC items.
21 The GRC Total column is only presenting those costs which are typically represented in a GRC.

	TOTAL COST		$86,270 - $103,530	$7,660 - $10,060	$5,960- $7,150	$950- $1,210	$100,840- $121,950	$95,430 - $116,640

	Status quo is maintained
	Expanded or new activity
*	Includes one or more mandated activities

The mitigations and costs presented in Tables 3 and 4 mitigate the risk of Records Management. Some of the activities also mitigate other risks presented in this RAMP Report. For example, Catastrophic Damage Involving Third Party Dig-Ins (Dig-Ins) included GIS-related costs. Because this activity mitigates Records Management as well as Dig-Ins, the costs and risk reduction benefits are being included in all applicable RAMP chapters.

1. Administrative
   This mitigation has an uncertain range of costs. The costs will depend on whether a third-party consultant is hired and how much time will be needed by that consultant to assess and provide recommendations to SDG&E's records management policies and practices.

2. Training
   The cost to increase the frequency of the current records management training from biennially to annually is estimated to be $30,000 per year. The additional training specific to operational asset records management would be between 4-12 hours of additional training for operational employees, with an estimated cost of $400,000 - $1,200,000 annually.

3. Operational and Compliance Oversight
   As mentioned in Section 6, SDG&E's proposed hybrid records management organization would consist of additional 5 to 15 employees. The expected cost of these additional resources is $1,500,000 annually.

4. Information Management Systems
   To support SDG&E's modernization efforts, the proposed applications are estimated to be $70,000,000 in 2017 through 2019.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[22] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[23]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts.

[22] D.16-08-018 Ordering Paragraph 8.
[23] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.

4. **Calculate the risk reduction (change in the risk score).** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 2 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[24] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another.

Figure 2 shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 4 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Records Management risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

SDG&E used the Maturity Model, which is a standard based on GARP developed by the ARMA International to identify and evaluate areas of records management risks. The Maturity Model is a

[24] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

performance-based standard that allows the user to assess the maturity of its records management program.

SDG&E applied the Maturity Model to three different timeframes:

1. Ad Hoc: The level of maturity should SDG&E abandon its current efforts for records management (i.e., administrative, training, operational compliance and oversight, and IT systems).
2. Current 2015: The level of maturity as of 2015.
3. Incremental 2019: The level of maturity if incremental mitigations are implemented in 2019.

The Current Controls were analyzed as one group; the Incremental Mitigations were analyzed as one group, also. Using the maturity model, SDG&E estimated the resulting likelihood of occurrence of the reasonable worst case scenario as follows:

- If the Ad Hoc scenario is applied, there is a risk of one event approximately every 2 years.
- If the Current 2015 scenario is applied, there is a risk of one event approximately every 12 years.
- If the Incremental 2019 scenario is applied, there is a risk of one event approximately every 27 years.

This means that reverting from the 2015 level of maturity to the Ad Hoc level will likely represent an approximately 600% increase in risk. On the other hand, progressing from the 2015 level of maturity to the 2019 prediction will likely represent a 55% reduction in risk.

8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Electric Records Management Controls (current controls)
2. Electric Records Management Mitigations (incremental mitigations)

Figure 3 displays the range[25] of RSEs for each of the SDG&E Records Management risk mitigation groupings, arrayed in descending order.[26] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

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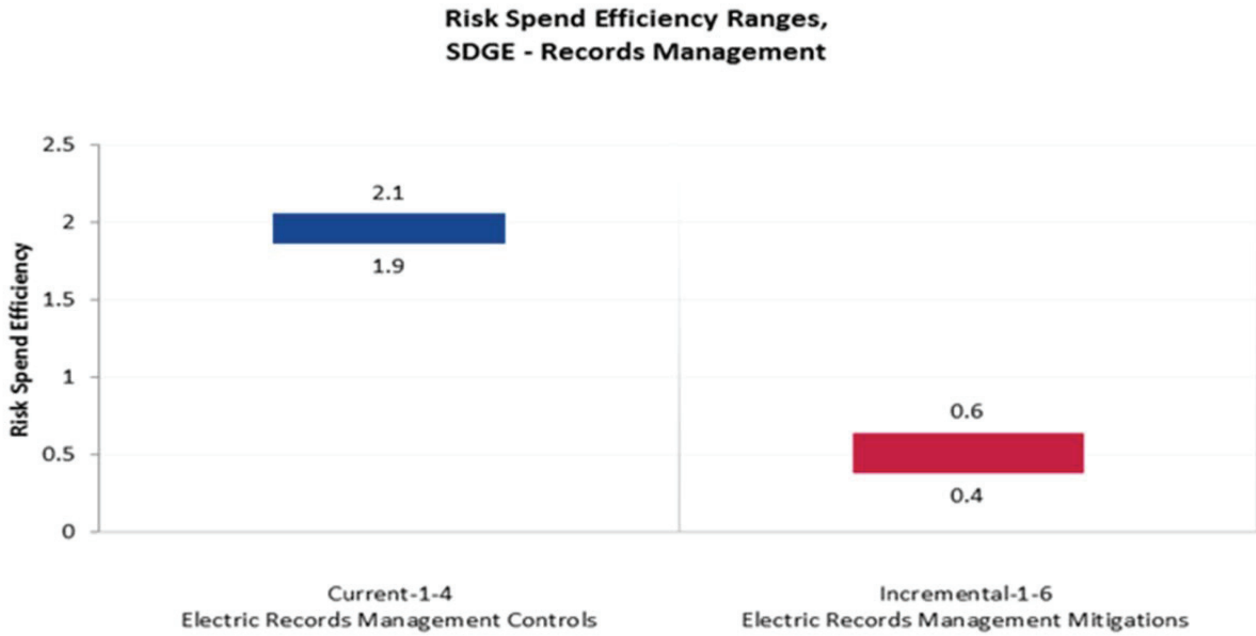
[25] Based on the low and high cost ranges provided in Table 4 of this chapter.
[26] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 3: Risk Spend Efficiency



9 Alternatives Analysis

SDG&E considered alternatives to the proposed mitigations as it developed the incremental mitigation plan for the Records Management risk. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources, and included discussions with key stakeholders.

9.1 Alternative 1 – Maintaining Current Practices and Policies

A potential alternative to the proposals discussed above is to maintain the current records management program, including the risk mitigations in their current state. Although current mitigations are operating effectively, there may be areas that could be improved to further mitigate the risk and provide additional benefit. SDG&E intends to leverage a records management expert (consultant) to identify any potential areas of improvement. Additionally, SDG&E operations groups have identified specific areas for modernization of records. Maintaining the status quo may hinder these projects from moving forward.

9.2 Alternative 2 – Centralized IT Records Application

An alternative for IT applications is to implement one centralized records management IT system for all operational asset groups. This centralized system would replace all existing systems, like GIS, and replace with them with a single system. This alternative would minimize the potential for multiple systems to have differing records and may reduce costs since SDG&E could stop supporting many of its other IT applications. However, this alternative would also prevent each operational asset group from identifying, implementing and utilizing a system that best meets the needs of the specific operational asset group. A one-size-fits-all approach that does not allow specialization because not all records require the same attributes to be collected and retained.

Further, inputting records can take considerable time and resources. SDG&E strives to create interfaces that allow its employees and contractors to quickly and efficiently input data into its systems. This is especially critical as it pertains to the accuracy and completeness of SDG&E's records. Additionally, an effort of this magnitude may cause a significant disruption to the existing records management process and may adversely impact the effectiveness of current mitigations. Therefore, this alternative was rejected in favor of the proposed plan.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Climate Change Adaptation
(Chapter SDG&E-14)

November 30, 2016

TABLE OF CONTENTS

Executive Summary

This chapter addresses the risk of Climate Change Adaptation, or the adjustment in natural or human systems in response to actual or expected climatic changes. Identified threats to SDG&E's gas and electric system due to an evolving climate across the San Diego region include increasing temperatures, a higher potential for wildfire occurrence, accelerated sea level rise, and changes in rainfall patterns. SDG&E's 2015 baseline mitigation plan for Climate Change Adaptation consists of two controls:

1. **Meteorological Support –** Two SDG&E meteorologists allocate 10 percent of their time to climate-related activities to better understand the regional impacts of climate change.
2. **Climate Advisory Group** – In May 2015, SDG&E developed a climate advisory group with representatives from 13 departments. Through semi-annual group meetings and one-on-one communication, these department representatives have worked with SDG&E's meteorologists to identify vulnerabilities to the electric and gas systems due to the projected changes in climate. Their input was combined with a literature review of projected climate change impacts to Southern California, and was provided to the Department of Energy as the first deliverable of the Partnership for Energy Sector Climate Resilience in February 2016.

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability. Examples of proposed activities are as follows:

- SDG&E will continue using the support of two meteorologists, who will dedicate time to researching and educating internal departments on how climate change will impact the electric and gas systems of SDG&E.
- SDG&E proposes the use of consultants to develop an in-depth review of climate change impacts and affected gas and electric assets over 2-3 years, to provide SDG&E risk managers with detailed asset-based risk assessments and potential mitigation strategies.
- SDG&E proposes to partner with a university team of experts to update SDG&E's projected impacts of climate change for both gas and electric threats.

A risk spend efficiency analysis was not performed for the Climate Change Adaptation risk because there is no linkage to adaptive or corrective actions which would have any measurable effect on the probability of their predicted safety consequences.

Risk: Climate Change Adaptation

1 Purpose

The purpose of this chapter (or plan) is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E) for the risk of Climate Change Adaptation. The Intergovernmental Panel on Climate Change (IPCC), global scientists leading the assessment of climate change, define climate change adaptation as the adjustment in natural or human systems in response to actual or expected climatic changes.[1] This is different from climate change mitigation, which refers to human interventions to reduce anthropogenic forcing, including implementing processes to reduce greenhouse gas emissions.[2]

Climate change and adaption are longer term (*e.g.*, 30 year) endeavors. Even so, Climate Change Adaptation is an emerging risk projected to expand over the coming decades. Identified threats due to an evolving climate across the San Diego region include increasing temperatures, a higher potential for wildfire occurrence, accelerated sea level rise, and changes in rainfall patterns that may have a broad reach across many departments within SDG&E.

This risk assessment will focus on the drivers of climate change and the potential resulting impacts to SDG&E. All climate-related impacts identified as threats to the SDG&E service territory of which the Company is aware are addressed in this risk. However, due to the long-term realization of a changing climate, there may be drivers and events currently unknown to SDG&E that may be included in the future. Further, the mitigation activities associated with this risk focus on informing and preparing the Company for climate change. However, there are efforts at SDG&E that, entirely or in part, address climate change. These efforts are captured in other risks presented in the Risk Assessment Mitigation Phase (RAMP) Report. Please refer to the mitigation activities of Wildfires Caused by SDG&E Equipment, Electric Infrastructure Integrity, and Catastrophic Damage Involving Medium-Pressure Pipeline Failure.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a RAMP Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of the utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the

[1] https://www.ipcc.ch/publications_and_data/ar4/wg2/en/annexessglossary-a-d.html.
[2] https://www.ipcc.ch/publications_and_data/ar4/wg2/en/annexessglossary-e-o.html.

California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[3] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

2 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[4] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks.[5] This includes identifying leading indicators of risk. Sections 2 – 8 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Climate Change Adaptation risk.

2.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as a cross-cutting, business model/strategic risk as shown in Table 1.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
CROSS-CUTTING	BUSINESS MODEL/STRATEGIC	

[3] Commission Decision (D.) 14-12-025 at p. 31.

[4] A.15-05-002, filed May 1, 2015, at p. JMD-7.

[5] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.

2.2 Potential Drivers[6]

When performing the risk assessment for Climate Change Adaptation, SDG&E first identified climate change as a driver of different weather-related impacts, including prolonged drought and changing rainfall patterns, rising sea levels, increases in temperature and the potential for heat waves, and an increase in wildfire potential in Southern California. These climate risks are projected to be realized over long-term periods, though it should be noted that impacts from drought and increased wildfire potential are already being realized in the San Diego region.

Also, SDG&E identified potential indicators of risk, referred to as drivers during the 2015 risk assessment for Climate Change Adaptation. These include, but are not limited to:

- Increases in the potential for wildfires and overall acres burned;
- Acceleration of sea level rise along the California coast;
- Changing rainfall patterns and an increased susceptibility to drought; or
- Increases in temperature and a growing number of heat waves.

2.3 Potential Consequences

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

- Health, safety and environmental impacts to customers and the public;
- Project delays;
- Real and personal property damage;
- Damage to SDG&E equipment;
- Increased costs for construction and operations;
- Operational and reliability impacts;
- Regulatory and compliance impacts.

These potential consequences were used in the scoring of Climate Change Adaptation that occurred during the SDG&E's 2015 risk registry process. See Section 3 for more detail.

2.4 Risk Chart[7]

Figure 1 shown below is to pictorially depict the risk of Climate Change Adaptation. The large dot to the left illustrates the potential drivers that lead to a risk event, and the right side shows the potential consequences of a risk event. SDG&E developed this risk chart for the Climate Change Adaptation risk to summarize all the information provided above.

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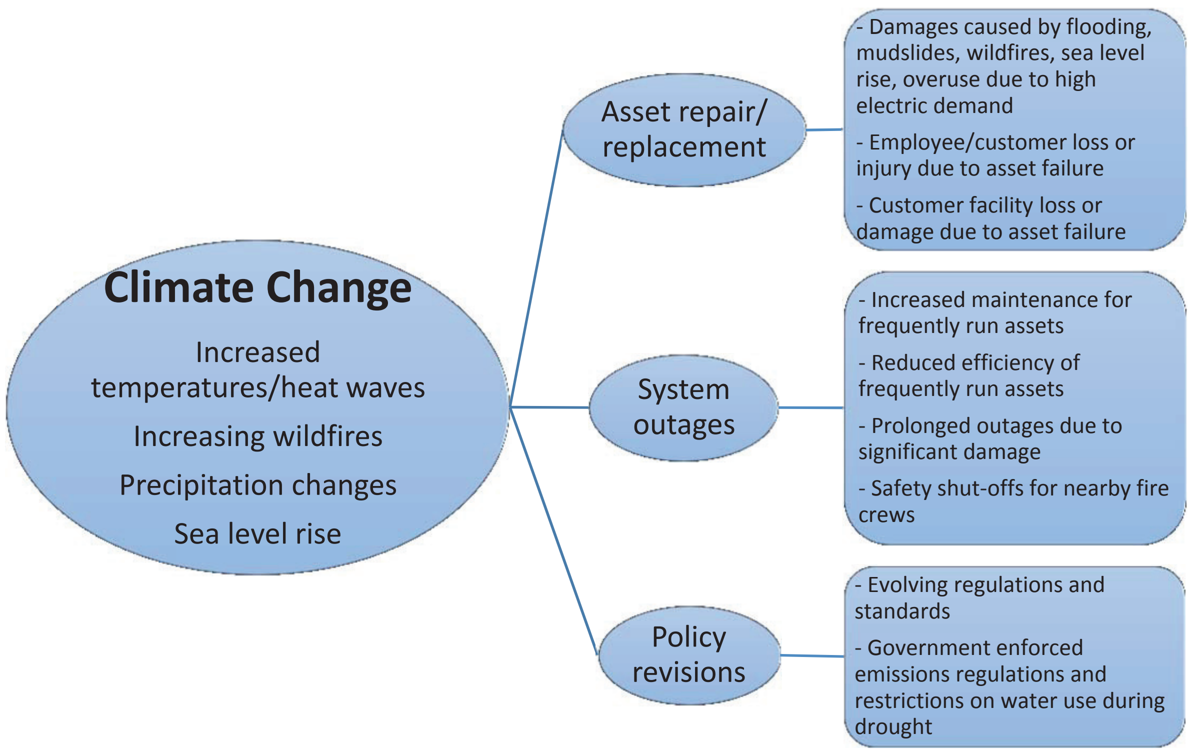
[6] An indication that a risk could occur. It does not reflect actual or threatened conditions.

[7] Climate change is a potential driver that can lead to a risk event. For example, a pipeline rupture (risk event) could occur because climate change may affect cathodic protection. Unlike other risks identified in this RAMP Report represented in the traditional bow tie diagram as the risk event, climate change as a driver did not suit that representation.

Figure 1: Risk Chart



3 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Climate Change Adaptation as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

3.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which an event can occur that may be related to climate change. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a hypothetical situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts assumed a reasonable worst case scenario to develop a risk score for Climate Change Adaptation:

- Extreme winds in SDG&E's Fire Threat Zone during a time of drought and elevated temperatures could cause a wire down event leading to a wildfire. This type of event could result in few serious injuries, service disruptions, and regulatory, legal and financial impacts.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

3.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[8] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 2: Risk ScoreTable provides a summary of the Climate Change Adaptation risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 2: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
4	5	4	5	3	2,656

3.3 Explanation of Health, Safety, and Environmental Impact Score

In determining the scores for this risk, Subject Matter Experts (SMEs) identified the climate variables currently impacting the SDG&E service area, including wildfire, focused on the risk scenario. Research done by the Desert Research Institute indicates that 93% of San Diego residents polled from the wildland urban interfaces in San Diego County have been impacted by wildfire. Should a wildfire event take place, energy may be turned off for thousands of customers, either because of damaged equipment or for safety reasons, at the request of fire agencies attempting to put out the fire. This may have impacts on medical baseline customers who rely on power for their medical equipment. In addition, wildfires can affect indoor air

[8] D.16-08-018 Ordering Paragraph 9.

quality for nearby residents by spreading ash and smoke, leading to decreased lung function and respiratory problems, increasing the risk of burns and injury from debris, and increasing the risk of injury due to motor vehicle accidents caused by smoke-related low visibility. Furthermore, catastrophic wildfire would have significant but short-term impacts on the environment by spreading smoke and ash to nearby regions, and burning vegetation in the immediate vicinity, which leads to a Health, Safety, and Environmental score of 4 (major).

The potential safety consequences of a changing climate are wide-reaching and include everything from long-term power outages to risks of wildfire, fast-moving floodwaters, and extreme heat. The long-term power outages would have the largest safety consequences on medical baseline customers, who require the use of powered medical devices. However, safety concerns would arise for all impacted customers in the event that the outages spanned a time of harsh weather conditions, including extreme heat or cold.

3.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SDG&E gave the other residual impact areas each a score for the following reasons:

- **Operational and Reliability:** A score of 5 (extensive) was provided for this impact area based on, in accordance with the scenario, the ongoing potential for large wildfires. During the October 2007 wildfires that burned 13% of San Diego County, estimates were that full electric service restoration to all customers would take as long as 20 days.[9] According to the 7X7 matrix, a score of 5 is defined as potentially effecting more than 50,000 customers; impacting multiple *critical* locations or customers; or substantial disruption of service for greater than 10 days.
- **Regulatory, Legal, and Compliance:** A score of 4 (major) was provided for this impact area. Climate change is already being discussed by the CPUC for regulatory consideration. In July of 2015, SDG&E executive leadership participated in a climate adaptation en banc hosted by the CPUC and highlighted the efforts of SDG&E in combatting the effects of climate change to build a more resilient system. The CPUC has also offered guidance to the major California utilities in responding to the projected impacts of climate change, urging them to develop inventories of affected assets and to identify and prioritize any vulnerabilities that may arise under a changing climate.
- **Financial:** A score of 5 (extensive) was given for this impact area due to the potential high cost of adaptation programs and the growing need to proactively build resiliency to weather-related hazards. Some of the largest adaptation projects across the country have been referenced, including SDG&E's Fire Risk Mitigation (FiRM) project. The FiRM project is a $1 billion initiative that replaces older overhead distribution lines in the areas deemed most at-risk for wildfires, with stronger steel poles and additional technologies that will make the system more resilient to harsh weather conditions.[10]

The projected severity of climate-related disasters leads to the potential for long-term outages, which can result in increased liability. The widespread impacts possible with climate-related

[9] http://www.oe.netl.doe.gov/docs/ESF12_SitRep11_CAWildfires_102907_100pm.pdf.
[10] http://www.sdge.com/key-initiatives/cleveland-national-forest-power-line-replacement-projects.

events, including wildfire, can also lead to project delays and increased costs for construction and operations to repair or replace damaged infrastructure. In addition, with climate becoming an emerging political topic, increased regulatory consideration and development of stricter climate-related policies will be possible in the years to come.

3.5 Explanation of Frequency Score

Due to its definition as an emerging risk, in determining the scores for this risk, SMEs have reviewed recent climate projections, including the IPCC Fifth Assessment Report[11] and the U.S. Global Change Research Program's National Climate Assessment,[12] to determine that significant climate change impacts will slowly build over the next 10-30 years. For this reason, the frequency score has been listed as a 3 (infrequent).

4 Baseline Risk Mitigation Plan[13]

As stated above, Climate Change Adaptation entails adverse impacts on system planning, system design and emergency operation that may occur due to the changing climate. The 2015 baseline mitigations discussed below include the current evolution of the utilities' risk management of this risk. The 2015 baseline mitigations include the amount to comply with laws that were in effect at that time.

On June 25, 2013, President Obama announced his Climate Action Plan, which defined goals in cutting greenhouse gas pollution in the United States, preparing the country for impacts due to climate change, and leading international efforts and collaborations to address climate change. In response to this plan, the Department of Energy (DOE) developed the Partnership for Energy Sector Climate Resilience. This initiative brings together utilities from across the country in an effort to build the resilience of energy infrastructure to the rising impacts of weather extremes and climate change, thereby enhancing national energy security. This partnership began in November 2014 with SDG&E in attendance as an initial partner.

After joining the Partnership for Energy Sector Climate Resilience, SDG&E SMEs identified that future changes in climate may have wide-reaching impacts to the Company. Because of this, SDG&E began putting baseline mitigations in place. SDG&E's 2015 risk mitigation plan consists of two controls: (1) Meteorology Support; and (2) Climate Advisory Group. These controls focus on safety-related impacts[14] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[15] as well as controls and mitigations that may address reliability. Accordingly, the controls and mitigations described in Sections 4 and 5 address safety-related impacts primarily. Note that the controls and mitigations in the baseline

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[11] *Available at* https://issuu.com/unipcc/docs/syr_ar5_final_full_wcover/1?e=25405816/36622773.
[12] *Available at* http://nca2014.globalchange.gov/report.
[13] As of 2015, which is the base year for purposes of this Report.
[14] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[15] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."

and proposed plans are intended to address various events related to Climate Change Adaptation, not just the scenario used for purposes of risk scoring.

1. Meteorology Support

Two SDG&E meteorologists began allocating 10 percent of their time to climate-related activities to better understand the regional impacts of climate change. Activities included performing literature reviews of climate science, supporting the Company's Enterprise Risk Management efforts, and joining in collaborations with the San Diego Foundation and the San Diego Regional Climate Collaborative to identify the steps other local entities were taking in response to climate change. Examples of literature review sources include the Department of Energy, Scripps Institution of Oceanography, and other federal and local studies. SDG&E also began efforts in 2015 to publish a Vulnerability Report designed for use by the Company to outline the projected climate-related impacts across Southern California, and to identify potential risks to the Company and its infrastructure. The SDG&E Vulnerability Report was submitted to the Department of Energy as a first deliverable in the Partnership for Energy Sector Climate Resilience. That partnership is an initiative that brings together utilities from across the country in an effort to build the resilience of energy infrastructure to the rising impacts of weather extremes and climate change.

Additionally, SDG&E applied for and was awarded a California Energy Commission grant in November 2015 to investigate vulnerabilities to the Company's electric infrastructure due to sea level rise and coastal flooding, as well as vulnerabilities to the Company's gas infrastructure due to all climate-related hazards.

2. Climate Advisory Group

In May 2015, SDG&E developed a climate advisory group with representatives from 13 departments. Through semi-annual group meetings and one-on-one communication, these department representatives have worked with SDG&E's meteorologists to identify vulnerabilities to the electric and gas systems due to the projected changes in climate. Their input was combined with a literature review of projected climate change impacts to Southern California, and was provided to the DOE as the first deliverable of the Partnership for Energy Sector Climate Resilience in February 2016.

Due to the cross-cutting nature of this risk, SDG&E has identified vulnerabilities, addressed in other RAMP chapters, that have a climate change adaptation component. Such risks and vulnerabilities are listed in Table 3 below. These efforts were not included in this chapter because SDG&E largely performs mitigation activities for reasons beyond climate change. For example, SDG&E implemented FiRM to decrease the likelihood of a wildfire, not solely to mitigate climate change. SDG&E SMEs will continue to work with climate scientists to integrate the latest science, and refine climate projections in the future. Please note that only the risks and vulnerabilities included in SDG&E's RAMP Report are being provided below. Those risks not included did not have a Health, Safety, and Environmental score that met the Company's criteria for inclusion in RAMP.

Table 3: Vulnerabilities to Other RAMP Chapters

RAMP Chapter	Potential Climate Drivers	Potential Impacts
Wildfires Caused by SDG&E Equipment	• Increased fire risk to coastal canyons/wildland interfaces • Increasing frequency of drought resulting in longer wildfire seasons	• Potential for damaged/destroyed wooden poles • Increased number of planned work cancellations due to high fire concerns • Potential for distribution impacts of household electricity and gas • Potential for impacts to job scheduling due to extreme fire potential in the spring
Electric Infrastructure Integrity	• Increased fire risk to coastal canyons/wildland interfaces • Changes in rainfall patterns, including higher intensity rainfall events and increased frequency of drought • Rising sea levels and storm surge • Increases in temperatures	• Potential for damaged/destroyed wooden poles • Potential for distribution impacts of household electricity and gas • Increased susceptibility of flooding of low-lying substations and underground infrastructure • Delays in repairs and maintenance as a result of inaccessibility due to flooding • Increases in extreme heat waves, average temperatures, and overnight temperatures may result in stresses and a decrease of the useful life of current infrastructure
Catastrophic Damage Involving Medium-Pressure Pipeline Failure	• Increased susceptibility to drought • Changes in rainfall patterns • Increase in wildfire risk to coastal canyons/wildland interfaces	• Potential decreased effectiveness of cathodic protection on pipelines due to dry soil • Mudslide and landslide prone areas may become more at-risk
Catastrophic Damage Involving High-Pressure Pipeline Failure	• Increased susceptibility to drought • Changes in rainfall patterns • Increase in wildfire risk to coastal canyons/wildland	• Potential decreased effectiveness of cathodic protection on pipelines due to dry soil • Mudslide and landslide prone areas may become more at-risk

	interfaces	
Employee, Contractor, and Public Safety	• Increase in fire risk region-wide, including coastal canyons/wildland interfaces • Increases in temperature and significant heat waves	• Potential for wildfires to result in air quality issues due to smoke, evacuations, etc. • Health issues due to heat

5 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 4 will continue to be performed in the proposed plan to, in most cases, maintain the current residual risk level. In addition, two new mitigations, Consultant Support and University Team, are being proposed. These incremental changes, along with updates about other controls are described in below. It should also be noted that some of the programs and projects proposed in the SoCalGas Climate Change Adaptation RAMP chapter extend to the gas infrastructure in the SDG&E territory. For these activities, please refer to the SoCalGas Climate Change Adaptation RAMP chapter.

1. <u>Meteorology Support</u>

SDG&E will continue to do this baseline activity during the 2017-2019 timeframe. Two meteorologists will dedicate time to researching and educating internal departments on how climate change will impact the electric and gas systems of SDG&E.

2. <u>Climate Advisory Group</u>

SDG&E will maintain this baseline activity in the proposed plan and continue to hold its climate advisory group.

3. <u>Consultant Support</u>

SDG&E proposes to use consultants to develop an in-depth review of climate change impacts and affected gas and electric assets. Similar future studies will be needed as climate science evolves. This initial review would likely take place over 2-3 years, though it would need to be revisited in future years as climate science evolves. The results would provide SDG&E risk managers with detailed asset-based risk assessments and potential mitigation strategies. Until the review is complete, SDG&E does not know at this time what actions or projects it may initiate given the results.

4. <u>University Team</u>

To further mitigate this risk, SDG&E proposes to partner with a university team of experts to update SDG&E's projected impacts of climate change. This partnership would consist of graduate-level teams researching the potential impacts of climate change on SDG&E infrastructure. The scope and length of time required to produce the final product could result in a cost closer to the low end of the range. In contrast, variables such as a premium added (because of the name recognition and distinguished personnel associated with the study) could support costs closer to the high end of the range.

6 Summary of Mitigations

Table 4 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for Climate Change Adaptation. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

Table 4: Baseline Risk Mitigation Plan[16]
(Direct 2015 $000)[17]

ID	Control	Risk Drivers Addressed	Capital[18]	O&M	Control Total[19]	GRC Total[20]
1	Meteorology Support	Addressed/identified potential risks posed to the electric system by climate change	n/a	$20	$20	$20
2	Climate Advisory Group	Addressed/identified potential risks posed to the electric system by climate change	Costs associated with this activity are captured in Meteorology Support			
	TOTAL COST		n/a	$20	$20	$20

* Includes one or more mandated activities

[16] Recorded costs were rounded to the nearest $10,000.
[17] The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[18] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[19] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[20] The GRC Total column shows costs typically presented in a GRC.

Table 5: Proposed Risk Mitigation Plan[21]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[22]	2019 O&M	Mitigation Total[23]	GRC Total[24]
1	Meteorology Support	Address/identify potential risks posed to the electric system by climate change	n/a	$20 - 30	$20 - 30	$20 - 30
2	Climate Advisory Group	Addressed/identified potential risks posed to the electric system by climate change	Costs associated with this activity are captured in Meteorology Support			
3	Consultant Support	Organizing the training of different working groups around SDG&E impacted by climate change	n/a	120 - 180	120 - 180	120 - 180
4	University Team	Investigating the latest science to inform system planning decisions	n/a	230 - 300	230 - 300	230 - 300

21 Ranges of costs were rounded to the nearest $10,000.
22 The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
23 The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
24 The GRC Total column shows costs typically represented in a GRC.

	TOTAL COST		$0	$370 - 510	$370 - 510	$370 - 510

☐	Status quo is maintained
☐	Expanded or new activity
*	Includes one or more mandated activities

1. Meteorology Support

   The 2019 O&M costs associated with this activity were determined by analyzing the amounts recorded in 2015. Because SDG&E does not anticipate changes to this activity, the base year was utilized as the forecast methodology. A range was developed to account for the fact that climate change is an emerging issue for which SDG&E may need to staff additional personnel or dedicate additional time in the future.

2. Climate Advisory Group

   The costs associated with this activity are labor-related and are, therefore, captured in the Meteorology Support mitigation.

3. Consultant Support

   The costs associated with obtaining a consultant were estimated using a zero-based forecast methodology to be between $120,000-180,000. This range was determined using a cost estimate of $10,000-15,000 per month based on similar consulting projects from past years.

4. University Team

   SDG&E's involvement in this academic climate change study is estimated to be about $225,000-$300,000, using a zero-based forecast methodology. In SDG&E's experience with collaborating with universities and other academic institutions, the costs could vary. The current estimate is based on the need for one full-time doctoral student, one professor, and one part-time undergraduate or master's level graduate student.

7 Risk Spend Efficiency

The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. A risk spend efficiency analysis was not performed for the Climate Change Adaptation risk because there is no linkage to adaptive or corrective actions which would have any measurable effect on the probability of their predicted safety consequences. Climate drivers are not "events" to be mitigated; however, they can reveal drivers of potential events or vulnerabilities. These climate change-related vulnerabilities identified in other RAMP chapters are discussed in Section 4. Risk spend efficiency calculations have been performed on the other RAMP risks that are vulnerable to the threats brought about by climate change and are analyzed in those risks, rather than in this chapter.

8 Alternatives Analysis

SDG&E considered alternatives to the proposed mitigations as it developed the proposed mitigation plan for the Climate Change Adaptation risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources.

8.1 Alternative 1 – Additional Resources

SDG&E considered hiring a climatologist, rather than working through SMEs, to perform the desired climate change research discussed in the proposed plan. SDG&E is interested in leveraging this additional expertise in the near future to conduct its initial climate change-related studies. However, at this time, there is not a long-term need for an additional resource. Accordingly, this alternative was dismissed due to the short-term nature of the resource need and the financial constraints that are coupled with hiring additional personnel.

8.2 Alternative 2 – Continue Current Efforts

SDG&E also considered continuing its current mitigation efforts without expanding to include the new mitigation activities (i.e., more research and studies). This alternative was dismissed in favor of the proposed plan because climate change is a dynamic issue that can have a potential safety impact. Preparing SDG&E for climate change, which in turn helps to keep customers and the public safe, is of the utmost importance and has significant value. Maintaining the status quo does not achieve the same level of risk reduction and awareness as the proposed plan.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Public Safety Events - Electric
(Chapter SDG&E-15)

November 30, 2016

A Sempra Energy utility®

309752

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Executive Summary

The Public Safety Events – Electric risk involves public safety and/or property damage related to SDG&E infrastructure, employees or third parties. Injuries to the public or equipment damage or failure can happen in a variety of ways such as motor vehicle accidents, intentional sabotage, construction site activity and non-compliance with safety procedures. SDG&E's 2015 baseline mitigation plan for this risk consists of three controls:

1. Physical Security – activities that maintain the safety of employees, contractors, the public, and SDG&E facilities, through the use of systems, personnel, policies, and procedures. This includes physical security systems, security guards, and the Critical Asset Security Team.
2. Communications and Outreach – efforts designed to increase public awareness of safety with regard to electric assets and services.
3. Design, Operations and Maintenance – SDG&E designs, constructs, maintains, and operates its system in a manner that aims to minimize safety risks to employees, contractors and the public in accordance with the General Orders.

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability. The 2015 baseline mitigations will continue to be performed in the proposed plan. In addition, two of the physical security mitigation activities will expand, with the proposed implementation of additional security systems, security guards at more locations and the increased cost of obtaining contract security.

The risk spend efficiency was developed for Public Safety Events – Electric. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The assessment was completed at a risk portfolio level where the mitigation activities (Physical Security; Communications and Outreach; and Design, Operations and Maintenance) were combined and assessed as one, aggregated mitigation. The metric used to determine the risk spend efficiency of the mitigations was based on physical security data, which evaluates the vulnerabilities facing SDG&E's facilities from a security perspective.

Risk: Public Safety Events – Electric

1 Purpose

The purpose of this chapter (or plan) is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of Public Safety Events – Electric. The Public Safety Events – Electric risk involves public safety and/or property damage related to SDG&E infrastructure, employees or third parties. Injuries to the public or equipment damage or failure can happen in a variety of ways such as motor vehicle accidents, intentional sabotage, construction site activity and non-compliance with safety procedures.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

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[1] Commission Decision (D.) 14-12-025 at p. 31.

The utilities continue to evolve with respect to their risk identification process. In doing so through this RAMP process, SDG&E recognized that the mitigation activities of this risk significantly overlap with those of other identified risks. The other risks include: Employee, Contractor and Public Safety,[2] Physical Security of Critical Electric Infrastructure,[3] and Electric Infrastructure Integrity. Accordingly, the Public Safety Events – Electric mitigation activities will be moved and incorporated into the mitigation plans for these other identified risks post-2015.

2 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[4] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks.[5] This includes identifying leading indicators of risk. Sections 2 – 8 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Public Safety Events – Electric risk.

2.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as an electric, operational risk as shown in Table 1.

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[2] The Employee, Contractor and Public Safety risk from 2015 has now been split into three distinct safety risks: Employee Safety; Contractor Safety; and Customer Safety.
[3] In 2015, the Health, Safety, and Environmental score for the Physical Security of Critical Electric Infrastructure risk did not meet the minimum threshold for the RAMP Report. Accordingly, SDG&E did not include Physical Security of Critical Electric Infrastructure in the RAMP.
[4] A.15-05-002, filed May 1, 2015, at p. JMD-7.
[5] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.

Table 1: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	ELECTRIC	SUBSTATION/ELECTRIC TRANS/DIST

2.2 Potential Drivers[6]

When performing the risk assessment for Public Safety Events – Electric, SDG&E identified potential indicators of risk, referred to as drivers. These include, but are not limited to:

- **Failure of security systems** – SDG&E uses variety of security systems (e.g., gates, card readers, etc.) to prevent the public from gaining access to SDG&E infrastructure. There could be a break down or a breach of one or more of these systems that could allow a member of the public to gain entry. This potential contact could lead to a public safety event.
- **Non-compliance with security procedures** – SDG&E has many safety procedures and policies which include security protocols. These are designed to keep employees, contractors, customers and the public safe. If an employee or contractor fails to follow a Company policy or procedure, this could lead to breach of the security of an SDG&E facility that, in turn, could lead to a public safety event.
- **Intentional and unintentional acts involving SDG&E electric infrastructure** – It is possible for the public to come into contact with SDG&E infrastructure either intentionally or unintentionally, regardless of the safeguards SDG&E puts in place. Intentional acts can include sabotage, terrorism, theft, and burglary. An example of an unintentional act could include someone losing control of a motor vehicle and crashing into utility equipment. Either could lead to an incident that has public safety implications.

Table 2 maps the specific drivers of Public Safety Events – Electric to SDG&E's risk taxonomy.

Table 2: Operational Risk Drivers

Driver Category	Public Safety Events - Electric Driver(s)
Asset Failure	• Failure of security systems
Asset-Related Information Technology Failure	• Failure of security systems
Employee Incident	• Non-compliance with security procedures
Contractor Incident	• Non-compliance with security procedures

[6] An indication that a risk could occur. It does not reflect actual or threatened conditions.

Public Incident	• Intentional acts involving SDG&E electric infrastructure • Unintentional acts involving SDG&E electric infrastructure
Force of Nature	Not applicable

2.3 Potential Consequences

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

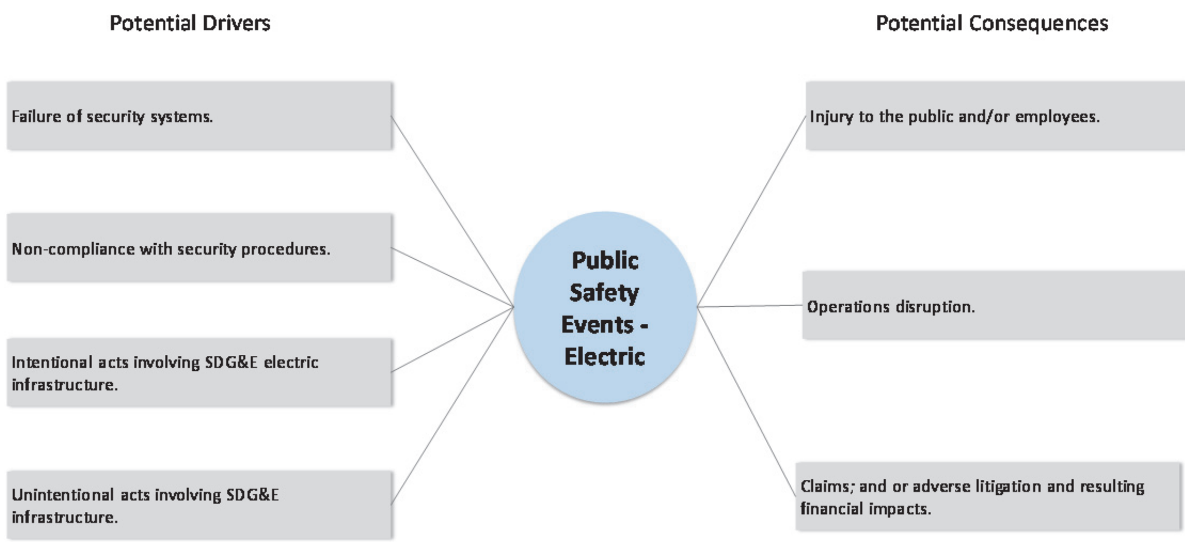
- Injury to the public and/or employees;
- Disruption to operations;
- Claims; and/or
- Adverse litigation and resulting financial impacts.

These potential consequences were used in the scoring of Public Safety Events – Electric that occurred during SDG&E's 2015 risk registry process. See Section 3 for more detail.

2.4 Risk Bow Tie

The risk "bow tie," shown in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



3 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Public Safety Events – Electric as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

3.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which a public safety event can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Public Safety Events – Electric:

- Members of the public trespass on SDG&E property in an attempt to steal copper wire. The individuals come into contact with SDG&E equipment resulting in serious injuries and operational disruptions.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

3.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[7] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the Public Safety Events – Electric risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 3: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
5	3	3	3	3	2,344

3.3 Explanation of Health, Safety, and Environmental Impact Score

When an attempted theft of copper wire occurs, there is potential for the public, employees and/or contractors to be seriously injured by SDG&E equipment. Subject matter experts gave this possible impact a score of 5 (extensive). Intruders from the public may incur a range of injuries ranging from slips and falls to contact with energized equipment. According to an assessment released in October 2010 by the United States Department of Energy (DOE), Office of Electricity Delivery and Energy Reliability (2010 DOE Assessment), the theft of copper wire theft can endanger the safety of utility employees, as the damage may cause them to unknowingly touch undergrounded wires and equipment."[8]

[7] D.16-08-018 Ordering Paragraph 9.
[8] An Updated Assessment of Copper Wire Thefts from Electric Utilities, United States Department of Energy, Office of Electricity Delivery and Energy Reliability, at p. 6: https://www.oe.netl.doe.gov/docs/Updated%20Assessment-Copper-Final-101210%20c.pdf.

3.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SDG&E gave the other residual impact areas each a score of 3 (moderate) for the following reasons:

- **Operational and Reliability:** The 2010 DOE Assessment found that, "Copper wire theft can affect the reliability of electrical service and cause customers to lose power, but the amount and duration of the outages to date has been minor…Power outages due to copper wire theft are typically in the 2,000-3,000 customer range."[9] According to the 7X7 matrix, a score of 3 is defined as potentially effecting more than 1,000 customers; impacting a single *critical* location or customer; or disrupting service for one day. Note that the severity of the operational impact is dependent on the type of asset from which the copper is removed.
- **Regulatory, Legal, and Compliance:** It is possible that a trespassing occurrence at a SDG&E facility could result in litigation or regulatory actions. In accordance with the definitions in the 7X7 matrix, the consequence for this action was deemed to be moderate based on experience with regulatory enforcement and knowledge of current and planned regulation.
- **Financial:** The 2010 DOE Assessment noted that, "A thief typically steals an amount of copper valued at several hundred dollars; the utility normally spends just over one thousand dollars to make the repairs."[10] Material and repair costs resulting from copper theft are relatively minor, particularly given that current copper prices are low, resulting in less demand. Additionally, injuries from copper theft occur infrequently. When considering the potential litigation and regulatory consequences from multiple incidents of this caliber occurring in a given year, SDG&E estimated that the financial impact could be between $1 million and $10 million.

3.5 Explanation of Frequency Score

Subject matter experts used empirical data to the extent available and/or their expertise to determine that the likelihood of an electric public safety incident occurring that would result in many severe injuries to the public or employees was considered to be 3 (infrequent), which is defined in SDG&E's 7X7 matrix as having the potential to occur every 10-30 years in its service territory. While copper theft can occur rather often, [11] it was estimated that the frequency has been reduced considerably because of low copper prices and the mitigation activities SDG&E has implemented to prevent the occurrence of an event.

4 Baseline Risk Mitigation Plan[12]

As stated above, Public Safety Event – Electric risk entails injuries to the public and/or property damage related to SDG&E infrastructure. The 2015 baseline mitigations discussed below include the current evolution of the utilities' risk management of this risk. The baseline mitigations have been developed

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[9] *Id*., at p. 5.
[10] *Id*., at p. 4.
[11] *Id*., at p. iv.
[12] As of 2015, which is the base year for purposes of this Report.

over many years to address this risk. They include the amount to comply with laws that were in effect at that time.

SDG&E's baseline mitigation plan for this risk consists of three controls: (1) Physical Security, (2) Communications and Outreach, and (3) Design, Operations and Maintenance. Subject matter experts from the Safety, Corporate Security, Real Estate and Planning, Customer Communications, Electric Transmission and Distribution Engineering departments collaborated to identify and document them. These controls focus on safety-related impacts[13] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[14] as well as controls and mitigations that may address reliability. Accordingly, the controls and mitigations described in Sections 4 and 5 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Public Safety Events – Electric, not just the scenario used for purposes of risk scoring.

1. <u>Physical Security</u>

The purpose of physical security is to maintain the safety of employees, contractors, the public, and SDG&E facilities, through the use of systems, personnel, policies, and procedures. Physical security at SDG&E supports the maintenance and improvement of safety through the implementation of proactive threat identification and mitigation measures and more effective access control, detection, and interdiction capabilities. Three physical security mitigation activities in this risk mitigation plan align with this purpose: physical security systems, contract security (security guards), and the Critical Asset Security Team (CAST).

Physical security systems provide protection enhancements to infrastructure to improve access control, intrusion detection, and interdiction capabilities to deter, detect, delay, or prevent undesirable events at Company facilities. The type and extent of security upgrades varies by facility, but several have been completed, including, fences, gates and cameras. These upgrades are largely under the jurisdiction of the Federal Energy Regulatory Commission (FERC), with 90% of the costs associated with FERC assets.

In addition to security systems, SDG&E employs *contract security* (security guards) to secure and physically protect assets and people. These security guards are located at critical facilities and work locations. Company policies and procedures outline physical security procedures, including access control, officer post orders and incident reporting.

[13] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[14] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."

The *Critical Asset Security Team (CAST),* composed of personnel from multiple business units, including Corporate Security, Engineering, Operations, Legal and Environmental assists with enhancing security at all of SDG&E's facilities. This cross-functional team was created to assess current security countermeasures across the SDG&E and SoCalGas infrastructure and to make incremental and long-term security recommendations. This team manages the implementation of many of the physical security systems.

2. Communications and Outreach

The activities in the Communication and Outreach mitigation are designed to increase public awareness of safety with regard to electric assets and services. They aim to improve the effectiveness of safety programs by providing the public with useful knowledge and tools to potentially avoid an incident related to SDG&E infrastructure. Some of these communications and outreach campaigns are mandated pursuant to Commission directives. SDG&E uses a variety of channels to communicate and educate its customers and the public about safety. These include: bill inserts, print media, television, radio, web and social media. Also, SDG&E maintains a significant presence in the community through information booths it staffs at many local events.

Examples of the communications and outreach campaigns include:

- Provision of safety and basic operational information about SDG&E's facilities and response as they relate to First Responder operations.
- General safety communications to inform the public about safe practices through a variety of messages, including the 'don't touch downed power lines' campaign.

The efforts listed above are a subset of the cross-cutting campaigns (i.e., support both gas and electric risk mitigation) intended to mitigate the Employee, Contractor and Public Safety risk.

3. Design, Operations and Maintenance

SDG&E designs, constructs, maintains, and operates its system in a manner that aims to minimize safety risks to employees, contractors and the public. SDG&E adheres to the CPUC's General Orders (GO), which establish regulatory requirements. Applicable General Orders for this risk include:

- GO 95 (Rules for Overhead Electric Line Construction);
- GO 128 (Rules for Construction of Underground Electric Supply and Communication Systems);
- GO 165 (Inspection Requirements for Electric Distribution and Transmission Facilities);
- GO 167 (Enforcement of Maintenance and Operation Standards for Electric Generating Facilities); and
- GO 174 (Rules for Electric Utility Substations).

Pursuant to these GOs, SDG&E's standard practices include risk-mitigating activities such as routinely inspecting and maintaining electric infrastructure through the Corrective Maintenance Program (CMP), and constructing overhead power lines and appurtenances to the technical specifications outlined by the GOs and other national and local safety codes.

Further, SDG&E develops and applies internal best practices that are maintained by SDG&E's engineering and operations departments. These include Standard Operating Procedures (SOP), Transmission Maintenance and Construction (TMC) procedures, Distribution Operating Procedures (DOP), Construction Standards, and Electric Standard Practices (ESP). All contribute to protecting employees, contractors, and the public from potential safety risks associated with electric infrastructure.

SDG&E's design and construction activities incorporate safety risk considerations in order to proactively address the risk driver of unintentional acts involving SDG&E electric infrastructure. These considerations, where feasible, include constructing electric facilities (e.g., electric substations) in areas of the community that are not easily visible or accessible by the general public, and where electric workers could perform their maintenance and operational functions safely. When electric facilities are constructed in areas clearly visible to the public, SDG&E displays visible signage to inform the public of potential dangers associated with coming in contact with electric equipment.

In addition to adhering to GO requirements and evolving, applying and maintaining internal engineering and operations best practices, SDG&E continually collaborates with other utilities in order to understand and adopt the latest engineering, design, and safety standards for constructing and operating electric equipment under various conditions.

5 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 4 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. In addition, two of the physical security mitigation activities will expand, with the proposed implementation of additional security systems, security guards at more locations and the increased cost of obtaining contract security. These incremental changes, along with updates about other controls are described in below.

1. Physical Security

Generally, the baseline projects described above have been completed and placed into service. SDG&E is proposing to complete similar security projects to increase protection, such as installing cameras and gates at additional locations. Similarly, the presence of security guards increases protection with the aim of reducing the likelihood of an intentional event.

There are two expanded activities, as compared to the baseline, with respect to security guards. First, SDG&E proposes to add security guards to new locations. The increased number of security guards is needed to respond to risks posed by recent breaches of substation security experienced nationally by other utilities (e.g., incident of intentional damage to Entergy transmission substation and towers in 2013). This kind of risk also could occur within SDG&E's service territory. Second, SDG&E must comply with Senate Bill (SB) 3, which will become effective January 1, 2017. The resulting effects are increases in costs above the GRC standard escalation. In other words, the cost associated with doing business (i.e., employing security guards) has increased, sometimes referred to as non-standard escalation.

2. Communications and Outreach

The Communications and Outreach mitigations will be largely unchanged through 2019 as SDG&E anticipates the continuation of the majority of the safety-related campaigns currently underway.

3. Design, Operations and Maintenance

The Design, Operations and Maintenance mitigation is expected to remain unchanged from the baseline controls described in the previous section. There may be revisions or updates to the General Orders and/or similar requirements, or changes if new requirements are developed. SDG&E will follow and abide by the effective directives and mandates.

6 Summary of Mitigations

Table 4 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for Public Safety Events – Electric. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

SDGE
A Sempra Energy utility

Table 4: Baseline Risk Mitigation Plan[15]
(Direct 2015 $000)[16]

ID	Control	Risk Drivers Addressed	Capital[17]	O&M	Control Total[18]	GRC Total[19]
1	Physical Security	• Failure of security systems • Non-compliance with security procedures • Intentional acts involving SDG&E electric infrastructure	$18,440	$6,600	$25,040	$6,820
2	Communications and Outreach*	• Unintentional acts involving SDG&E electric infrastructure	n/a	730	730	730
3	Design, Operations and Maintenance*	• Unintentional acts involving SDG&E electric infrastructure	Mitigation activities associated with GOs and other mandates are accounted for in other RAMP risks (e.g., Electric Infrastructure Integrity)			
	TOTAL COST		$18,440	$7,330	$25,770	$7,550

* Includes one or more mandated activities

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[15] Recorded costs were rounded to the nearest $10,000.
[16] The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[17] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[18] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[19] The GRC Total column shows costs typically presented in a GRC.

1. Physical Security

Subject matter experts forecasted the costs for the physical security systems and contract security mitigations from a review of historical internal costs and applying high-level assumptions for applicable labor costs.

2. Communications and Outreach

The cost estimates for the baseline Communications and Outreach mitigations were based on applicable, historical costs of campaigns. The costs for communication and outreach will be requested and defended in the Test Year 2019 GRC.

3. Design, Operations and Maintenance

SDG&E's costs associated with Design, Operations and Maintenance of its assets (i.e., through projects and programs associated with the GOs and other mandates) are described and accounted for in other RAMP risks, such as Electric Infrastructure Integrity. Accordingly, these costs are not included here.

While all the controls and baseline costs presented in Table 4 mitigate Public Safety Events – Electric, these controls also may mitigate other risks presented in this RAMP Report. For example, the security guards and one security system project are included in the RAMP risk of Workplace Violence as well. Additionally, the general communications about safety to the public support the mitigation of the RAMP risk of Employee, Contractor and Public Safety. Because these activities benefit Public Safety Events – Electric as well as these other risks, both the costs and risk reduction benefits are included in all applicable RAMP chapters.

Table 5 summarizes SDG&E's proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan, and is not requesting funding approval. SDG&E will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 5 the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 5: Proposed Risk Mitigation Plan[20]
(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[21]	2019 O&M	Mitigation Total[22]	GRC Total[23]
1	Physical Security	• Failure of security systems • Non-compliance with security procedures • Intentional acts involving SDG&E electric infrastructure	$41,090 - 49,920	$8,040 - 9,180	$49,130 - 59,100	$11,380 - 12,960
2	Communications and Outreach*	• Unintentional acts involving SDG&E electric infrastructure	n/a	630 - 760	630 - 760	630 - 760
3	Design, Operations and Maintenance*	• Unintentional acts involving SDG&E electric infrastructure	Mitigation activities associated with GOs and other mandates are accounted for in other RAMP risks (e.g., Electric Infrastructure Integrity)			
	TOTAL COST		$41,090 - 49,920	$8,670 - 9,940	$49,760 - 59,860	$12,010 - 13,720

(white box)	Status quo is maintained
(blue box)	Expanded or new activity
*	Includes one or more mandated activities

1. Physical Security

[20] Ranges of costs were rounded to the nearest $10,000.
[21] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
[22] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[23] The GRC Total column shows costs typically represented in a GRC.

The capital cost estimates for physical security systems were zero-based, derived from initial project projections. The O&M costs were estimated as a percentage of the capital costs using subject matter expertise and experience with historical projects.

The physical security systems are largely capital projects. While the projects will change (e.g., expansion to additional locations), the projected annual spend is expected to be in line with historical spending. The costs for security guards are based on a five-year average labor cost, plus the cost of complying with (SB) 3, plus the cost of additional guarded locations. The cost of CAST was estimated using a base-year forecast methodology, as the activity and related costs are not anticipated to change significantly from 2015 levels.

2. Communications and Outreach

For the Communications and Outreach mitigation, SDG&E used a base year (2015) forecast methodology as the mitigation activities are not anticipated to change from those implemented in 2015.

3. Design, Operations and Maintenance

As in 2015, there are no forecasted costs for the Design, Operations and Maintenance mitigation. Activities and costs associated with mitigating potential safety risks associated with electric infrastructure *failures* and coincident injuries to employees, contractors, or the public, are detailed in the Electric Infrastructure Integrity risk plan.

7 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[24] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[25]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 6). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

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[24] D.16-08-018 Ordering Paragraph 8.
[25] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

7.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

7.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[26] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

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[26] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

7.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 6. They multiplied the risk reduction developed in subsection 7.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure 2 shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 5 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

7.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 7.1, above, in order to assess the RSE for the Public Safety Events – Electric risk. The RAMP Approach chapter in this Report, provides a more detailed example of the calculation used by the Company.

As mentioned above, the Public Safety Events - Electric risk is related to the public's exposure to electrical assets and facilities. As such, the controls in place to manage this risk include communication efforts to warn the public of electric hazards, physical security measures that prevent the public from coming in contact with electrical facilities, and standards and processes that adhere to applicable General Orders from the Commission. The current controls were combined and assessed as one grouping. The incremental mitigations (Physical Security; Communications and Outreach; and Design, Operations and Maintenance) were combined and assessed as one grouping, also. The analysis addressed: (1) The value of continuing existing activities in terms of maintaining the level of the risk; and (2) The value of the proposed incremental spend in terms of further reducing the risk. Of the total funding proposed for the mitigations, approximately 90% is a continuation of existing activities, whereas the remaining 10% represents an expansion of existing activities.

The approach used to estimate the risk reduction from incremental mitigations was based on an assessment methodology developed by Sempra Energy's Corporate Security department, within SDG&E's parent company. This assessment evaluates the vulnerabilities facing SDG&E's facilities from a security perspective.

The difference in baseline scores indicates that if current activities were not in place, the likelihood of the Public Safety Events – Electric risk could increase four-to-five times. Sempra Corporate Security's team determined that the proposed mitigations could potentially further reduce the likelihood between 25% and 35%.

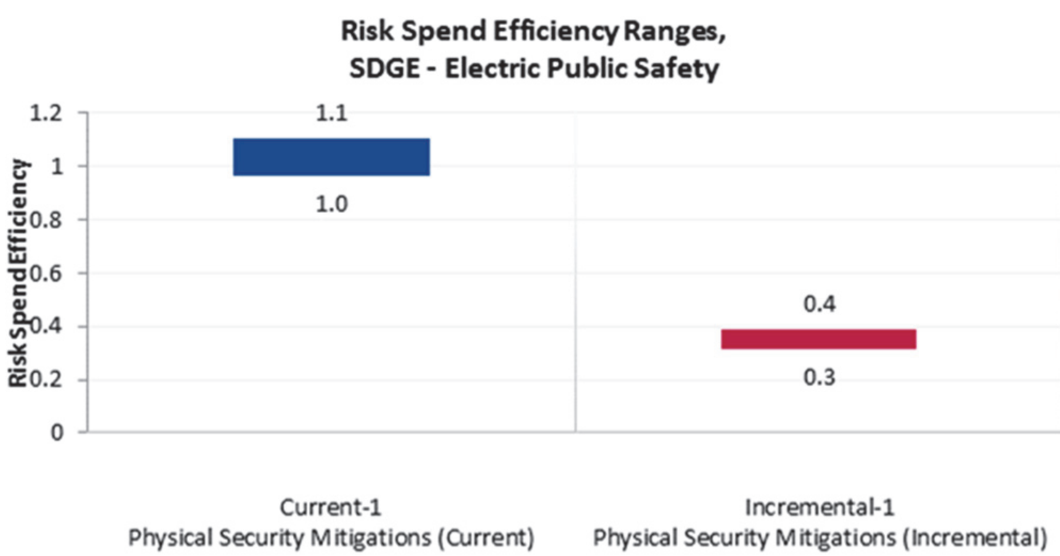
7.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Physical Security Mitigations (current controls)
2. Physical Security Mitigations (incremental mitigations)

Figure 3 displays the range[27] of RSEs for each of the SDG&E Public Safety Events – Electric risk mitigation groupings, arrayed in descending order.[28] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

Figure 3: Risk Spend Efficiency



[27] Based on the low and high cost ranges provided in Table 5 of this chapter.

[28] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

8 Alternatives Analysis

SDG&E considered alternatives to the proposed mitigations as it developed the proposed mitigation plan for the Public Safety Events – Electric risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources.

8.1 Alternative 1 – Physical Security Tradeoffs

Physical security systems (e.g., cameras, fences) and guards could be used as alternatives to each other in some locations for some threats. This would mean that some SDG&E locations would have security guards only while others would have security systems only. The main benefit of this alternative is potential cost savings; however, the use of only one type of mitigation also may increase the risk. Accordingly, this alternative was dismissed in favor of the proposed plan, which includes both physical security systems and guards. Implementing physical security systems and guards together often can reduce risk and provides mutual back-up protection. This alternative is believed to balance affordability with reducing risk.

8.2 Alternative 2 – Security Guard Modifications

SDG&E is proposing to add locations at which it will staff security guards. SDG&E considered maintaining the status quo, meaning no incremental additions of security guards. This alternative would be more cost effective as the additional resources would increase costs; however, similar to the first alternative, this cost savings would result in a potential increase in risk. Accordingly, this alternative was rejected, as the additional locations to be staffed by security guards are mainly needed due to the identification of substantiated threats throughout the industry associated with substation safety.

Risk Assessment and Mitigation Phase
Risk Mitigation Plan

Catastrophic Damage Involving Medium-Pressure Pipeline Failure (SDG&E-16)

November 30, 2016

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Executive Summary

The Catastrophic Damage Involving a Medium-Pressure Pipeline Failure (Medium-Pressure Pipeline Failure) risk relates to the public safety and property impacts that can result from failure of medium-pressure and non-Department of Transportation (DOT) pipelines.

To assess this risk, SDG&E first identified a reasonable worst case scenario, and scored the scenario against five residual impact categories (e.g., Health, Safety, Environmental; Operational & Reliability, etc., discussed in Section 4). Then, SDG&E considered as a baseline, the SDG&E mitigation in place as of 2015 (in Section 5) and estimated the costs (baseline mitigations are summarized in Section 7) SDG&E identified the 2015 controls that comply with Code of Federal Regulation Part 192 and General Order 112:

1. Maintenance
2. Qualifications of Pipeline Personnel
3. Requirements for Corrosion Control
4. Operations
5. Gas Distribution Pipeline Integrity Management

These 2015 controls focus on safety-related impacts (e.g., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability.

Based on the foregoing assessment, SDG&E proposed future mitigations (discussed in Section 6). SDG&E will continue to apply these 2015 controls and proposes to expand and enhance aspects of the Distribution Integrity Management Program (DIMP) and the DIMP Distribution Risk Evaluation and Monitoring System (DREAMS) program as well as add new activities, such as a Cathodic Protection Reliability program.

Finally, SDG&E developed the risk spend efficiency. The risk spend efficiency is a new tool that SDG&E developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. SDG&E's mitigations in its proposed plan were grouped for risk spend efficiency purposes into four categories. The metric used to determine the risk spend efficiency of the mitigations was based on data relating to medium pressure pipelines, including data from PHMSA and asset data. Based on a benefit-cost assessment (i.e. risk spend efficiency), the four mitigations for this risk can be prioritized as follows, from highest risk spend efficiency to lowest:

1. DIMP/Distribution integrity (current controls)
2. Regulatory compliance activities (current controls)
3. Expanded integrity activities (incremental mitigations)
4. Technical training (current controls)

Next, SDG&E developed the risk spend efficiency (sometimes referred to as RSE). The risk spend efficiency is a new tool that SDG&E developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. The RSE was determined using the proposed mitigations and resulted in prioritizing mitigation activities.

Finally, SDG&E considered two alternatives to the proposed mitigations for the Medium-Pressure Pipeline Failure risk, and summarizes the reasons that the two alternatives were not selected as a proposed mitigation.

Risk: Catastrophic Damage Involving Medium Pressure Pipeline Failure

1 Purpose

The purpose of this chapter is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of damage caused by a medium-pressure pipeline (Maximum Allowable Operating Pressure [MAOP] at or lower than 60 psig) failure event with catastrophic consequences (referred to herein as Medium-Pressure Pipeline Failure). This risk concerns a gas public safety event on a medium-pressure distribution pipeline or gas facility, and focuses on routine maintenance and pipeline replacement mitigations consistent with industry standard medium pressure pipeline operations of state of the art polyethylene pipelines and cathodically protected steel pipelines.[1]

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used as base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[2] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

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[1] Mitigation activities addressing damage to gas infrastructure caused by third parties, also referred to as dig-ins, is not addressed in this chapter, but rather discussed in the Risk Assessment Mitigation Phase (RAMP) chapter of Catastrophic Damage Involving Gas Infrastructure (Dig-Ins).
[2] Commission Decision (D.) 14-12-025 at p. 31.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

2 Background

Typically, medium-pressure distribution systems use a series of mains, larger diameter pipe, to feed service lines. The service lines are smaller diameter pipes which feed customer homes, businesses, and some commercial applications. Medium-pressure pipelines are comprised of steel or plastic material.

For safety and compliance purposes, the Code of Federal Regulations (CFR) Part 192 and General Order (GO) 112 are the leading sources, among other legal and regulatory provisions, of requirements for SDG&E's medium-pressure pipeline. CFR Part 192 prescribes minimum safety requirements for pipeline facilities and the transportation of gas and GO 112 complements and enhances the requirements set forth on a federal level at a state level.

With regard to medium pressure lines, the Company currently operates over 8,000 miles of medium-pressure main with nearly 4,500 miles being plastic and upwards of 3,600 being steel (see Table 1 below). These medium-pressure pipelines serve over 875,000 SDG&E consumers.

Table 1: Medium-Pressure Pipelines

Medium-Pressure Main	SDG&E
Miles of Steel	3,596
Miles of Plastic	4,461
Total Miles Medium-Pressure Main	8,057

Various causes and events can lead to medium pressure pipeline failures. Factors can range from improper installation techniques or material defects, aging/environmental factors such as corrosion and fatigue, and inadequate operations or maintenance of the pipeline infrastructure. However, for the purposes of this chapter, the Medium Pressure Failure risk focuses on the more serious results of failures that lead to a release of natural gas with possibility of hazard to life and property.

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand, analyze and categorize risks."[3] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks.[4] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, potential drivers and potential consequences of the Medium-Pressure Pipeline Incident risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as a gas, operational risk as shown in Table 2.

Table 2: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
OPERATIONAL	GAS	MEDIUM AND LOW-PRESSURE (<=60 PSI)

3.2 Potential Drivers[5]

When performing the risk assessment for Medium-Pressure Pipeline Incident, SDG&E identified potential indicators of risk, referred to as potential drivers. The potential drivers for this risk are derived from the listing of cause categories from the Pipeline and Hazardous Materials Safety Administration (PHMSA) database, along with historical events and credible scenarios developed by Subject Matter Experts (SMEs). The potential drivers include, but are not limited to:

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[3] A.15-05-002, filed May 1, 2015, at p. JMD-7.
[4] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[5] An indication that a risk could occur. It does not reflect actual or threatened conditions.

1. **Corrosion** is a naturally occurring phenomenon commonly defined as the deterioration of a material (usually a metal) that results from a chemical or electrochemical reaction with its environment.[6]
2. **Natural Forces** attributable to causes not involving humans, such as earth movement, earthquakes, landslides, subsidence, heavy rains/floods, lightning, temperature, thermal stress, frozen components, high winds.
3. **Other Outside Force Damage** is attributable to outside force damage other than excavation damage or natural forces such as damage by car, truck or motorized equipment not engaged in excavation, etc.
4. **Pipe, Weld or Joint Failure** is attributable to material defect within the pipe, component or joint due to faulty manufacturing procedures, design defects, or in-service stresses such as vibration, fatigue and environmental cracking.
5. **Equipment Failure** is attributable to malfunction of component including but not limited to regulators, valves, meters, flanges, gaskets, collars, couples, etc.

   Incorrect Operations can include a pipeline incident attributed to insufficient or incorrect operating procedures or the failure to follow a procedure.

In accordance with the taxonomy of SDG&E, the potential drivers above can be classified as an asset failure, employee incident, contractor incident, public incident, or force of nature. Table 3 below maps the specific potential risk drivers of Medium-Pressure Pipeline Failure to SDG&E's taxonomy.

Table 3: Potential Operational Risk Drivers

Potential Driver Category	Potential Medium-Pressure Pipeline Failure Driver(s)
Asset Failure	• Corrosion • Pipe, Weld, or Joint Failure • Equipment Failure
Asset-Related Information Technology Failure	Not applicable
Employee Incident	• Other Outside Forces • Incorrect Operation • Pipe, Weld, or Joint Failure
Contractor Incident	• Other Outside Forces • Incorrect Operation
Public Incident	• Other Outside Forces

[6] Corrosion Basics, An Introduction, L.S. Van Delinder, ed. (Houston, TX: NACE, 1984).

Force of Nature	• Natural Forces

3.1 Potential Consequences

If one of the potential risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, may include:

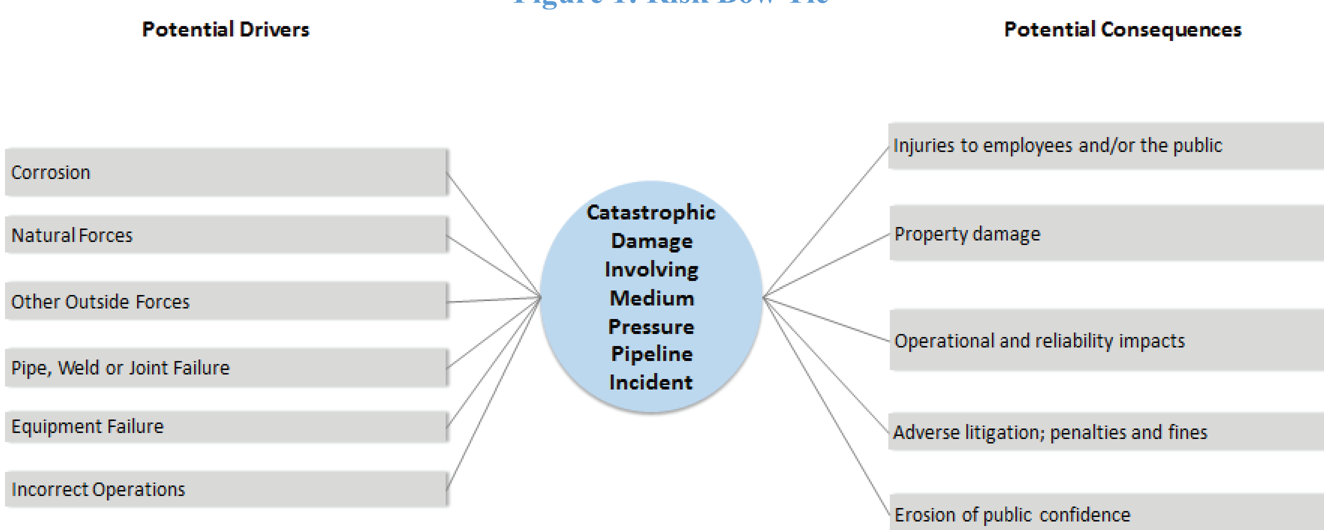
- Injuries to employees and/or the public.
- Property damage.
- Operational and reliability impacts.
- Adverse litigation and resulting financial consequences.
- Increased regulatory scrutiny.
- Erosion of public confidence.

These potential consequences were used in the scoring of Medium-Pressure Pipeline Incident that occurred during the SDG&E's 2015 risk registry process. See Section 4 for more detail.

3.2 Risk Bow Tie

The risk "bow tie," shown in Figure 1, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

Figure 1: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Medium-Pressure Pipeline Incident as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process discussed in this section.

4.1 Risk Scenario – Reasonable Worst Case

For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Medium-Pressure Pipeline Incident:

- A medium pressure pipeline failure due to a control device malfunction, which results in uncontrolled gas release causing injuries to employees and the public, and/or results in over 1,000 customers without gas supply for at least 24 hours.

Note that the following narrative and scores are based on this reasonable worst case risk scenario; they do not address all consequences that may happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[7] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 4 provides a summary of the Medium-Pressure Pipeline Failure risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 4: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
5	3	3	3	3	2,344

[7] D.16-08-018 Ordering Paragraph 9.

4.3 Explanation of Health, Safety, and Environmental Score

The Company scored this risk a 5 (extensive) in the Health, Safety, and Environmental impact area due to the potential of an event resulting in serious injuries to the public or employees, as well as environmental impacts. For example, from 2010-2016 there have been 37 material failure/weld/fitting incidents in the United States on distribution mains, causing two fatalities and approximately 40 injuries.[8] On the other hand, fatalities are rare for these types of incidents compared to other risk events such as dig-ins or failures on high-pressure pipelines. Accordingly, SDG&E determined that a score of 6 (severe) was not appropriate.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SDG&E scored the other residual impact areas in the following manner:

- **Operational and Reliability**: SDG&E scored this impact category as a 3 (moderate). A risk score of 3 is defined in the 7x7 matrix as greater than 1,000 customers affected, impacts a single critical location or customer, or disruption of service for one day. Based on the risk scenario, it a significant customer disruption may occur in which a whole street, several homes, or a whole block loses gas service depending if the damages involved medium pressure gas main or service lines.
- **Regulatory, Legal, and Compliance**: SDG&E scored this impact category as a 3 (moderate). SDG&E scored in this manner because of the potential lawsuits and financial impacts. The most common legal issue associated with this risk scenario typically involves lawsuits.
- **Financial**: The Company could suffer financial repercussions as a result of the other risk areas. Potential litigation and penalties from the CPUC and PHMSA are prime examples of the costs associated with the medium-pressure pipeline system failing. Though the exact cost of litigation and other potential financial consequences can vary depending on the type of incident, if a failure were to occur, the potential financial loss could be between $1 million and $10 million. The risk score of a 3 (moderate) was assigned due to the fact that all incidents are collateral damages of the first risk area, health, safety, and environment assigning it a secondary type of risk.

4.5 Explanation of Frequency Score

The frequency of an event occurring was assumed to be once every 10-30 years; a score of 3 (infrequent). According to PHMSA, between 1996-2015, there have been nine (9) fatalities in California due to medium-pressure failures. See below.

PHMSA Pipeline Incidents: (1996-2015)
Incident Type: Serious **System Type:** GAS DISTRIBUTION **State:** CALIFORNIA

Calendar Year	Number	Fatalities	Injuries
1996	1	0	3
1997	1	1	2
1998	3	0	4
1999	3	0	3
2000	2	0	2
2001			
2002	1	1	0
2003	3	1	2
2004			
2005	1	0	1
2006	1	0	1
2007	4	0	5
2008	4	1	5
2009			
2010			
2011			
2012	2	3	1
2013			
2014	2	2	1
2015	1	0	2
Grand Total	**29**	**9**	**32**

Therefore, the risk score is a reasonable estimate of how frequently these types of events happen.

5 Baseline Risk Mitigation Plan

As stated above, Medium-Pressure Pipeline Failure risk potentially impacts the public and/or property damage. The 2015 baseline mitigations discussed below includes the current evolution of the utilities' risk management of this risk. The baseline mitigations have been developed over many years to address this risk and they include activities to comply with laws that were in effect at that time. SDG&E's baseline mitigation plan for this risk consists of controls based on CFR Part 192 and GO 112-E.

The primary areas highlighted in the risk registry are:

1. CFR 192 Subpart M – Maintenance
2. CFR 192 Subpart N – Qualifications of Pipeline Personnel
3. CFR 192 Subpart I – Requirements for Corrosion Control
4. CFR 192 Subpart L – Operations
5. CFR 192 Subpart P – Gas Distribution Pipeline Integrity Management

These controls focus on safety-related impacts[9] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[10] as well as controls and mitigations that may address reliability.[11] Accordingly, the controls and mitigations described in this section and in Section 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed risk mitigation plans are intended to address various events related to Medium-Pressure Pipeline Failure and are not limited to the reasonable worst case risk scenario used for the Risk Score.

1. <u>CFR 49 Part 192 Subpart M – Maintenance</u>

Federally mandated activities to provide the minimum safety requirements for medium-pressure pipelines. These activities include performing pipeline patrols; bridge and span, meter set assemblies, valve and regulator inspections; and maintenance on a regular basis throughout the year. These activities are intended to address threats as identified by PHMSA, specifically outside forces (vandalism, fault lines, liquefaction, etc.), equipment failure (pipeline facilities and components) and corrosion. The activities include but are not limited to:

- Inspections of natural gas pipeline over bridges and land crossings at least once every two calendar years, but with intervals not exceeding 27 months
- Each pressure limiting station, relief device, signaling device, and pressure regulating station and its equipment must be inspected and tested at intervals not exceeding 15 months, but at least once each calendar year.
- Each valve must be checked and serviced at intervals not exceeding 15 months, but at least once each calendar year. (CFR 192.747).
    - Prompt remedial action must be taken to repair an inoperable valve unless an alternative valve is used to divert gas.
- Region operations may perform tests and inspections at times other than the compliance period but cannot be substituted for federally mandated valve inspection in CFR 192.747.

2. <u>CFR 49 Part 192 Subpart N – Qualifications of Pipeline Personnel</u>

The training, set forth in Subpart N, requires a qualification program on covered tasks, recordkeeping, and evaluation. Each covered task is attached to a gas standard which contains a full description of what

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[9] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[10] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[11] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

the employee/contractor will have to perform. For distribution programs, the following training subsets are the most prominent:

- Distribution construction technician training
- Distribution lead construction technician
- Distribution system protection specialist
- Distribution valve tech training
- Distribution welder training
- Distribution instrument tech training
- Distribution regulator tech training

By properly training employees and contractors through the distribution technician training, the frequency of potential accidents can be lowered because the training educates the employees and contractors on proper safety techniques and standards. After a prescribed amount of years, SDG&E's employees are evaluated and requalified to reflect any changes in Company or federal standards.

3. CFR 49 Part 192 Subpart I –Requirements for Corrosion Control Operations

As prescribed by CFR 192 Subpart I –Requirements for Corrosion Control Operations, the minimum safety requirements include monitoring of cathodic protection (CP) areas, remediation of CP areas that are out of tolerance, and preventative installations to avoid areas out of tolerance. These activities are intended to address threats as identified by PHMSA specifically corrosion both external and internal. The following summarizes the required intervals for completing these preventative measures:

- Each pipeline that is under cathodic protection must be tested at least once each calendar year, but with intervals not exceeding 15 months, to determine whether the cathodic protection meets the requirements of §192.463.
- Each cathodic protection rectifier or other impressed current power source must be inspected six times each calendar year, but with intervals not exceeding two and a half months, to insure that it is operating.

4. CFR 49 Part 192 Subpart L – Operations

The minimum safety requirements prescribed by CFR 192 Subpart L – Operations include locate and mark, emergency preparedness and odorization. These activities are intended to address threats as identified by PHMSA. Locate and mark activities are specific to third party damage while emergency preparedness and odorization are intended to address all threats. The following provides the required intervals for completing these preventative measures as prescribed in Subpart L and SDG&E complies with these requirements:

- To assure the proper concentration of odorant in accordance with this section, each operator must conduct periodic sampling of combustible gases using an instrument capable of determining the percentage of gas in air at which the odor becomes readily detectable

5. CFR 49 Part 192 Subpart P – Gas Distribution Pipeline Integrity Management

PHMSA established DIMP requirements to enhance pipeline safety by having operators identify and reduce pipeline integrity risks for distribution pipelines, as required under the Pipeline Integrity, Protection, Enforcement and Safety Act of 2006.

(a) SDG&E has implemented certain Programs and Activities to Address Risk (PAARs) and DREAMS PAAR prioritizes certain early-vintage steel (pre-1960) and plastic (pre-1986), including Aldyl-A, for replacement. With regard to plastic, PHMSA Advisory Bulletin ADB-07-01 states that "the number and similarity of plastic pipe accident and non-accident failures indicate past standards used to rate the long-term strength of plastic pipe may have overrated the strength and resistance to brittle-like cracking for much of the plastic pipe manufactured and used for gas service from the 1960s through the early 1980s." The DREAMS risk evaluation therefore considers the cause of the leak, the leakage history, cathodic protection (for steel), vintage of the pipe and the location using E-GIS.

(b) *EPOCH*

Projects are generated from field crew field observations concerning the condition of the pipe. Generally, Epoch projects start with a single coded leak repair. The section of pipe to be replaced is added to the Epoch list and risk-ranked. The scores are reevaluated when another leak occurs in the same area of an identified Epoch project; which could result in the project moving up the list.

6 Proposed Risk Mitigation Plan

SDG&E will continue with its baseline activities described in Section 5 above. In addition, SDG&E is proposing to expand and add new mitigations to further address the risk of medium pressure pipeline failure. The proposed activities and costs for the mitigations are primarily based on the Code of Federal Regulation Part 192 and General Order 112-F state requirements.

It should be noted that the proposed activities do not account for the Notice of Proposed Rule Making (NPRM) issued by PHMSA on Pipeline Safety: Safety of Gas Transmission and Gathering Pipelines which may expand the integrity requirements beyond HCAs, require the verification of Maximum Allowable Operating Pressure (MAOP), and records requirements among other items.

SDG&E proposes to expand the Gas Distribution Pipeline Integrity Management mitigation as well as add new projects and programs included in a mitigation labeled Improvements. These incremental activities are described below.

1. *Expansion of DIMP*

SDG&E proposes to expand the DREAMS program. For DREAMS, SDG&E proposes to accelerate this program in order to replace certain mains and services at a faster rate. As part of the DREAMS program, SDG&E primarily replaces Aldyl-A pipe. Currently, SDG&E replaces approximately 17 miles of pipe per year in the DREAMS program of which Aldyl-A pipe is 16.5 miles. SDG&E is proposing to accelerate the replacement of Aldyl-A pipe in the SDG&E gas system by replacing an additional 17 miles per year to total 34 miles per year.

2. *Improvements*

Further, SDG&E proposes to implement new projects and programs. Examples of these new projects and programs are:

- Dresser Mechanical Couplings – This program consists of evaluating the coupling field location, excavating, and assessing the weld housing to encapsulate the dresser mechanical couplings main in and near downtown San Diego. In the event of a strong earthquake or exposure of 12" pipeline, leaking or failure may occur if not addressed properly.
- Oil Drip Piping – This project is designed to verify the location of above ground and buried oil drip lines and containers. As part of the process, SDG&E consults with Pipeline Operations and Region Engineering to determine and remove facilities that are not necessary. The buried facilities are at risk of excavation damage because certain maps showing their size and location are not available.
- Buried Piping in Vaults – SDG&E has pipeline buried in vaults that may be corroded by above ground facilities and pitting of below ground piping. This activity will determine the locations vaults containing medium and high pressure facilities. SDG&E will assess the coating and the condition of the above-ground and below-ground facilities within the vaults.
- CP Reliability Program – This is a region specific program which will perform a detailed cathodic protection evaluation that will include the development of a relative risk algorithm to assess the "health" of the CP system. The information would feed into a relative risk ranking tool for DIMP segments that are under CP protection. The CP system analysis would include enhanced documentation and expanded analysis of the system's routine maintenance records collected per 49 CFR 192 Subpart I – Requirements for corrosion control. The end result of the CP reliability analysis should be a health ranking and project list that could be used to prioritize such projects. The CP reliability project will assess 520 CP areas to determine the research required to generate the risk algorithm. The timing of implementing this program is currently uncertain as SDG&E may commence this program in a year other than the test year (2019). Accordingly, a larger range of costs for O&M is provided in Table 6 for the Improvements mitigation.
- Closed Valves between High and Medium Pressure Piping – SDG&E has identified valves for remediation. Currently, the valves are closed and locked; however, the valves need to be removed because an inadvertent opening would overpressure medium pressure pipelines. This

proposed activity involves verifying the valve location, excavating, and removing the closed and locked valves which connect high pressure piping to medium pressure piping.

- Early Vintage Steel Replacement - This program is intended to remove pre-1947, non-piggable high pressure pipeline as well as pre-1955 medium pressure steel mains. In the years prior to 1955, cold tar asphaltic wrap was used as the primary protection against corrosion with cathodic protection supplementing as secondary protection. Over time, the cold tar asphaltic wrap can degrade and dis-bond from the pipe. This program is intended to remove early-vintage pipe. This would be a 10 year program to remove 15 miles of pipe per year of poor performing pipe.
- Threaded Piping Removal – Prior to 1933, piping in the gas distribution system was joined by treaded couplings. This project aims to proactively remove a total of 152 miles of threaded pipe over a 10-year period. This would be a 10-year program to remove 15 miles of pipe per year.

7 Summary of Mitigations

Table 5 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) addressed the 2015 baseline costs for Medium-Pressure Pipeline Incident. While control or mitigation activities may address both potential risk drivers and potential consequences, potential risk drivers link to the likelihood of a risk event. Thus, potential risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for or track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 5 were estimated using assumptions provided by SMEs and available accounting data.

Table 5: Baseline Risk Mitigation Plan[12]
(Direct 2015 $000)[13]

ID	Control	Potential Risk Drivers Addressed	Capital[14]	O&M	Control Total[15]	GRC Total[16]
1	Maintenance*	• Asset Failure • Public Incident • Force of Nature	$1,220	$5,780	$7,000	$7,000
2	Qualifications of Pipeline Personnel*	• Employee Incident • Contractor Incident	200	500	700	700
3	Requirements for Corrosion Control *	• Asset Failure • Public Incident Force of Nature	530	1,400	1,930	1,930
4	Operations*	• Asset Failure • Employee Incident • Contractor Incident • Public Incident	500	500	1,000	1,000
5	Gas Distribution Pipeline Integrity Management*	• Asset Failure • Public Incident	6,210	20	6,230	6,230
	TOTAL COST		$8,660	$8,200	$16,860	$16,860

* Includes one or more mandated activities

[12] Recorded costs were rounded to the nearest $10,000.
[13] The figures provided in Tables 5 and 6 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[14] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[15] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[16] The GRC Total column shows costs typically presented in a GRC.

Specifically as it relates to training, SDG&E does not track its employees' and contractors' labor in a manner that distinguishes when and how long an employee or contractor attended training compared to when they were performing their "typical" job function. Accordingly, for training, assumptions were used based on the known number of students that attended the safety-related distribution training, the duration of the training and a derived labor rate. Training materials and instructor costs were also included in the cost of the Qualifications of Pipeline Personnel control.

Table 6Table 6 summarizes SDG&E's proposed mitigation plan, associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan, and is not requesting funding approval. SDG&E will request approval of funding, in its next GRC. As set forth in Table 6, the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Table 6: Proposed Risk Mitigation Plan[17]
(Direct 2015 $000)

ID	Mitigation	Potential Risk Drivers Addressed	2017-2019 Capital[18]	2019 O&M	Mitigation Total[19]	GRC Total[20]
1	Maintenance*	• Asset Failure • Public Incident • Force of Nature	$2,980 - 3,300	$5,870-6,490	$8,850 - 9,790	$8,850 - 9,790
2	Qualifications of Pipeline Personnel*	• Employee Incident • Contractor Incident	1,420 - 1,730	790 - 960	2,210 - 2,690	2,210 - 2,690
3	Requirements for Corrosion Control *	• Asset Failure • Public Incident Force of Nature	6,070 - 6,710	1,460 - 1,620	7,530 - 8,330	7,530 - 8,330
4	Operations*	• Asset	1,410 -	470 - 520	1,880 - 2,080	1,880 - 2,080

[17] Ranges of costs were rounded to the nearest $10,000.
[18] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
[19] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[20] The GRC Total column shows costs typically represented in a GRC.

		Failure • Employee Incident	1,560			

Status quo is maintained
Expanded or new activity
* Includes one or more mandated activities

5	Gas Distribution Integrity Management Programs*	• Asset Failure • Public Incident	64,480 - 89,160	220 - 300	64,700 - 89,460	64,700 - 89,460
6	Improvements	• Asset Failure • Public Incident	129,270 - 142,870	0 - 6,700	129,270 - 149,570	129,270 - 149,570
	TOTAL COST		$205,630 - $245,330	$8,810 - 16,590	$214,440 - 261,920	$214,440 - 261,920

While all the mitigations and costs presented in Tables 5 and 6 mitigate the Medium-Pressure Pipeline Failure risk, some of the activities also mitigate other risks presented in this RAMP Report, including: Catastrophic Damage Involving Third Party Dig-Ins (Dig-Ins) and Employee, Contractor and Public Safety. Because these activities mitigate Medium-Pressure Pipeline Failure as well as these aforementioned risks, both the costs and risk reduction benefits are included in all applicable RAMP chapters.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[21] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[22]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the

[21] D.16-08-018 Ordering Paragraph 8.
[22] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.

4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 4 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[23] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure 2 shows the RSE calculation.

Figure 2: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 6 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 8.1, above, in order to assess the RSE for the Medium Pressure Pipeline Incident risk. The RAMP Approach chapter in this Report, provides a more detailed example of the calculation used by the Company.

To calculate the RSE, SDG&E began with the six mitigations in its proposed plan:

1. Maintenance

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[23] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

2. Qualifications of Pipeline Personnel
3. Requirements for Corrosion Control
4. Operations
5. Gas Distribution Pipeline Integrity Management
6. Improvements

SDG&E then analyzed and arranged these mitigations into common groupings that addressed similar potential drivers or potential consequences for purposes of the RSE analysis:

(a) DIMP/Distribution integrity (current controls)
(b) Technical training (current controls)
(c) Regulatory compliance activities (current controls)
(d) Expanded integrity activities (incremental mitigations)

For each of these four mitigation groupings, SDG&E determined the preferred methodology for quantifying the RSE. The primary assumption for the RSE for the Medium-Pressure Pipeline Failure risk was that performance would deteriorate in the absence of the mitigation. Data from the PHMSA and asset data, where applicable, was used to model the deterioration boundaries. The appropriate data is selected based on the judgment of SMEs.

- **DIMP/Distribution Integrity (current control)**

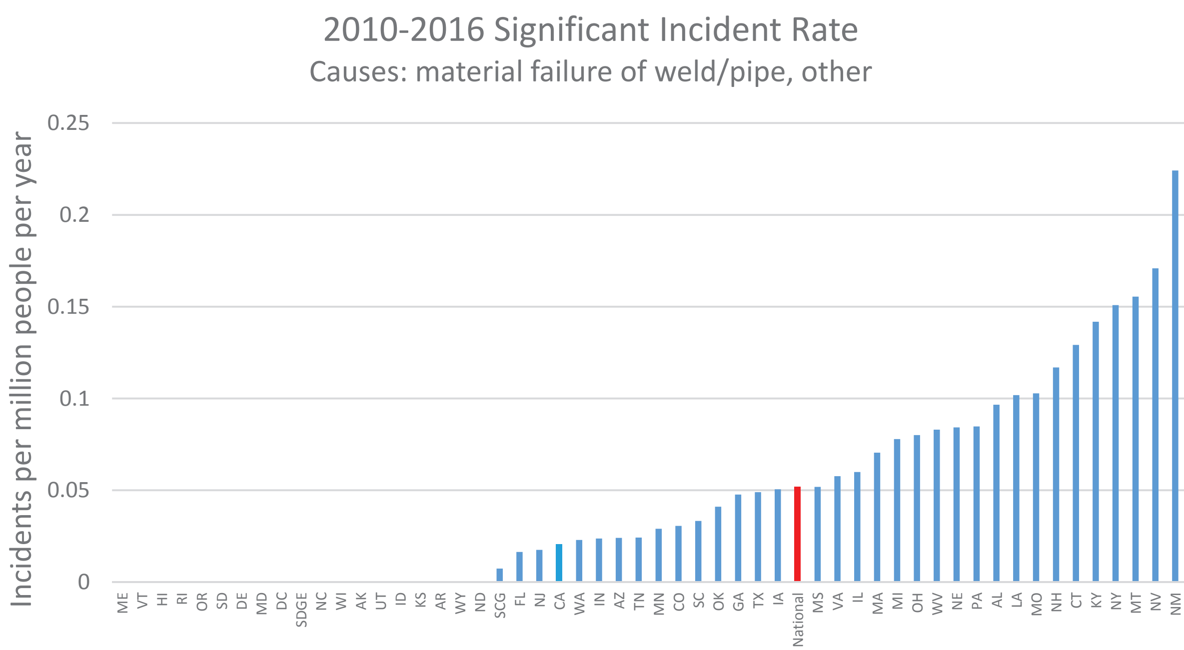
The RSE modeling approach for distribution integrity programs entailed finding the level of possible performance deterioration if these programs did not exist, which would represent the baseline, inherent risk level. It is assumed that should the program not be funded, then performance would deteriorate to at best the incident rate of the worst state in the nation. The term "at best" is used because even the worst-performing states are assumed to have some programs in place.

The potential drivers associated with a medium pressure pipeline incident are material failure of weld or pipe and other. This was compared to the current incident rate due to all potential drivers so as to attain the level of deterioration from current levels should that program not be funded.

Not all targeted assets will be remediated within the time period of interest. To account for this, the risk reduction of the program will be prorated proportionally comparing the number of assets remediated to the total assets.

The chart shown below contains the pipeline failure incident rates of all 50 states, in addition to SDG&E and the national average. SDG&E is among the entries with zero incidents per million people per year, and the worst-performing state is New Mexico at 0.224 incidents per million people per year. Using SDG&E's service population of 3.6 million people, the incident rates can be converted to an incident expectation, given by the following calculation:

$$Expected\ Incident\ Rate = \Delta(Incident\ Rate) * Service\ Population$$
$$= (0.224 - 0)\ incidents\ per\ million\ people\ per\ year * 3.6\ million\ people$$
$$= 0.81\ incidents\ per\ year$$



The average number of SDG&E incidents per year from all causes for the same time period is 0.46[24], the proportion of targeted miles being addressed is 100%, and the assumed replacement effectiveness is 1. Putting it all together, the residual risk multiplier is given by the following calculation:

$$Residual\ Risk\ Multiplier$$
$$= Potential\ deterioration\ factor * Proportion\ of\ Remediated\ Assets * Effectiveness$$
$$Residual\ Risk\ Multiplier = \frac{0.81\ incidents\ per\ year}{0.46\ incidents\ per\ year} * 100\% * 1$$
$$Residual\ Risk\ Multiplier = 1.7$$

Therefore, if the mitigation is not funded, the projected risk is 1.7 times the current residual risk.

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[24] Expected Incidents per year for All Causes for SDG&E = Current Incidents per year per million people * Service population
= 0.1282 incidents per year per million people * 3.6 million people
= 0.46 incidents per year

- **Technical Training (current control)**

The RSE modeling approach for these programs was the same as that used for distribution integrity programs above with a couple of slight differences. The first difference was that a different set of incident causes is used to establish the worst state performance level. Potential drivers considered applicable to this category are: incorrect operations. The second difference was that there is no secondary adjustment for the percentage of targeted assets and no effectiveness factor. It was assumed that the effect of structured training takes time to fade, up to a decade, due to lack of refresher training and turn over. The fading effect is accounted for by dividing by 3.

For this category of projects, the residual risk multiplier is (0.9 / 0.5) X (100%) X (1) / (3) = 0.7. Therefore, if the mitigation is not funded, the projected risk is 0.7 times the current residual risk.

- **Regulatory Compliance Systems (current control)**

The RSE modeling approach for these programs was the same as that used for distribution integrity programs with two exceptions. The first exception was that a different set of incident drivers is used to establish the worst state performance level. Potential drivers considered applicable to this category were: all causes. The second exception is that there was no secondary adjustment for the percentage of targeted assets and no effectiveness factor.

For this category of projects, the residual risk multiplier is (3.8 / 0.5) X (100%) X (1) = 8.2. Therefore, if the mitigation is not funded, the projected risk is 8.2 times the current residual risk.

- **Expanded distribution integrity activities (incremental mitigation)**

The RSE modeling approach for these programs was the same as that used for distribution integrity programs with one exception. The exception was that a different set of incident drivers is used to establish the worst state performance level. Potential drivers considered applicable to this category were: corrosion and material failure of weld or pipe.

The average number of incidents per year from all potential drivers for the time period of interest is 0.5, the percentage of targeted miles being addressed is 12%, and the assumed replacement effectiveness is 5. Putting it all together, the residual risk multiplier is (0.8 / 0.5) X (12%) X (4) = 0.9. Therefore, if the mitigation is not funded, the projected risk is 0.9 times the current residual risk.

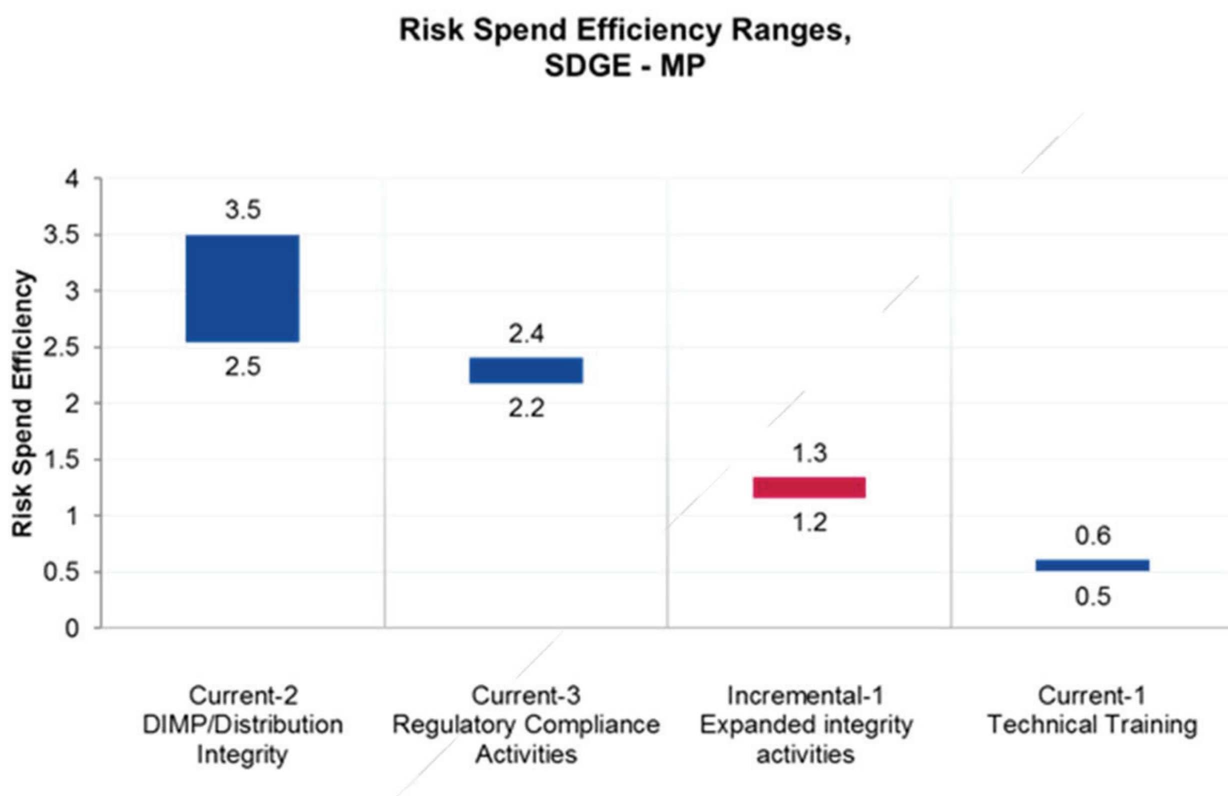
8.3 Risk Spend Efficiency Results

Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. DIMP/Distribution integrity (current controls)
2. Regulatory compliance activities (current controls)
3. Expanded integrity activities (incremental mitigations)
4. Technical training (current controls)

Figure 3 displays the range[25] of RSEs for each of the SDG&E Medium Pressure Pipeline Failure risk mitigation groupings, arrayed in descending order.[26] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

Figure 3: Risk Spend Efficiency



9 Alternatives Analysis

SDG&E considered alternatives to the proposed mitigations for the Medium-Pressure Pipeline Failure risk. After consideration, these alternatives were dismissed in favor of the proposed plan, as described below.

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[25] Based on the low and high cost ranges provided in Table 6 of this chapter.
[26] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

9.1 Alternative 1 – Adjustments to Scope

For SDG&E, each individual proposed program was considered as an alternative risk mitigation plan (i.e. CP betterment, replacement of threaded main, Oil drip piping removal, etc.). SDG&E considered prioritizing the program that had the largest risk/benefit reduction, affordability, and reasonable completion time. However, this alternative was not considered because of the small impact relative to overall risk mitigation proposal and objective. The reason for this is that it is more effective to address all risks at the same time to ultimately have a larger risk/benefit impact in the overall scheme of mitigating the Medium-Pressure Pipeline Failure risk.

9.2 Alternative 2 – DIMP Status Quo

SDG&E considered maintaining the status quo for Aldyl-A medium pressure pipe replacement under the DIMP program. Each year the program would *require $20 million per year* to operate and eventually eliminate all Aldyl-A pipe. Due to the fact that a small percentage of non-state-of-the-art pipes exist in the system, SDG&E determined there would be a higher benefit to eliminating the current risk associated with Aldyl-A pipe altogether in a timely manner rather than extending the time it will take to replace all of it.

Risk Assessment Mitigation Phase
Risk Mitigation Plan
Workforce Planning
(Chapter SDG&E-17)

November 30, 2016

310317

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Executive Summary

Workforce Planning is the risk of the loss of employees with deep knowledge, understanding and experience in operations due to retirements. Employees age 62 or older who meet Company years of service requirements are eligible and considered likely to retire. The departure of employees who fill critical operational roles could affect employee and/or public safety, as their knowledge and experience is essential to safely operating and maintaining SDG&E's gas and electric systems.

SDG&E's 2015 baseline mitigation plan for this risk consists of four controls:

1. A variety of training and knowledge transfer programs,
2. Compliance and inspection programs,
3. Outside contractors/contingent labor, and
4. Employee engagement survey and action plans.

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018, as well as controls and mitigations that may address reliability. The 2015 baseline mitigations will continue to be performed in the proposed plan. In addition, there will be an expansion of training associated with critical roles in various operational areas including Gas Operations, Customer Service Field, Electric Transmission and Distribution as well as Human Resources' Organizational Effectiveness. Key areas of focus will be job knowledge sharing, supervisor development and education about new technologies.

A risk spend efficiency was calculated for Workforce Planning. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. For Workforce Planning, the risk spend efficiency was completed at the risk portfolio level, with the activities grouped into one, aggregated mitigation. The methodology for calculating the risk spend efficiency was generally based on job proficiency data.

Risk: Workforce Planning

1 Purpose

The purpose of this chapter is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of Workforce Planning. SDG&E defines this risk as the loss of employees with deep knowledge, understanding and experience in Operations due to retirements. Employees age 62 or older who meet Company years of service requirements are eligible and considered likely to retire. The departure of employees who fill critical operational roles, could affect employee and/or public safety, as their knowledge and experience is essential to safely operating and maintaining SDG&E's gas and electric systems.

At the same time, the utility industry is undergoing a significant transformation. A main business objective for SDG&E is adopting new technologies in order to deliver the safest and most reliable services to its customers. This evolving technological environment is creating a demand for new, additional skillsets. The goal is to have experience in new/emerging technologies, while still maintaining necessary legacy knowledge. SDG&E's workforce planning mitigation strategies enable the thoughtful transition of retirement eligible employees and, where appropriate, the procurement of skills in new/emerging technologies. One example of orderly transition is the recent voluntary retirement program (VREP). Management offered a voluntary separation package to a select group of retirement eligible employees in areas believed to have skill surpluses to make room for thoughtful technology skill acquisition. SDG&E has periodically offered similar VREP programs in the past and a small percentage of employees with critical knowledge are expected to accept the recent VREP offering.

This analysis of the Workforce Planning risk, considered only safety-related critical roles where significant retirements are expected. Critical roles are ones that can be highly specialized, and employees in them tend to remain in these jobs for many years. During their tenure, they gain work experience which enables them to work with a heightened awareness towards safety. As employees in critical roles become eligible to retire, SDG&E needs to prepare to replace this collective knowledge and experience, in order to mitigate the risk to public and/or employee safety.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used as a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the numerous actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[1] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

SDG&E has a low average retirement rate as compared to other utilities. SDG&E's company historical, average 5-year retirement rate is 2.5%, compared to the utility industry average retirement rate of approximately 3%.[2] For the specific identified critical roles listed in this chapter, the 5-year historical average rate is 2.7% (or an average of 14 of 514 employees total eligible to retire), which is slightly higher than the Company-wide retirement rate.

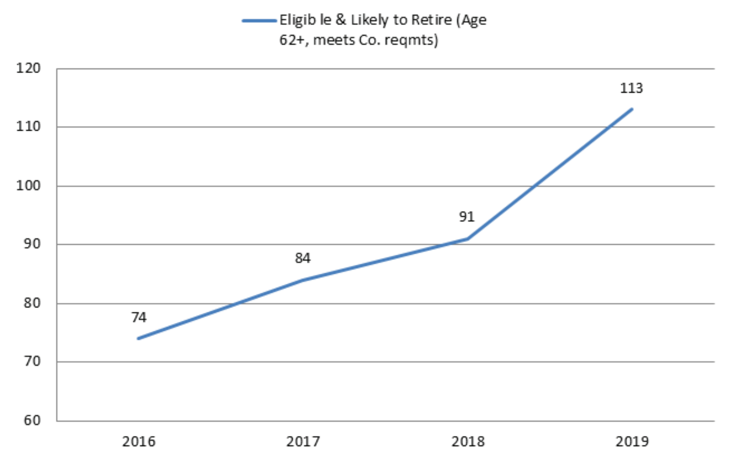
Regarding critical roles, it is anticipated that the retirement rate will increase significantly in the next few years. In fact, overall SDG&E retirements are slightly on the upswing as of early 2016, tracking to be 3.9%, as a whole, by year end. Using factors including SDG&E's average retirement age of 62, eligibility requirements, and a range of retirement rates (13% minimum expected retirements each year; 25% maximum expected retirement rate) based historical averages for critical roles, it is estimated that by year end 2019, a cumulative 34% (or 167 out of 488 age 62+) of employees in critical roles are eligible and likely to retire.

As mentioned above, SDG&E's average retirement age is 62, which is comparable to the utility industry average. PricewaterhouseCoopers reports that the 2015 utility industry average retirement age is 61.5, which is also consistent with the Social Security partial benefits age of 62. Although the average retirement age is 62, employees could consider retiring at an earlier age, between 55 and 61 years of age consistent with Company policies. If this happens, then estimates indicate that a cumulative 57% (278 out of 488) of employees in critical roles would be retiring by the end of 2019. SDG&E does not believe this is a likely scenario; therefore, this chapter addresses the most likely range of retirement rates (between 13% and 25%). Figure 1 depicts the 13% retirement scenario, wherein 13% of retirements

[1] Commission Decision (D.) 14-12-025 at p. 31.
[2] U.S. Department of Energy, *Workforce Trends in the Electric Utility Industry*, 2006, p. 6.

occur each year; however, the retirement bubble still continues to grow through 2019, which heightens the need and importance of successful workforce planning and knowledge transfer.

Figure 1: SDG&E Operations Critical Roles – Projected Retirement Bubble[3]



The assessment and analysis presented herein focuses on Workforce Planning as it pertains to SDG&E's electric and gas operations. For purposes of the Workforce Planning risk analysis, the following eight departments are considered "essential" to operations, and, therefore, encompass the critical roles:

1. Gas Operations
2. Customer Service Field and Smart Meter Operations
3. Kearny Maintenance and Operations
4. Electric Regional Operations
5. Electric Grid Operations
6. Construction Services
7. Electric Distribution Operations
8. Electric Transmission and Distribution Engineering

SDG&E applied its definition of essential operations to these eight departments based on comprehensive discussions with the director of each, as well as feedback from executive management. As stated previously, the risk analysis focused on the critical roles within these departments – roles that potentially could affect public or employee safety, which have a *likely* retirement risk. While other, non-operational

[3] Data as of January 31, 2016. Retirement bubble reflects the number *likely* (age 62+ & eligible) to retire, after the average 13% retirements are subtracted, and annual the incremental *likely* to retire are added in each year.

job functions are important to SDG&E, those jobs may not directly affect safety or have a retirement risk and, therefore, are excluded from the scope of this risk.

2 Background

For purposes of analyzing this risk, SDG&E first defined Operations as eight departments residing in the Electric Transmission and System Engineering, Electric Distribution Operations, Customer Services, and Gas Operations organizations. Next, critical roles within the eight organizations with a retirement risk were identified. A description of each essential department and associated critical roles is provided below. The tables show, for each critical role, the number of employees eligible to retire through 2019, as compared to the total number of employees in that role.[4]

1. Gas Operations

SDG&E's gas distribution system consists of a network of approximately 14,600 miles of interconnected gas mains, services and associated pipeline facilities. The primary function of this steel and plastic pipeline network is to deliver natural gas from SDG&E's transmission system to approximately 865,300 customer meters in an area of over 1,400 square miles. SDG&E routinely performs work to maintain the daily operation of the system, connect new customers, maintain the necessary capacity to serve all customers, replace damaged or deteriorating facilities, and relocate facilities to meet customer and governmental agency needs. This work is accomplished by approximately 340 employees, from front-line construction crews to technical planners and engineers. Examples of critical roles in this department include: Meter and Revenue System Protection Manager, Pipeline Operations Supervisor, District Operations Manager, Field Operations Supervisor, Locator, Working Foreman, Welding and Pipeline Inspection Supervisor, and Shop Services Supervisor.

Table 1: Gas Operations – San Diego Critical Roles

Gas Operations – San Diego Critical Role Retirement Range	2019 # Emps eligible to retire (age 62+)	2019 Total # Emps
Total	19	78
25% retirement rate	5	
Critical Roles avg. retirement rate (13%)	2	

[4] Data as of 1/31/16.

2. Customer Service Field and Smart Meter Operations

Customer Service Field (CSF) consists primarily of field technicians who perform services at customer premises, including gas and electric meter work, establishing and terminating gas and electric service, lighting gas pilot lights, conducting customer appliance checks, investigating reports of gas leaks, investigating customer complaints of high bills, shutting off and restoring gas service for fumigation, responding to structure fires (e.g., to check for gas leakage/shut off gas service) and other emergency incidents, and other related field services for customers. Field technicians work from five different operating base locations that are dispersed throughout SDG&E's service territory, which spans more than 4,100 square miles from the California-Mexico border to southern Orange County. Examples of critical roles in this department include: Appliance Mechanic, Electric Meter Tester/Meter Test Electrician, Engineer I, Principle Engineer, Senior Engineer, and Service Technician.

Table 2: CSF and Smart Meter Operations Critical Roles

CSF & Smart Meter Operations Critical Role Retirement Range	2019 # Emps eligible to retire (age 62+)	2019 Total # Emps
Total	31	120
25% retirement rate	8	
Critical Roles avg. retirement rate (13%)	4	

3. Kearny Maintenance & Operations

Kearny Maintenance and Operations (Kearny) is responsible for constructing and maintaining SDG&E's substation and transmission infrastructure and equipment throughout the service territory. Also, Kearny is responsible for the testing of protective rubber goods as well as testing, repairing and calibrating tools for electrical employees and other users at SDG&E. Examples of critical roles in this department include: Principle Engineer and Relay Specialist.

Table 3: Kearney Critical Roles

Kearny Critical Role Retirement Range	2019 # Emps eligible to retire (age 62+)	2019 Total # Emps
Total	3	7
25% retirement rate	1	
Critical Roles avg. retirement rate (13%)	<1	

SDGE
A Sempra Energy utility

4. Electric Regional Operations

Electric Regional Operations (ERO) is responsible for the construction, operations, maintenance and restoration of power for SDGE's electric distribution system. Other functions include: SDG&E's training center for field operations functions, electric crew scheduling, helicopter operations and business system integration and operations. Examples of critical roles in this department include: Construction Project Coordinator, District Crew Dispatcher, Fault Finding Specialist,* Inspector A, Senior Customer Project Planner, Troubleshooter,* Working Foreman.*

Table 4: ERO Critical Roles

ERO Critical Role Retirement Range	2019 # Emps eligible to retire (age 62+)	2019 Total # Emps
Total	66	137
25% retirement rate	17	
Critical Roles avg. rate rate (13%)	9	

*Linemen feed into the Fault Finding Specialist, Troubleshooter, and Working Foreman-Electric Distribution critical roles that have a retirement risk as defined in this chapter. (See Section 5.2.4)

5. Electric Grid Operations

The Electric Grid Operations (EGO) organization is responsible for the safe, reliable, and efficient operation of SDG&E's electric transmission system. This is achieved through compliance with associated North American Electric Reliability Corporation (NERC) Standards, transmission outage coordination and operations planning, training, and 24-hour real-time situational awareness of all transmission assets using EGO's state of the art Energy Management System (EMS).

EGO works closely with the California Independent System Operator (CAISO) and Peak Reliability Coordinator, provides inter-departmental platforms vital to the integration of new transmission and generation projects, as well as the leadership needed so that critical facilities are secured in accordance with NERC physical and cyber security standards. In addition, assessments and optimal fulfillments of contractual obligations performed by EGO throughout the year make it so adequate readiness is always available to meet safety and reliability goals. Examples of critical roles in this department include: EMS Software Supervisor, Grid Business Process Manager, Grid Operations Services Manager, Mission Control Training Manager, and Engineers (Principle and Senior).

Table 5: EGO Critical Roles

EGO Critical Role Retirement Range	2019 # Emps eligible to retire (age 62+)	Total # Emps
Total	4	12
25% attrition	1	
Critical Roles avg. attrition rate (13%)	1	

6. Construction Services

Construction Services is responsible for the contract administration of gas and electric distribution infrastructure projects performed mainly by third-party contractors. The department also oversees SDG&E's Vegetation Management compliance program, which includes contract administration, education and outreach, and inspection requirements as set forth by the CPUC. A large percentage of the organization's workforce consists of Contract Administrators (CAs) who have prime responsibility for field oversight of these projects. Construction Services also is responsible for the management of high impact infrastructure projects. Examples of critical roles in this department include: Contract Administrator – Electric, Contract Administrator – Gas, Construction Advisor – Electric, Construction Advisor – Gas, and Construction Services Supervisor/Supervisor-Construction Services.

Table 6: Construction Services Critical Roles

Construction Services Critical Role Retirement Range	2019 # Emps eligible to retire (age 62+)	Total #Emps
Total	18	48
25% retirement rate	5	
Critical Roles avg. retirement rate (13%)	2	

7. Electric Distribution Operations

Electric Distribution Operations (EDO) operates 1,034 electric distribution circuits to provide safe and reliable service to SDG&E customers behind the 1.4 million electric meters in San Diego County and south Orange County. The EDO department consists of three sections:

- The Distribution Control Center, staffed with Distribution System Operators who oversee the planned switching during routine work and restoration switching steps during emergencies.
- An EDO workgroup that directly supports the control center with technology and process issues, especially ones related to the Supervisory Control and Data Acquisition (SCADA)

system. SCADA enables EDO to operate equipment remotely and to limit outage impacts to our customers.

- Another EDO workgroup that includes the Enterprise GIS Services (EGISS) section, which updates electric facility information in the GIS mapping system feeding into the circuit diagrams in the network management system utilized by the distribution control center.

Examples of critical roles in this department include: Distribution System Operator and Working Foreman – System Operator.

Table 7: EDO Critical Roles

EDO Critical Role Retirement Range	2019 # Emps eligible to retire (age 62+)	Total #Emps
Total	2	23
25% retirement rate	<1	
Critical Roles avg. retirement rate (13%)	<1	

8. Electric Transmission & Distribution Engineering

The Electric Transmission and Distribution (T&D) Engineering department's main role is the engineering and design of transmission, substation, and distribution projects for the Company in accordance with industry and Company standards. This includes developing and maintaining Company standards, and developing work methods and technical solutions to provide safe and reliable service to customers. The department consists of the following sections: Transmission Engineering & Design, Substation Engineering & Design, Electric Distribution Engineering, Civil/Structural Engineering, System Protection & Control Engineering, Customer Generation, Distributed Energy Resources, and Project Management & Drafting. Examples of critical roles in this department include: Construction Standards Administrator (includes Sr.), Drafting Supervisor, Electric Distribution Analyst (includes Senior), Lead Substation Project Designer, Principle Engineer, Senior Engineer, Substation Designer (includes Senior), Substation Team Lead, Substation Engineering & Design Manager, and Transmission Engineering Designer (includes Senior).

Table 8: Electric T&D Engineering Critical Roles

Electric T&D Engineering Critical Role Retirement Range	2019 # Emps eligible to retire (age 62+)	2019 Total # Emps
Total	24	63
25% retirement rate	6	
Critical Roles avg. retirement rate (13%)	3	

3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[5] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within its evaluation and prioritization of risks.[6] This includes identifying leading indicators of risk. Sections 2 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Workforce Planning risk.

3.1 Risk Classification

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as a cross-cutting, people risk, associated with the organizational health function, as shown in Table 9.

Table 9: Risk Classification per Taxonomy

Risk Type	Asset/Function Category	Asset/Function Type
CROSS-CUTTING	PEOPLE	ORG. HEALTH

[5] A.15-05-002, filed May 1, 2015, at p. JMD-7.
[6] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.

3.2 Potential Drivers[7]

When performing the risk assessment for Workforce Planning, SDG&E identified potential indicators of risk, referred to as drivers. These include, but are not limited to:

- **Economic factors -** these can accelerate or delay retirement decisions, which may cause the shifting of retirement bubbles.
- **Increasing number of retirement-eligible critical employees** - this number is growing each year relative to the total pool of experienced employees.
- **Lack of job satisfaction** - may quicken the pace and increase the number of those seeking to retire.
- **Transition to newer and/or emerging technology -** longer-tenured, more experienced employees may struggle to adapt, which may lead to earlier retirements.
- **Increased demand for specialized skills** - may lead to competition in the industry, resulting in attrition and vacancies.
- **Company culture that encourages movement between jobs –** can make it difficult to gain knowledge and experience developed through "time in role."

3.3 Potential Consequences

If one of the risk drivers listed above were to occur, resulting in an incident, the potential consequences, in a reasonable worst case scenario, could include:

- Few, serious injuries;
- Property damage;
- Inefficiencies due to less experienced employees;
- Disruption to operations;
- Regulatory scrutiny; and/or
- Adverse litigation and resulting financial impacts.

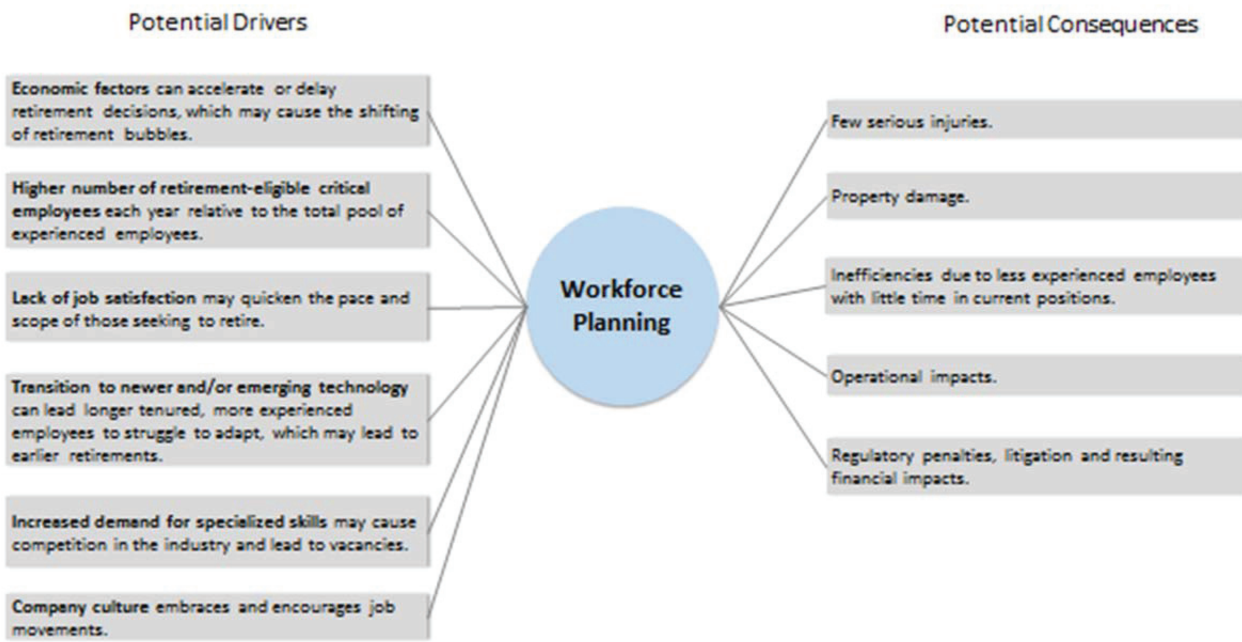
These potential consequences were used in the scoring of Workforce Planning that occurred during the SDG&E's 2015 risk registry process. See Section 4 for more detail.

3.4 Risk Bow Tie

The risk "bow tie," shown in Figure 2, is a commonly-used tool for risk analysis. The left side of the bow tie illustrates potential drivers that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

[7] An indication that a risk could occur. It does not reflect actual or threatened conditions.

Figure 2: Risk Bow Tie



4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Workforce Planning as one of the enterprise risks. During the development of the risk register, subject matter experts assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

4.1 Risk Scenario – Reasonable Worst Case

There are many possible ways in which an electric infrastructure integrity incident can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Workforce Planning:

- A less-experienced employee fills a position recently vacated by a long-time experienced employee due to retirement and due to lack of experience, the employee performs work that gives rise to serious injuries.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

4.2 2015 Risk Assessment

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[8] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 10 provides a summary of the Workforce Planning risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

Table 10: Risk Score

Residual Impact				Residual Frequency	Residual Risk Score
Health, Safety, Environmental (40%)	Operational & Reliability (20%)	Regulatory, Legal, Compliance (20%)	Financial (20%)		
4	3	3	2	3	255

4.3 Explanation of Health, Safety, and Environmental Impact Score

As indicated in the reasonable worst case scenario, a less experienced workforce may lead to unintended safety consequences. SDG&E scored this risk a 4 (major) in the Health, Safety, and Environmental impact category as it has the potential to result in one or more serious injuries or illnesses to the public or employees.

4.4 Explanation of Other Impact Scores

Based on the selected reasonable worst case risk scenario, SDG&E gave the following scores to the remaining residual impact areas:

- **Operational and Reliability**: A score of 3 (moderate) was given to this impact area, which is defined in the 7X7 matrix as greater than 1,000 customers affected. The actions of less experienced personnel could potentially cause operational disruptions of this magnitude. Inefficiencies due to less experienced employees also contributed to the determination of this score.

[8] D.16-08-018 Ordering Paragraph 9.

- **Regulatory, Legal and Compliance**: An incident that occurs because of a less experienced workforce could result in potential regulatory, legal or compliance consequences, such as violations. Based on this, SDG&E scored this risk impact area a 3 (moderate).
- **Financial**: The incident caused by a less experienced worker, could result in monetary impacts that result from a violation. However, SDG&E believes that the potential financial impact would be minor, or a score of 2, which is defined in the 7X7 matrix as a potential financial loss between $50,000 and $1 million.

4.5 Explanation of Frequency Score

The frequency score of 3 (infrequent) was based on SDG&E's knowledge of the business and historical experience. This score also took into account SDG&E's continuing efforts in implementing and growing a strong safety culture that not only starts with new employees, but also continues through those employees as they near retirement.

5 Baseline Risk Mitigation Plan[9]

As stated above, SDG&E defines Workforce Planning risk as the loss of employees with deep knowledge, understanding and experience in Operations due to retirements. The 2015 baseline mitigations discussed below include the current evolution of the utilities' risk management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time.

Subject matter experts (i.e., Directors) in each of the eight essential operational areas described in Section 2 identified the baseline mitigation plan controls in place for the Workforce Planning risk. These include a variety of training and knowledge transfer programs, compliance and inspection programs, outside contractors/contingent labor, and employee engagement survey and action plans. These controls focus on safety-related impacts[10] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018,[11] as well as controls and mitigations that may address reliability.[12] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various Workforce Planning incidents, not just the scenario used for purposes of risk scoring.

These baseline plan control activities are further described below, organized by essential operations area:

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[9] As of 2015, which is the base year for purposes of this Report.
[10] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[11] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[12] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

1. Gas Operations
   - **Operator Qualification** - Operator Qualification (OpQual) Gas Standard G8113, is a federally- mandated law that states that any person who performs a gas pipeline construction-related activity that influences safety of the pipeline, and/or inspects, operates or maintains an existing operating gas pipeline, must be trained and tested in the task that they are performing.

   - **Environmental and Safety Compliance Management Program (ESCMP)** - SDG&E maintains an ESCMP to address compliance requirements, awareness, goals, monitoring and verification related to all applicable environmental, health and safety laws, rules and regulations, and company standards.

   - **SDG&E Combination Welding School** – 14 weeks of instruction on SDG&E combination welding training

2. CSF & Smart Meter
   - **Operations Qualification** – See description under Gas Operations in this section.

   - **ESCMP** – See description under Gas Operations in this section.

   - **Appliance Mechanic Class** – A four-week class training that includes: Fundamentals of Natural Gas, Electric Troubleshooting, Carbon Monoxide Investigations, Leak Investigations, and Purging Large Meter Sets.

   - **Apprentice Electric Meter Tester Program** - A three-year competency-based apprentice training program that consists of "hands on" competency and skill testing.

   - **Metering School** – A third-party training program that covers the principles of metering engineering (i.e., all the various meter forms, how they function, the specific metering application, and equipment and tools).

   - **Service Technician Training** – 11-week class training, four-week ride-along in field, one-week qualification. Training includes: Gas fundamentals, appliance familiarization, meter reading, gas controls, gas pressures and regulators, venting, carbon monoxide, fundamentals of electricity, advanced schematics and electrical troubleshooting, indoor/outdoor gas leaks, first responder/incident command, gas and electric meter sets and changes, and heating equipment.

3. Kearny
   - **ESCMP** – See description under Gas Operations in this section.

- **Relay School/Classes** – Provides understanding of SDG&E's relays, electric system, and protection schemes to develop ability to identify problems, troubleshoot outages and restore substation/transmission events.

4. ERO
   - **ESCMP** – See description under Gas Operations in this section.

   - **CPUC General Order 165 - Corrective Maintenance Program** – SDG&E is required to inspect its electric distribution system according to the CPUC General Order 165 (GO 165). GO 165 establishes inspection cycles and record-keeping requirements for utility distribution equipment. In general, utilities must patrol their systems once a year in urban areas, and once every two years in rural areas (SDG&E performs all patrols on an annual basis). Utilities must conduct detailed inspections every 3-5 years, depending on the type of equipment. For detailed inspections, utilities' records must specify the condition of inspected equipment, any problems found, and a scheduled date for corrective action. Utilities are required to perform intrusive inspections of distribution wood poles depending on the age and condition of the pole and prior inspection history.

   - **Apprentice Lineman Program** - SDG&E has a three-year, state-approved, apprenticeship program for the development of journeymen electrical workers, with certification by the Joint Apprentice Committee. Electric overhead and underground training for apprentices is required to last 155 weeks over a three-year period. The training introduces basic electrical education and awareness, communication, familiarization with safety rules, proper personal protective equipment, use of tools, material, equipment, and work practices associated with high voltage overhead electrical work. In the third year, the apprentices gain field experience working under the supervision of Journeyman Lineman.[13]

   - **Fault Finder & Relief Fault Finder classes** – Teaches essential knowledge and skills to safely and reliably perform Relief Fault Finding for SDG&E's system. Includes the Inspect Corrective Maintenance Program (CMP), and Overhead & Underground (GO 165).

   - **Progressive Planner Training programs** – Class and on-the-job training to obtain skills and knowledge in providing new upgrades to electrical services to industrial, commercial and residential buildings. Examples of topics covered are: rate information, service requirements, material needs, load management, conservation techniques and metering installations.

[13] There are in place strong development and acquisition plans to mitigate the retirement risk for Linemen; however, lineman also can fill critical roles such as Fault Finding Specialist, Troubleshooter, and Working Foreman-Electric Distribution.

- **Troubleshooter Training Program** – Training on electric service restoration and outage repair, inspections under the CMP and the Overhead and Underground (CPUC Gen Order 165).

- **Working Foreman Development Program** – Teaches working foreman essential knowledge and skills to safely oversee their crews, public safety, and all aspects of the work in the field.

5. EGO
   - **ESCMP** – See description under Gas Operations in this section.
   - **Engineer Intern/Associate Program** - Intern/Associate entry level engineer rotation program that provides the inexperienced engineer an opportunity to acquire experience and proficiency in performing fundamental engineering work.
   - **Management Advisory Group (MAG)** - MAG team helps keep engineers on track and grow throughout the organization. Discussions around interns, associates, rotation of engineers, engineer presentations, succession planning.
6. Construction Services
   - **Operations Qualification** – See description under Gas Operations in this section.
   - **ESCMP –** See description under Gas Operations in this section.
   - **Outside Contractors/Contingent Labor –** Used for workload peaks.
7. EDO
   - **ESCMP** – See description under Gas Operations in this section.
   - **Joint Transmission System Operator (TSO)/Distribution System Operator (DSO) training program** - Training program to operate the switches of the Electric Transmission and Distribution systems in a safe and reliable manner.
8. Electric T&D Engineering
   - **ESCMP** – See description under Gas Operations in this section.
   - **Industry and Trade Training Workshops** - Current training consists of continuing education or industry-sponsored workshops for new technologies. Such technologies include power electronic-based devices and advanced communication systems to build and operate a "smart" reliable electric power grid.

- **SDG&E Project Management/Planner Training Class** - Content of the class includes skills and knowledge to provide new upgrades to existing electrical services to industrial, commercial and residential buildings.

- **Substation Design Training Classes** – Training on SDG&E substation electrical and structural designs.

- **High Performing Leader I (formerly Supervisor Toolkit) -** This comprehensive 10-month leadership development program is for new leaders in the SDG&E and shared services organizations.

- **Outside Contractors/Contingent Labor –** The use of supplemental workforce on an as-needed basis.

9. Human Resources (HR) Organizational Effectiveness
   - **Engagement Survey and Action Planning –** Approximately every 18 months, SDG&E surveys all employees to obtain input on their overall engagement and their supervisor's effectiveness. Action plans are put into place for those departments with lower scores for the directors and supervisors to increase employee engagement and satisfaction via methods such as coaching, training, and team building**.**

6 Proposed Risk Mitigation Plan

SDG&E will continue to perform the 2015 baseline mitigations outlined in Section 5, to, in most cases, maintain the current residual risk level. In addition, SDG&E is proposing to expand or add mitigations during the 2017- 2019 timeframe. These incremental changes are described below.

1. Gas Operations
   - **Supervisor University** - The program includes specific and consistent technical, business, and systems training to adequately equip a potential Supervisor candidate to be 80% proficient at graduation.

2. CSF & Smart Meter
   - **Job Knowledge Sharing Program** – The 2017 program is geared to share knowledge on meter engineering. Various methods will be used to promote knowledge sharing from employees in critical roles, who also may be retiring. These methods will include, but are not exclusive to: interviews, lunch and learns, knowledge sharing workshops, and mentoring).

   - **Third-Party Metering Engineering School** – In 2017 there will be third-party Electric Metering Engineering training in Texas or Seattle for employees to attend. Training will cover the principles of metering engineering, all the various meter forms, how they function, the specific metering application, and equipment and tools.

3. Construction Services
   - **Contract Administrator training modules –** There will be new Contract Administrator training modules to supporting training at monthly meetings

4. Electric T&D Engineering
   - **Job Knowledge Sharing Program (Pilot)** - This program is geared to share knowledge across the Electric Transmission and System Engineering division. Various methods will be used to promote knowledge sharing from employees in critical roles, who also may be retiring. These methods will include, but are not exclusive to: interviews, lunch & learns, knowledge sharing workshops, and mentoring).

   - **In-House Utility Technology Training Program** – An SDG&E program to develop and provide training and refreshers on new utility technologies, such as smart-grid operations, distributed generation, line sensing and power quality devices, and SCADA controls.

   - **Engineering Outside Contractors:** The use of experienced external engineering contractors to supplement internal staff.

   - **Substation Design Program** – A substation design training program that will include written tests to achieve measureable status and formal classes based on reviewed designs to determine which areas are lacking in experience.

   - **Transmission Engineering Design Program** – SDG&E will develop a required, internal transmission engineering training program. It will formalize the QA/QC program around design review and job package creation practices to provide consistency.

5. HR Organizational Effectiveness
   - **Supervisor Effectiveness Program –** This will be a Supervisor development program, beginning in the essential Operations areas, and then will expand to all, that enhances supervisor knowledge, leadership skills, safety awareness and policy knowledge in order to mitigate risks associated with retirement and knowledge loss. HR Organizational Effectiveness eventually will provide this training to all Operations departments.

7 Summary of Mitigations

Table 11 summarizes the 2015 baseline mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for the Workforce Planning Risk. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 11 below were estimated using assumptions provided by SMEs and available accounting data.

Table 11: Baseline Risk Mitigation Plan[14]
(Direct 2015 $000)[15]

ID	Control	Risk Drivers Addressed	Capital[16]	O&M	Control Total[17]	GRC Total[18]
1	Gas Operations	• Economic factors • A higher number of retirement eligible critical employees each year • Lack of job satisfaction • Transition to newer and/or emerging technology • Increased demand	There were no retirements in critical roles within Gas Operations in 2015.			
2	CSF & Smart Meter		n/a	340	340	270
3	Kearny Maintenance & Ops		n/a	20	20	0
4	Electric Regional Operations		n/a	1,070	1,070	1,060
5	Electric Grid Operations		n/a	10	10	0
6	Construction		n/a	10	10	10

14 Recorded costs were rounded to the nearest $10,000.
15 The figures provided in Tables 11 and 12 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
16 Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
17 The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
18 The GRC Total column shows costs typically presented in a GRC.

	Services	for specialized skills and lead to vacancies • Company culture embraces and encourages job movements				
7	Electric Distribution Operations		There were no retirements in critical roles within Electric Distribution Operations in 2015.			
8	Electric Transmission & Distribution Engineering		n/a	330	330	70
9	HR – Organizational Effectiveness		n/a	80	80	0
	TOTAL COST		n/a	$1,860	$1,860	$1,410

Table 12 summarizes SDG&E's proposed mitigation plan and associated projected ranges of O&M expenses for 2019. There are no capital costs for the baseline and proposed mitigations. It is important to note that SDG&E is identifying potential ranges of costs in this plan and is not requesting funding approval. SDG&E will request approval of funding in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC. As set forth in Table 12, the utilities are using a 2019 forecast provided in ranges based on 2015 dollars.

Subject matter experts used average labor costs for roles expected and/or required to participate in the training and knowledge sharing activities, along with per-person course costs where available.

Table 12: Proposed Risk Mitigation Plan[19]

(Direct 2015 $000)

ID	Mitigation	Risk Drivers Addressed	2017-2019 Capital[20]	2019 O&M	Mitigation Total[21]	GRC Total[22]
1	Gas Operations	• Economic factors can accelerate or delay retirement decisions, which may cause the shifting of retirement bubbles. • A higher number of retirement-eligible critical employees each year relative to the total pool of experienced employees. • Lack of job satisfaction may quicken the pace and scope of those seeking to retire. • Transition to newer and/or emerging technology can lead longer tenured, more experienced employees to struggle to adapt, which may lead to earlier retirements. • Increased demand for specialized skills may cause competition in the industry and lead to vacancies.	n/a	$200 - 430	$200 - 430	$160 - 380
2	Customer Service Field & Smart Meter Ops		n/a	610 - 1,150	610 - 1,150	480 - 900
3	Kearny		n/a	20-60	20-60	0
4	ERO		n/a	1,900 - 3,580	1,900 - 3,580	1,880 - 3,540
5	EGO		n/a	10 - 30	10 - 30	0 - 10
6	Construction Services		n/a	50 - 560	50 - 560	10 - 60
7	EDO		n/a	30-40	30 - 40	20 - 30
8	Electric Transmission & Distribution		n/a	770 - 1,070	770 - 1,070	230 - 300
9	HR Organizational Effectiveness		n/a	30 - 120	30 - 120	30 - 120

[19] Ranges of costs were rounded to the nearest $10,000.
[20] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
[21] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[22] The GRC Total column shows costs typically represented in a GRC.

		• Company culture embraces and encourages job movements.				
	TOTAL COST			$3,620 - $7,040	$3,620 - $7,040	$2,810 - $5,340

☐	Status quo is maintained
☐	Expanded or new activity
*	Includes one or more mandated activities

While all the mitigations and costs (baseline and proposed) presented in tables above mitigate the Workforce Planning risk, some of the mitigations also mitigate other risks presented in the RAMP Report. Most of the costs and benefits associated with the training classes in this risk's baseline plan, which are also continuing in the proposed plan, are also included in the risk of Employee, Contractor and Public Safety. However, generally, the apprenticeship programs are only included in this risk. The incremental programs are specific to this risk as well.

8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[23] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[24]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

8.1 General Overview of Risk Spend Efficiency Methodology

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of

[23] D.16-08-018 Ordering Paragraph 8.
[24] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigation:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score):** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 10 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[25] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another.

[25] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

Figure 3 shows the RSE calculation.

Figure 3: Formula for Calculating RSE

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 12 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

8.2 Risk Spend Efficiency Applied to This Risk

SDG&E analysts used the general approach discussed in Section 8.1 above in order to assess the RSE for the Workforce Planning risk. The RAMP Approach chapter in this Report provides a more detailed example of the calculation used by the Company.

The risk reduction associated with the aforementioned projects was estimated using research, proprietary data and information from SDG&E, along with input from subject-matter experts. The reasonable worst case scenario used to calculate the relative benefits of the mitigations was: a less experienced electric employee fills a position recently vacated by a long-time experienced employee due to retirement, and due to lack of experience, the employee performs work that gives rise to serious injuries. The current controls were analyzed as one group. Incremental mitigations were analyzed as one group, also.

Analysis of Current Controls Grouping

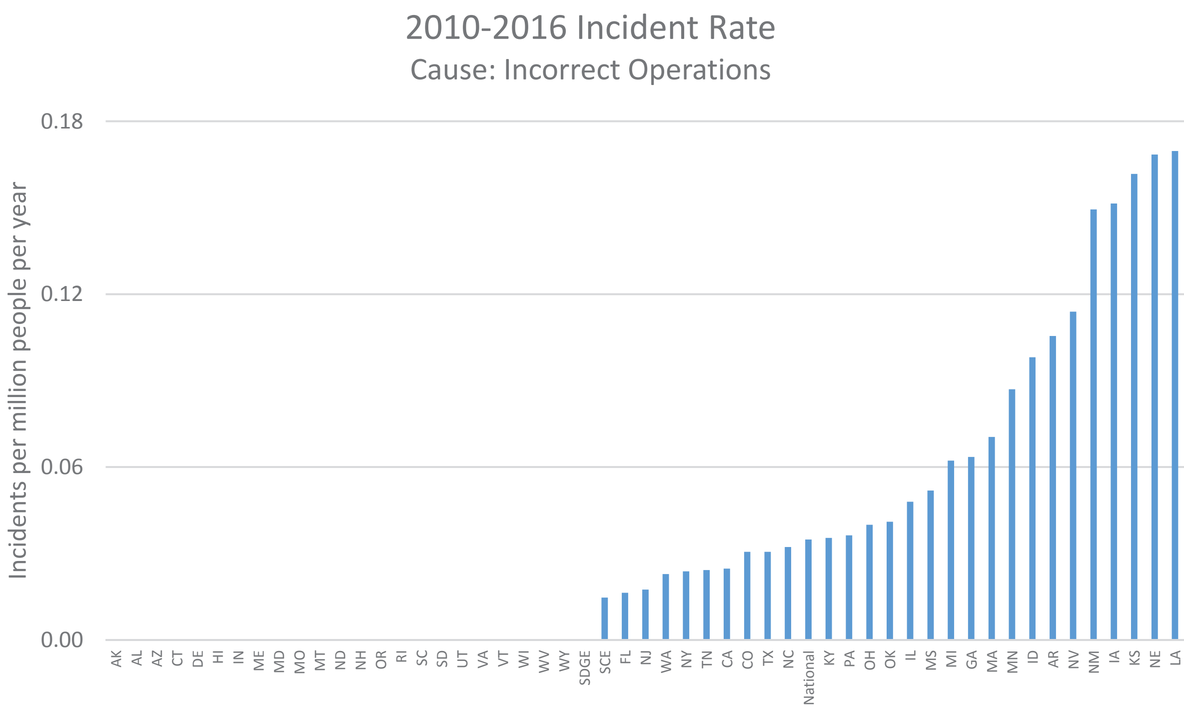
The Federal Pipeline and Hazardous Materials Safety Administration (PHMSA) collects historical information on significant gas incidents from all causes. The cause that is most closely-related to employee human error is incorrect operations.

Analysts postulated that eliminating workforce planning and training would result in an upward trend in the level of human error, and that this could be represented by an increase in incident rate from incorrect operations. It is assumed that at some point in the future, poor performance would increase to the level of the worst-performing state in the nation, and it is assumed that such a point in time would occur in one decade.

This is believed to be an effective proxy because, in the absence of training, proper employee development, and workforce planning, one can expect to have a workforce that is ill-prepared to make the best decisions and conduct ongoing safe operations. In addition, this is believed to be a conservative approach, since all major utilities have planning and training functions, including those that operate in the worst-performing state. The data represents minimum performance degradation expectations.

Mitigated risk can be calculated by multiplying residual risk by the ratio of future incident count expectations to the current expectation. The chart shown below contains the incident rates due to incorrect operations of all 50 states, of SoCalGas, and the national average. SDG&E is among the states with zero incidents per million people per year, and the worst-performing state is Louisiana at 0.1697 incidents per million people per year. Using SDG&E's service population of 3.6 million people, the incident rates can be converted to an incident expectation, given by the following calculation:

$$Expected\ Incident\ Rate = \Delta(Incident\ Rate) * Service\ Population$$
$$= (0.1697 - 0)\ incidents\ per\ million\ people\ per\ year * 3.6\ million\ people$$
$$= 0.611\ incidents\ per\ year$$



The incident frequency corresponding to the residual risk analysis is 0.058 incidents per year. Considering that a decade will not have elapsed by the end of year 2019, a ½ coefficient is applied to the residual risk multiplier. The calculation is shown below:

$$Residual\ Risk\ Multiplier = \frac{Incident\ Rate\ from\ select\ Causes}{Incident\ Rate\ from\ all\ Causes} * Decade\ coefficient$$
$$Residual\ Risk\ Multiplier = \frac{0.611\ incidents\ per\ year}{0.058\ incidents\ per\ year} * \tfrac{1}{2}$$
$$Residual\ Risk\ Multiplier = 5.3$$

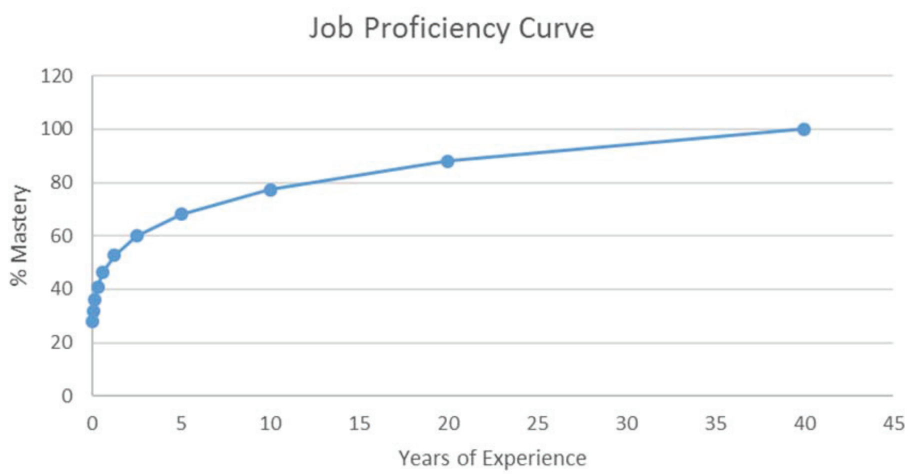
This implies that the mitigated risk frequency is 5.3 times the residual risk frequency.

Analysis of Incremental Mitigations Grouping

A benchmarking study estimated that 34.2% of utility workers industrywide are eligible for retirement through the end of year 2019. Consequently, it is expected that there is going to be a temporary drop in the level of workforce job proficiency.

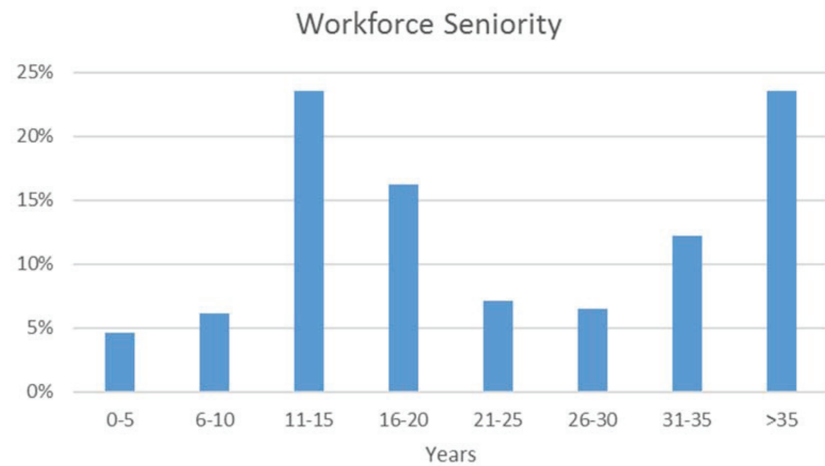
The analysis used an estimate of net workforce proficiency as a proxy to estimate the risk reduction from the incremental mitigations. This is believed to be an effective proxy because as less experienced personnel are replacing employees in large numbers, it can be assumed that there will be a decline in workforce proficiency for some period. Further it was assumed here that there is a direct correlation between proficiency and safety.

In order to define the benefit in terms of a percent improvement in workforce proficiency, it is important to know how proficiency evolves for technical employees as a function of experience. Based on productivity information for engineers,[26] the function displayed below was derived:



The above curve can be matched with a second curve that shows the range of work experience to get the desired net workforce proficiency. Although actual work experience is not tracked for SDG&E employees, years of seniority is tracked and serves as a representative parameter. The curves below show the current state of the workforce for employees having a safety-related jobs.

[26] Jaber, Mohamad. Learning Curves Theory, Models & Applications, p. 376.



Merging the proficiency curve with the job seniority curves yields the current net workforce proficiency. To get the future state of the net workforce proficiency the job seniority curves need to be modified by assuming a first in/first out pattern. The net result from these calculations is a 44% improvement in proficiency. Thus, the implied benefit is 44% of the residual risk.

8.3 Risk Spend Efficiency Results

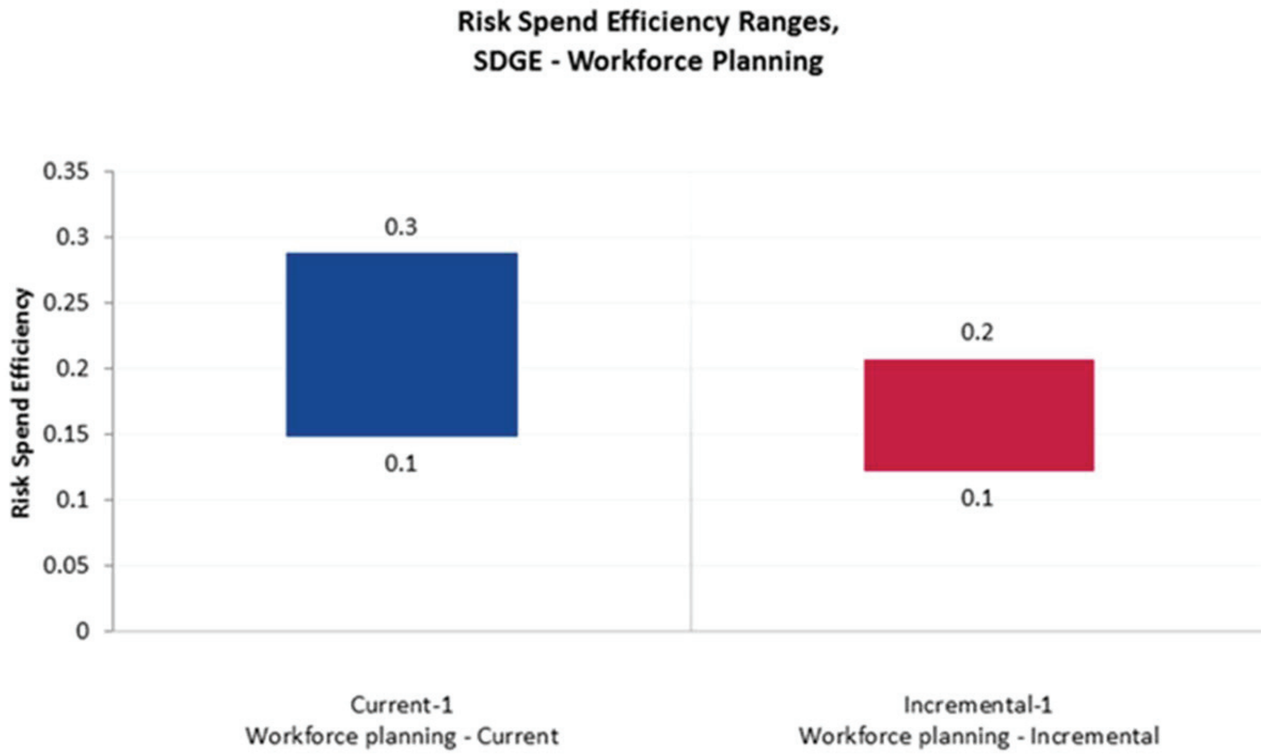
Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Workforce Planning (current controls)
2. Workforce Planning (incremental mitigations)

Figure displays the range[27] of RSEs for each of the SDG&E Workforce Planning risk mitigation groupings, arrayed in descending order.[28] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

[27] Based on the low and high cost ranges provided in Table 12 of this chapter.
[28] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

Figure 4: Risk Spend Efficiency



9 Alternatives Analysis

SDG&E considered alternatives to the proposed mitigations as it developed the incremental mitigation plan for the Workforce Planning risk. Typically, alternatives analysis occurs when implementing activities, and with vendor selection in particular, to obtain the best result or product for the cost. The alternatives analysis for this risk plan also took into account modifications to the proposed plan and constraints, such as budget and resources.

9.1 Alternative 1 – Increases to Contract Labor

SDG&E considered increasing its contract labor as an alternative, rather than backfilling critical roles with Company employees. But in the interest of both employee and public safety, SDG&E prefers to keep "core knowledge" in-house. Additionally, the cost to use contract labor to fill all "critical roles" is estimated to be 20% - 50% higher than using in-house employees. Nonetheless, contract labor may be used to supplement the workforce for peak/seasonal needs. Accordingly, SDG&E prefers its proposed plan to backfill vacancies due to retirements with new employees, and train them to meet Company standards, anticipating that these employees would have a long-standing career with SDG&E.

9.2 Alternative 2 – Maintain Current Mitigations

SDG&E also considered the status quo. In other words, SDG&E would do nothing else to mitigate this risk other than the baseline activities in place in 2015. The current training plans have enabled SDG&E to achieve low historic OSHA recordable rates. However, emerging technologies require additional, new training. Further, when discussing workforce and succession planning to meet the future needs of SDG&E's Operating groups, additional training was deemed necessary. For example, the streamlining of processes, a corporate focus, requires existing training to be updated. Therefore, this alternative was dismissed as it would not meet the future needs of SDG&E Operations.

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Investigation Into the November 2016 Submission of San Diego Gas & Electric Company's Risk Assessment and Mitigation Phase.	Investigation 16-10-015 (Filed October 27, 2016)
Order Instituting Investigation Into the November 2016 Submission of Southern California Gas Company's Risk Assessment and Mitigation Phase.	Investigation 16-10-016 (Filed October 27, 2016)

NOTICE OF AVAILABILITY OF SAN DIEGO GAS & ELECTRIC COMPANY'S AND SOUTHERN CALIFORNIA GAS COMPANY'S RISK ASSESSMENT AND MITIGATION PHASE REPORT

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November 30, 2016

310391

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Investigation Into the November 2016 Submission of San Diego Gas & Electric Company's Risk Assessment and Mitigation Phase.	Investigation 16-10-015 (Filed October 27, 2016)
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NOTICE OF AVAILABILITY OF
SAN DIEGO GAS & ELECTRIC COMPANY'S AND
SOUTHERN CALIFORNIA GAS COMPANY'S
RISK ASSESSMENT AND MITIGATION PHASE
REPORT

Please take notice that on November 30, 2016, San Diego Gas & Electric Company ("SDG&E") and Southern California Gas Company ("SoCalGas") submitted its **Risk Assessment and Mitigation Phase Report** ("Report") to the California Public Utilities Commission ("CPUC"). The Report is available on the websites of SDG&E and SoCalGas through the following links:

SDG&E: http://www.sdge.com/regulatory-filing/20016/risk-assessment-and-mitigation-phase-report-sdge-socalgas

SoCalGas: https://socalgas.com/regulatory/I16-10-016.shtml

Pursuant to Rule 1.9 of the Rules of Practice and Procedure of the CPUC, SDG&E and SoCalGas will upon request provide a copy of the Report to parties who request it. Copies of the Report may be obtained by contacting:

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A copy of this Report may also be requested from the contact listed above.

Respectfully submitted,

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November 30, 2016