Risk Assessment Mitigation Phase
(Chapter SDG&E-4)
Electric Infrastructure Integrity

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Risk: Electric Infrastructure Integrity

I. INTRODUCTION

The purpose of this chapter is to present the Risk Mitigation Plan for San Diego Gas & Electric Company's (SDG&E or Company) Electric Infrastructure Integrity (EII) risk. Each chapter in this Risk Assessment Mitigation Phase (RAMP) Report contains the information and analysis that meets the requirements adopted in Decision (D.) 16-08-018, and D.18-12-014 and the Settlement Agreement included therein (the SA Decision).[1]

SDG&E has identified and defined RAMP risks in accordance with the process described in further detail in Chapter RAMP-B of this RAMP Report. On an annual basis, SDG&E's Enterprise Risk Management (ERM) organization facilitates the Enterprise Risk Registry (ERR) process, which influenced how risks were selected for inclusion in the 2019 RAMP Report, consistent with the SA Decision's directives.

The purpose of RAMP is not to request funding. Any funding requests will be made in SDG&E's General Rate Case (GRC). The costs presented in this 2019 RAMP Report are those costs for which SDG&E anticipates requesting recovery in the Test Year (TY) 2022 GRC. SDG&E's TY 2022 GRC presentation will integrate developed and updated funding requests from the 2019 RAMP Report, supported by witness testimony.[2] For this 2019 RAMP Report, the baseline costs are for the activities performed and associated costs incurred in 2018, as further discussed in Chapter RAMP-A. This 2019 RAMP Report presents capital costs as a sum of the years 2020, 2021 and 2022 as a three-year total; whereas, O&M costs are only presented for 2022.

Costs for each activity that directly addresses each risk are provided where those costs are available and within the scope of the analysis required in this RAMP Report. Throughout this

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1 D.16-08-018 also adopted the requirements previously set forth in D.14-12-025. D.18-12-014 adopted the Safety Model Assessment Proceeding (S-MAP) Settlement Agreement with modifications and contains the minimum required elements to be used by the utilities for risk and mitigation analysis in the RAMP and GRC.

2 *See,* D.18-12-014 at Attachment A, A-14 ("Mitigation Strategy Presentation in the RAMP and GRC").

2019 RAMP Report, activities are delineated between controls and mitigations, consistent with the definitions adopted in the SA Decision's Revised Lexicon. A "Control" is defined as a "[c]urrently established measure that is modifying risk."[3] A "Mitigation" is defined as a "[m]easure or activity proposed or in process designed to reduce the impact/consequences and/or likelihood/probability of an event."[4] Activities presented in this chapter are representative of those that are primarily scoped to address SDG&E's EII risk; however, many of the activities presented herein also help mitigate other risk areas as outlined in Chapter RAMP-A.

As discussed in Chapter RAMP-D, Risk Spend Efficiency (RSE) Methodology, no RSE calculation is provided where costs are not available or for costs that are not presented in this RAMP Report (including costs for activities that are outside of the GRC and certain internal labor costs). Additionally, SDG&E did not perform RSE calculations on certain mandated activities. For purposes of this 2019 RAMP Report, mandated activities are defined as activities conducted in order to meet a mandate or law, such as a Code of Federal Regulation (CFR), California Public Utilities Code, or CPUC General Order. Activities with no RSE score presented in this 2019 RAMP Report are identified in Section VII below.

SDG&E has also included a qualitative narrative discussion of certain risk mitigation activities that would otherwise fall outside of the RAMP Report's requirements, to aid the Commission and stakeholders in developing a more complete understanding of the breadth and quality of SDG&E's mitigation activities. These distinctions are discussed in the applicable control/mitigation narratives in Section V. Similarly, a narrative discussion of certain "mitigation" activities and their associated costs is provided for certain activities and programs that may indirectly address the risk at issue, even though the scope of the risk as defined in the RAMP Report may technically exclude the mitigation activity from the RAMP analysis. This additional qualitative information is provided in the interest of full transparency and understandability, consistent with guidance from Commission Staff and stakeholder discussions.

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[3] *Id*. at 16.

[4] *Id.* at 17.

A. Risk Definition

For purposes of this 2019 RAMP Report, SDG&E's EII risk is defined as "the risk of an asset failure, caused by degradation, age, operation outside of design criteria due to unexpected events or field conditions (*e.g.*, force of nature), or an asset no longer complying with the latest engineering standards, which results in a safety, environmental, or reliability incident." A potential Risk Scenario[5] assessed as part of this risk is an energized wire down event caused by third-party contact, foreign object, or failure of an electric component (*e.g.*, a connector). If a member of the public comes into contact with the energized wire or in close proximity to the energized wire on the ground, the result could be injury and/or possibly death.

B. Summary of Elements of the Risk Bow Tie

Pursuant to SA Decision,[6] for each control and mitigation presented herein, SDG&E has identified which element(s) of the Risk Bow Tie the mitigation addresses. Below is a summary of these elements.

Table 1: Summary of Risk Bow Tie Elements

ID	Description of Driver/Trigger/Potential Consequence
DT.1	In-service equipment past its useful life or that becomes obsolete
DT.2	Equipment in-service beyond design specifications
DT.3	In-service equipment failing prematurely
DT.4	Active in-service equipment and associated components failing to operate as designed
DT.5	In-service equipment failing with lack of or delayed company insight
DT.6	In-service equipment contacted by customers or third parties
DT.7	In-service equipment failing in large volume (*i.e.*, simultaneous failure of numerous assets) due to acute climates or environmental conditions
PC.1	Serious injuries and/or fatalities
PC.2	Operational and reliability impacts

[5] The Risk Scenario, as assessed as part of SDG&E's 2018 Enterprise Risk Registry, is a potential reasonable worst-case scenario used to assess the residual risk impacts and frequency. The scenario may not necessarily address all Drivers/Triggers.

[6] D.18-12-014 at Attachment A, A-11 ("Bow Tie").

PC.3	Findings of non-compliance
PC.4	Penalties and fines
PC.5	Adverse litigation
PC.6	Erosion of public confidence

C. Summary of Risk Mitigation Plan

Pursuant to the SA Decision,[7] SDG&E has performed a detailed pre- and post-mitigation analysis of controls and mitigations for each risk selected for inclusion in RAMP, as further described below. SDG&E's baseline controls for this risk consist of the following programs/activities:

Table 2: Summary of Controls

Control ID	Control Name
SDG&E-4-C1	GO165: Distribution Inspect and Repair program – Overhead
SDG&E-4-C2	4 kV Modernization and System Hardening – Distribution
SDG&E-4-C3	Distribution Overhead Switch Replacement Program
SDG&E-4-C4	Management of Overhead Distribution Service (Non-CMP)
SDG&E-4-C5	Restoration of Service
SDG&E-4-C6	Underground Cable Replacement Program - Reactive
SDG&E-4-C7	Tee Modernization Program - Underground
SDG&E-4-C8	Replacement of Underground Live Front Equipment – Reactive
SDG&E-4-C9	DOE Switch Replacement – Underground
SDG&E-4-C10	Vegetation Management (Non-HFTD)
SDG&E-4-C11	GO165: Distribution Inspect and Repair Program – Underground Capital Asset Replacement
SDG&E-4-C12	GO165: Distribution Inspect and Repair Program – Underground Structure Repair
SDG&E-4-C13	Management of Underground Distribution Service (Non-CMP)
SDG&E-4-C14	Field SCADA RTU Replacement

[7] *Id.* at Attachment A, A-11 ("Definition of Risk Events and Tranches").

SDG&E-4-C15	Distribution Circuit Reliability
SDG&E-4-C16	Emergency Substation Equipment
SDG&E-4-C17	Reactive Substation Reliability and Repair for Distribution Components
SDG&E-4-C18	GO 174: Substation Relay Testing, Inspection and Repair Program
SDG&E-4-C19	Underground Cable Replacement Program – Proactive
SDG&E-4-C20	Enterprise Asset Management – Substation

SDG&E will continue the baseline controls identified above and puts forth additional projects and/or programs (*i.e.*, mitigations), as follows:

Table 3: Summary of Mitigations

ID	Mitigation Name
SDG&E-4-M1	Overhead Public Safety (OPS) Program[8]
SDG&E-4-M2	Replacement of Underground Live Front Equipment – Proactive
SDG&E-4-M3	Proactive Substation Reliability for Distribution Components
SDG&E-4-M4	Substation Breaker Replacements – FLISR (Fault Locations, Isolation, and Restoration)
SDG&E-4-M5	Enterprise Asset Management – Distribution

Finally, pursuant to the SA Decision,[9] SDG&E presents considered alternatives to the Risk Mitigation Plan for the EII risk and summarizes the reasons that the alternatives were not included in the Risk Mitigation Plan in Section VIII.

[8] This mitigation activity was identified in SDG&E's previous RAMP and GRC filings as the "Wire Safety Enhancement (WiSE) Central" program. With the Commission's recent rulemaking on Wildfire Mitigation Plan (R.18-10-007), SDG&E reduced the scope of the WiSE program to align with wildfire mitigation activities outside of SDG&E's High Fire Threat District (HFTD). Additional details on WiSE is located within the Wildfire Mitigation chapter (SDG&E-1) of this 2019 RAMP Report. Further details on OPS is located in Section V of this EII Chapter.

[9] D.18-12-014 at 33.

II. RISK OVERVIEW

Safety is a core value at SDG&E. SDG&E's safety-first culture focuses on its employees, customers, and the public, and is embedded in every aspect of our work. SDG&E's public website has a page dedicated to power line safety.[10] SDG&E continually aims to improve its electric infrastructure and educate employees, customers and the public about safety measures related to energized lines, both overhead and underground. The residual risk of electric infrastructure failures causing safety, environmental, or major reliability incidents has remained stable over recent years, which is evidenced by SDG&E winning its 13th consecutive "Best in the West" award.[11] Developing strong controls through programs such as SDG&E's Corrective Maintenance Program, modifying and consistently issuing new Construction Standards, and implementing other proactive resiliency measures like pole, cable, switch and aging substation infrastructure replacements, continue to mitigate SDG&E's EII risk and limit substantial growth in residual risks.

The EII risk can be characterized by several possible scenarios, including the wire down event used for risk impact and frequency scoring that involves asset failures. The wire down event is one of SDG&E's primary concerns with respect to its overhead equipment and involves is the downing of a piece of energized overhead equipment (*e.g.*, wires or conductors). 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 any such wire down events and has a dedicated team reviewing all wire down events to determine root cause and identify any trends to potentially trigger the development of a new program. SDG&E's Electric Distribution Engineering department is dedicated to the development and implementation of strategies that support all the unique field constructions and operations practices while assuring electric distribution efficiency, access, control, cost effectiveness and safety are being considered in all final decisions. Data analysis suggests there are various drivers of wire-down events, such as third-party contact, acute weather causing

[10] San Diego Gas & Electric Company, Downed Power Line Safety, *available at* https://www.sdge.com/safety/downed-powerline-safety.

[11] *See* http://www.sdgenews.com/article/sdge-wins-national-award-best-electric-reliability-america.

foreign object contact, or introducing extensive stress, aged infrastructure, and degradation of connectors. These Drivers/Triggers are further discussed below. SDG&E's Risk Mitigation Plan aims to mitigate these aforementioned Drivers/Triggers and therefore reduce Potential Consequences.

Asset age and wire size are predictable and impactful attributes leading to the natural decline of electric infrastructure integrity. Not only can aged assets be affected by severe wearing due to weathering and electrical or mechanical use, but they may not be able to provide the benefits 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 operate 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 Risk Mitigation Plan focuses on safety and reliability measures designed to protect its employees, customers and the public. The controls and mitigations in SDG&E's Risk Mitigation Plan are intended to address various EII-related events, not just the scenario used for purposes of SDG&E's 2018 ERR scoring. Another potential risk event associated with this chapter is the inadvertent contact of intact, energized SDG&E equipment by an employee, contractor, or the public, potentially causing serious injury or fatality. While the Potential Consequences of this risk event (*i.e.,* serious injury or fatality) are similar to those covered in the Employee Safety, Contractor Safety and Customer and Public Safety risk Chapters of this 2019 RAMP Report, the risk event is captured in this EII Chapter. While other risk Chapters focus on mitigations that address public outreach, education, communication, training, and other internal procedural enhancements, this EII risk Chapter focuses on infrastructure protection and improvements. While the controls/mitigations presented herein focus on infrastructure protection and improvements, the risk reduction benefits also impact the human safety risks (*e.g.,* Employee Safety, Customer & Public Safety). The costs for such risk mitigation activities are reflected in this Chapter.

Activities presented in this Chapter are representative of those that are primarily scoped to address SDG&E's Customer & Public Safety risk (SDG&E-5); however, many of the activities presented herein also help mitigate other risk areas as further described below. Further,

this Chapter primarily focuses on risks and mitigations unrelated to wildfire mitigation predominately outside of SDG&E's High Fire Threat District (HFTD). Wildfire-related risks and mitigations are covered in SDG&E's "Wildfires Involving SDG&E Equipment" risk Chapter (SDG&E-1). However, where the same mitigation activities are included in both the Wildfire Chapter and this EII Chapter, the costs included herein have been allocated according to HFTD and non-HFTD percentages (unless otherwise noted), consistent with SDG&E's Wildfire Mitigation Plan. For example, vegetation management is performed across SDG&E's entire service territory. Vegetation management therefore appears as an activity performed to reduce risk in both SDG&E-1 and the instant Chapter. The costs associated with the vegetation management activities in this chapter only include the non-HFTD percentage of costs.

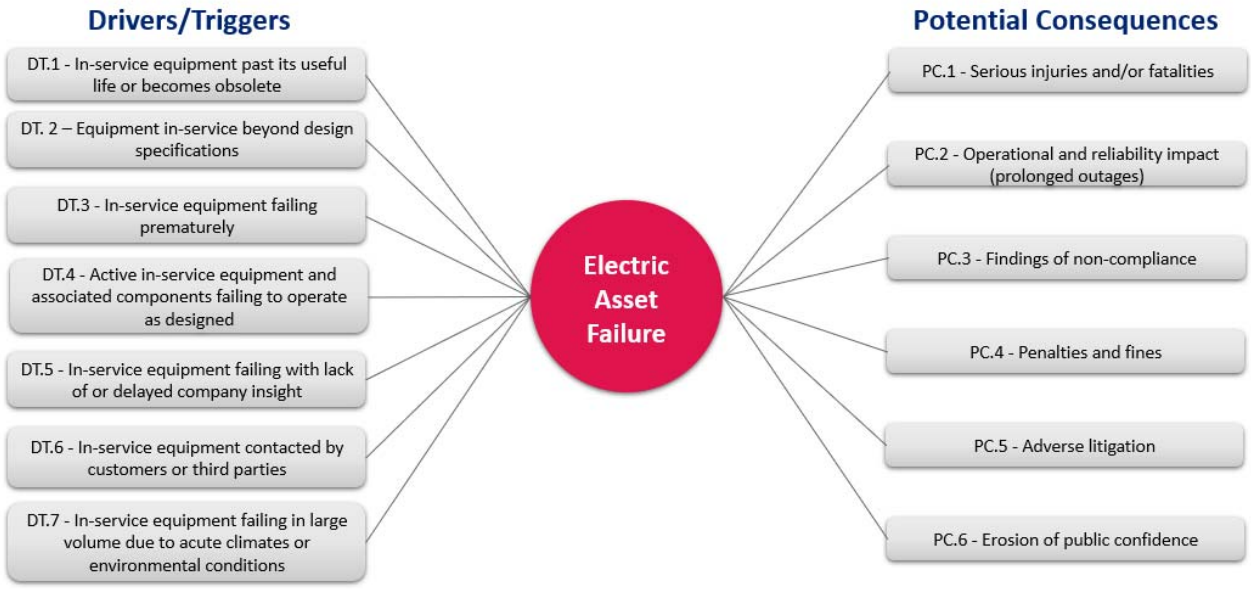
III. RISK ASSESSMENT

In accordance with the SA Decision, this section describes the Risk Bow Tie, possible Drivers/Triggers, and Potential Consequences of the EII risk.

A. Risk Bow Tie

The risk Bow Tie shown in Figure 1 below 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. A mapping of each Control/Mitigation to the element(s) of the Risk Bow Tie addressed is provided in Appendix A.

Figure 1: Risk Bow Tie



B. Asset Groups of Systems Subject to the Risk

The SA Decision directs the utilities to endeavor to identify all asset groups or systems subject to the risk.[12] SDG&E's EII risk impacts all of SDG&E's electric distribution system infrastructure and assets including the overhead electric system, underground electric system, and substations. The assets include capacitors, circuit breakers, conductors, wires, transformers, structures, and poles, for example. These assets all contribute to SDG&E delivering safe and reliable power to its customers. These asset groups are further identified as follows:

- Distribution Overhead (OH) – comprises overhead distribution asset infrastructure system, which includes conductors or wires, pole structures, transformers, switches, capacitors, and associated auxiliary equipment. The electric distribution system is further defined as assets operating at a nominal voltage of 12kV and 4kV.
- Distribution Underground (UG) – comprises underground distribution asset infrastructure system, which includes cables, underground structures (vaults,

[12] D.18-12-014 at Attachment A, A-11 ("Definition of Risk Events and Tranches").

manholes, handholes), switches, transformers, capacitors, and associated auxiliary equipment.

- Substation – comprises the substation asset infrastructure system, which includes transformers, breakers, batteries, relays, capacitors, disconnect switches, and associated auxiliary equipment.
- Operational Technology (OT) – comprises the auxiliary control system or network to the electric assets that process operational data, which includes telecommunications, energy management systems (EMS), remote supervisory control and data acquisition (SCADA), and advanced technologies (microprocessor-based relays with synchrophasor/phasor measurement unit (PMU) capabilities, real-time automation controllers, auto-sectionalizing equipment, line monitors, direct fiber lines, and wireless communication radios).

C. Risk Event Associated with the Risk

The SA Decision[13] instructs the utility to include a Risk Bow Tie illustration for each risk included in RAMP. As illustrated in the above Bow Tie, the Risk Event (*i.e.,* center of the Risk Bow Tie) is an electric asset failure event that results in any of the Potential Consequences listed on the right. The Drivers/Triggers that may contribute to this risk event are further described in the section below. The risk scenario (*i.e.*, a potential reasonable worst-case scenario used to assess the residual risk impacts and frequency) as assessed for SDG&E's 2018 ERR, is an energized wire-down event caused by a third-party contact, foreign object, or failure of an electric component (a connector). A member of the public contacts the energized wire or is in close vicinity of the energized wire on the ground, resulting in injuries and/or deaths. This risk scenario does not necessarily address all Drivers/Triggers and Potential Consequences and does not reflect actual or threatened conditions.

[13] *Id.* at Attachment A, A-11 ("Bow Tie").

D. Potential Drivers/Triggers[14]

The SA Decision[15] instructs the utility to identify which element(s) of the associated Bow Tie each mitigation addresses. When performing the risk assessment for the failure of an electric asset or accidental contact with an electrified asset by the public, SDG&E identified potential leading indicators, referred to as Drivers or Triggers. These include, but are not limited to:

- **DT.1 – In-service equipment past its useful life or becomes obsolete:** Electric assets are usually in service for several decades and possibly for several years beyond the book life of the asset. A common key indicator of failure for an electric asset pertains to the age of the specific asset. These assets can also be considered obsolete when new or updated safety, construction, and operational standards have been established in the industry or within the Company.
- **DT.2 – Equipment in-service beyond design 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 above recorded values), may stress the infrastructure and cause failures.
- **DT.3 – 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 design ratings, or for reasons unknown to SDG&E.

[14] An indication that a risk could occur. It does not reflect actual or threatened conditions.

[15] D.18-12-014 at Attachment A, A-11 ("Bow Tie").

- **DT.4 – Active in-service equipment and associated components failing to operate as designed**: Due to their sensitive nature, electric assets that are expected to operate based on protection settings to mitigate or reduce the impacts of an asset failure can be expected to either fail periodically or not operate as designed. These failures or delays in operation may cause the assets the protection settings are designed to protect to experience more damage or to extend an expected isolated event.
- **DT.5 – In-service equipment failing with lack of or delayed company insight**: Assets outside of design standards or original construction that does not result in an outage or visibility to SDG&E can lead to an extended exposure to the public (*e.g.,* a leaking transformer). Failure of these systems may cause prolonged or undetected risk exposure to the public.
- **DT.6 – In-service equipment contacted by customers or third parties:** SDG&E's electric facilities may be contacted by members of the public or other third parties. An incident of this type may involve energized overhead distribution primary conductor during the occurrence of a wire-down event or while the conductor is intact and operating under normal operating conditions.
- **DT.7 – In-service equipment failing in large volume due to acute weather events or environmental conditions:** 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. Adverse weather events may lead to large volumes of failures that extend the normal outage response time, due to limited resources or unsafe field conditions to assess and mitigate damage.

E. Potential Consequences of Risk Event

Potential Consequences are listed to the right side of the Bow Tie illustration provided above. If one of the drivers listed above were to result in an incident, the potential consequences, in a reasonable worst-case scenario, could include:

- **PC.1** – Serious injuries[16] and/or fatalities;
- **PC.2** – Operational and reliability impacts;
- **PC.3** – Findings of non-compliance;
- **PC.4** – Penalties and fines;
- **PC.5** – Adverse litigation; and
- **PC.6** – Erosion of public confidence.

These Potential Consequences were used in the scoring of the EII risk that occurred during the development of SDG&E's 2018 ERR.

IV. RISK QUANTIFICATION

The SA Decision sets minimum requirements for risk and mitigation analysis in RAMP,[17] including enhancements to the Interim Decision 16-08-018.[18] SDG&E used the guidelines in the SA Decision as a basis for analyzing and quantifying risks, as shown below. Chapter RAMP-C of this RAMP Report explains the Risk Quantitative Framework which underlies this Chapter, including how the Pre-Mitigation Risk Score, Likelihood of Risk Event (LoRE), and Consequence of Risk Event (CoRE) are calculated.

Table 4: Pre-Mitigation Analysis Risk Quantification Scores[19]

Electric Infrastructure Integrity	Low Alternative	Single Point	High Alternative
Pre-Mitigation Risk Score	3180	**3720**	4620
LoRE	**1200**		
CoRE	2.7	**3.1**	3.9

[16] For purposes of this 2019 RAMP Report, SDG&E defines "serious injury" as an injury that requires an overnight hospital stay.

[17] D.18-12-014 at Attachment A.

[18] *Id.* at 2-3.

[19] The term "pre-mitigation analysis," in the language of the SA Decision (Attachment A, A-12 ("Determination of Pre-Mitigation LoRE by Tranche," "Determination of Pre-Mitigation CoRE,"

Pursuant to Step 2A of the SA Decision,[20] the utility is instructed to use actual results, available and appropriate data. SDG&E's safety risk assessment primarily utilized internal data for the assessment of safety, financial, and reliability attributes.

For the safety assessment, internal records were used to identify the impact from in-scope risk events that lead to either fatalities or serious injuries to the public, employees, or contractors. For the reliability assessment, SDG&E's reliability database was used to identify in-scope events, such as those due to equipment failure due to outside contacts. The reliability database contains useful information such as the number of customers affected and the duration of the outage. For the financial assessment, a per-event cost was estimated using historical expenditures.

A. Risk Scope & Methodology

The SA Decision requires a pre- and post-mitigation risk calculation.[21] The below section provides an overview of the scope and methodologies applied for risk quantification.

Table 5: Risk Quantification Scope

In-Scope for purposes of risk quantification:	The risk of an electric asset failure due to internal or external factors, which results in serious injuries, fatalities, or reliability impacts.
Out-of-Scope for purposes of risk quantification:	The risk of reliability and safety incidents resulting from wildfires associated to electric assets.

SDG&E's EII risk quantification assessment utilized a compilation of internal data from various sources. For the safety attribute, information was gathered from internal sources to help identify historical instances of fatalities or serious injuries. For the reliability attribute, internal

"Measurement of Pre-Mitigation Risk Score")), refers to required pre-activity analysis conducted prior to implementing control or mitigation activity.

[20] D.18-12-014 at Attachment A, A-8 – A-9.

[21] *Id.* at Attachment A, A-11 ("Calculation of Risk").

electric reliability data was used. For the financial attribute, some financial records were reviewed to form an estimate of an average EII event.

EII Safety Methodology: The SDG&E Risk Quantification Framework's Safety Attribute contains Fatalities and Serious Injuries as the sub-attributes. A comprehensive review of safety incidents related to EII was undertaken, including the use of safety reports collected by the SDG&E Safety department, as well as information gathered by legal. Note that the method used to assign an incident to a particular risk is done through a prioritization standpoint. All safety incidents affecting SDG&E employees or contractors are discussed in those risk chapters.

B. Sources of Input

The SA Decision[22] directs the utility to identify Potential Consequences of a Risk Event using available and appropriate data. The below provides a listing of the inputs utilized as part of this assessment.

- An extract from the Claims database was used for safety.
- Electric Reliability database for years 2014-2018.

V. RISK MITIGATION PLAN

The SA Decision requires a utility to "clearly and transparently explain its rationale for selecting mitigations for each risk and for its selection of its overall portfolio of mitigations."[23] This section describes SDG&E's Risk Mitigation Plan by each selected control and mitigation for this risk, including the rationale supporting each selected Control and Mitigation.

As stated above, SDG&E's EII Risk is the risk of an asset failure, caused by degradation, age, operation outside of design criteria due to unexpected events or field conditions (*e.g.*, a force of nature), or an asset no longer complying with the latest engineering standards, which results in a safety, environmental, or reliability incident. The Risk Mitigation Plan discussed below includes both Controls that are expected to continue and new and/or incremental

[22] *Id.* at Attachment A, A-8 – A-9 ("Identification of the Frequency of the Risk Event").

[23] *Id.* at Attachment A, A-14 ("Mitigation Strategy Presentation in the RAMP and GRC").

Mitigations for the period of SDG&E's TY 2022 GRC cycle.[24] The Controls are those activities that were in place as of 2018, most of which have been developed over many years, to address this risk and include work to comply with laws that were in effect at that time.

Overview of SDG&E's Electric System:

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 roughly 1.4 million electric consumers comprise predominantly residential customers, along with a smaller number of commercial and industrial customers. Table 3 below provides an overview of SDG&E's electric system.

Table 6: SDG&E Electric Infrastructure Overview

Transmission	Distribution	Substation
Circuits (Tie lines) 500 kV: 6 230 kV: 48 138 kV: 39 69 kV: 146	Circuits 12 kV: 831 4 kV: 224	Distribution Substations 12 kV: 102 (no 4 kV) 4 kV (step downs and substations): 34
Overhead Miles: 1,831	Overhead Miles: 6,500	Transmission Substations: 25
Underground Miles: 174	Underground Miles: 10,765	

Overview of SDG&E's Risk Mitigation Plan:

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. SDG&E 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,

[24] *Id.* at 16-17 and 33. A "Control" is defined as a "[c]urrently established measure that is modifying risk." A "Mitigation" is defined as a "[m]easure or activity proposed or in process designed to reduce the impact/consequences and/or likelihood/probability of an event."

aging infrastructure, continually and changing load patterns, thousands of parts and pieces used to construct the electric distribution system 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.*, System 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.

SDG&E's Risk Mitigation Plan aims to mitigate electric asset failures associated with the electric overhead and underground system, and within the substation fence. These mitigations were developed by utilizing the potential drivers outlined in Section III.D, above, analysis from failed equipment, internal subject matter experts and outage data. When determining scope, duration and urgency for a mitigation plan, SDG&E considers several factors, such as: impacts to affordability, consequence of the asset failure, the volume of assets identified, and resource or manufacture constraints to design, physically construct and remove the identified risky asset. In addition, some asset failures require collaboration with manufacturers and industry experts to further analyze the root cause and develop the appropriate mitigation. Depending on the complexity, volume of assets, external constraints, environmental impact, comprehensive permitting and duration to construct, some mitigations require several years of planning before any construction can occur. However, the electric system is dynamic, and a new risk could be introduced daily, requiring SDG&E to be nimble and capable of altering a course of action, based on new information.

After additional research and evaluation of existing processes, SDG&E identified a need to develop Enterprise Asset Management tools to integrate all asset data, create predictive analytics and assist with further optimizing projects. Over the past year, SDG&E has constructed a dedicated department to address this specific topic and collaborated with additional departments and subject matter experts (SME) to evaluate all electric assets associated with the distribution and transmission system. This collaboration and development or enhancements to tools as well as databases, will allow SDG&E to further expand its capabilities and enhance the development of mitigations.

Climate Change Adaptation:

As stated above, SDG&E's electric service territory is 4,100 square miles spanning two counties. 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 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.

SDG&E considers the overhead electrical system to be its primary concern, from a risk perspective, because of public safety and its susceptibility to adverse weather. Adverse weather is a driver to premature failure of assets that can potentially lead to significant issues. SDG&E's underground electrical system poses operational and safety risks and is naturally subject to several environmental factors that may accelerate premature failures, such as soil conditions and flooding.

As further discussed in Chapter RAMP-A, SDG&E views climate change as a Driver/Trigger to an EII risk event. As stated above in the description of DT.7, in-service equipment failing in large volume due to acute weather events or environmental conditions, SDG&E is keenly aware of the increasing risk of catastrophic events and chronic long-term

impacts resulting from climate change and aims to provide safe and reliable electric service to the communities it serves by building resiliency to such climate risks and adapting to future climate change. The primary avenue through which SDG&E can increase climate resilience is by investing in resilient electric infrastructure that will continue to provide safe, affordable, reliable energy despite increasingly severe and frequent climate impacts.

The climate vulnerability assessments undertaken by SDG&E, and the other California IOUs, as part of the U.S. Department of Energy Partnership for Energy Sector Climate Resilience, represent an important initial, voluntary step in better understanding utility exposure to climate impacts. SDG&E has already developed several of these vulnerability assessments over the past years and fully intends to continue to do so moving forward.

In addition to the partnership with the DOE, SDG&E has worked with the California Energy Commission on two separate initiatives that assessed climate hazards in the SDG&E service territory. The studies were targeted at assessing the threat of sea level rise and coastal flooding on electric and gas infrastructure and provided key insights that allow SDG&E to effectively plan and manage infrastructure in light of climate change.

SDG&E's Risk Mitigation Plan - Controls:

A. SDG&E-4-C1: GO165 Distribution Inspect and Repair Program

SDG&E's General Order (GO) 165 Distribution Inspect and Repair program replaces wood poles after identifying compromised poles from GO 165 wood pole intrusive inspections. In lieu of the existing program, short- and long-term deterioration of overhead equipment could increase likelihood of asset failure (*e.g.*, broken poles) and cause potential risks, including injury or death, to the public and workers. Degraded equipment would also increase volume and frequency of forced distribution outages, creating risks for public safety. As this program is mandated per GO 165, non-compliance poses risk of regulatory action, including fines.

The Commission's Safety and Enforcement Division (SED) provided feedback that SDG&E should include a narrative discussion on the effectiveness of inspections per CPUC guidance on Senate Bill (SB) 901. SDG&E's Overhead (OH) Visual Inspection program utilizes GO 95, Rules for Overhead Electric Line Construction, as its basis for identifying non-conformances. The OH Visual Inspection looks for a variety of conditions that could impact public and employee safety, structural integrity, and system reliability. The OH Visual

Inspection consists of a detailed, walk-around inspection of all distribution poles, pole-mounted facilities with primary and secondary conductors, CIP attachments, and distribution equipment on transmission poles. These inspections identify conditions that are out of compliance with GO 95. On average, SDG&E performs approximately 45,000 OH visual inspections on our electric distribution system per year. For an OH visual inspection, the top five conditions found are as follows:

- Damaged/Missing Sign;
- Damaged/Missing/Incorrect Station Pole ID;
- Damaged Ground Molding;
- Damaged/Missing High Voltage signs; and
- Pole steps lower than 10 feet.

SDG&E also performs a Pole Intrusive Inspection on each wood electric distribution pole. Any pole 15 years of age or older is inspected intrusively. The form of the intrusive inspection is normally an excavation about the pole base and/or a sound and bore of the pole at ground line. Currently, treatment is applied in the form of ground line pastes and/or internal pastes. SDG&E performs these inspections on a 10-year cycle. The 10-year cycle fulfills the requirements of GO 165, which are: (1) all poles over 15 years of age are intrusively inspected within ten years; and (2) all poles that previously passed intrusive inspection are to be inspected intrusively again on a 20-year cycle.

The wood pole integrity inspections are currently performed by an SDG&E contractor who also applies wood preservative treatments and installs mechanical (steel) reinforcements. The type of treatment is dependent upon the age of the pole, the individual inspection history, and the overall condition of the structure. SDG&E's Vegetation Management group administers the wood pole intrusive inspection and treatment program. For this program, SDG&E performs approximately 20,000 wood pole intrusive inspections. There are three findings from this type of inspection. They are:

- Pole replacement;
- Pole reinforcement (with steel); and
- No corrective action needed.

B. SDG&E-4-C2: 4kV Modernization and System Hardening Program – Distribution

The purpose of SDG&E's 4kV Modernization and System Hardening program is to systematically remove the 4kV distribution system from service and replace with or upgrade to modern 12kV standards. The 4kV system makes up over 20% of SDG&E distribution circuits (by circuit count) and represents approximately 5% of SDG&E system load and overall distribution system length. Half of the 4kV substations are more than 50 years old, and replacement components for those substations are no longer available. The operation of 4kV substations is of a major safety concern because the company is facing a shortage of qualified crews and electricians who are familiar with and knowledgeable about design and operation of those aging and obsolete substations. The maintenance cost is unusually high and continues to increase. The 4kV substations also present reliability and safety risks for customers, because high failure rates, lack of replacement parts, and limited options to transfer load to adjacent circuits, have the potential to cause more frequent and unnecessary extended outages. In addition, 4kV overhead circuits are more likely to experience a wire down compared to 12kV circuits due to a higher percentage of small wire conductors and smaller conductor clearances. SDG&E's 4kV modernization plan addresses all areas of 4kV substation and distribution infrastructure removals and upgrades.

The scope of the program includes: 4kV package or "unit" substation removal and modernize other aging substation infrastructure; cutover to 12kV, including complete rebuilding, relay upgrades, accommodations, and design.

C. SDG&E-4-C3: Distribution Overhead Switch Replacement Program

SDG&E's Distribution Overhead Switch Replacement Program aims to replace overhead distribution switches that have shown signs of severe or quickly emerging corrosion that may lead to catastrophic failure. SDG&E has determined through quantitative risk modeling various data attributes that characterize high risk switches and has prioritized several switches that can be removed in the near term to avoid failure. For example, SDG&E's engineering analyses of failed overhead switches have determined that various switches, such as hooksticks, often fail due to excessive corrosion of major components. Switches have failed in as little as eight years of operation along the dense salt fog coast.

Switch replacements may also require simultaneous or subsequent upgrades to relevant equipment such as poles, crossarms, wires, guys, and other hardware.

Distribution switches have higher propensity for failure and/or inoperability along the coast identified by the SDG&E-defined "Contamination District One"[25] area which includes assets within two miles of the coast. Their inoperability during an outage can extend 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 not consistently exercised 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. Solid blade cutouts and antiquated single phase disconnect switches will be targeted to be replaced with newer model disconnects with superior material specifications, three-phase gang-operated switches (mitigating ferro resonance over-voltages and flashovers, both SCADA and Non-SCADA) as well as remote operable SCADA tie switches for improved reliability. In addition, operation of the at-risk switches will be included to assist with minimizing inoperable state during an outage. Intent to target high corrosion areas.

D. SDG&E-4-C4: Management of Overhead Distribution Service (Non-CMP)

This project is required to reinforce the electric overhead distribution system infrastructure by responsive action to system damages, deterioration and unsafe conditions outside normal restoration of service. The overall objective is to maintain continuity of safe and reliable customer service.

This project provides for the reconstruction of existing overhead distribution facilities as necessary, to:

- Correct improper voltage conditions;
- Replace overloaded overhead facilities;
- Make emergency repairs not normally associated with restoration of service;
- Repair or replace deteriorated or unsafe equipment not found through the "Corrective Maintenance Program;"

[25] "Contamination District One" is the designated area within two miles of the coastline where equipment and/or assets tend to deteriorate due to increased salt particles in the air.

- Install fault indicators/fusing/switching equipment as necessary; and
- Install a barrier around the pole to prevent reoccurrence.

E. SDG&E-4-C5: Restoration of Service

SDG&E, as an investor owned utility, has an obligation to serve. This project is required to accomplish restoration of electric service due to system interruptions caused by severe inclement weather conditions, fires, equipment failures and damages caused by a third party. This project provides for the reconstruction of existing overhead and underground distribution facilities as necessary to restore electric service to customers. The funds within this budget cover all costs associated with the following factors:

- Storm Damage (rain/wind/fire, for example);
- Damage to electric distribution facilities by others (car/equipment contacts, for example); or
- Emergency repairs of facilities that are required for service restoration (cable or equipment failures, for example).

F. SDG&E-4-C6: Underground Cable Replacement Program – Reactive

SDG&E's underground cable replacement program is designed to reactively replace equipment during outages on the distribution system. This program provides funding for the replacement of underground cable involved in a forced outage. This project is required to support SDG&E's obligation to serve, by funding the restoration of electric service after system interruptions caused by underground cable failures involved in severe inclement weather conditions, equipment failures and damages caused by a third party.

G. SDG&E-4-C7: Tee Modernization Program - Underground

SDG&E's Tee Modernization Program involves the proactive at-risk identification and replacement of 600-amp tee connectors. 600-amp tees are used in underground connections in handholes, manholes, and at-switch terminations. These tee failures often occur along feeder cables causing forced outages to large customer counts that require extensive reconstruction to permanently restore the outage. Tee connector failures have become one of the largest contributors to customer outages in the last few years. The modernization of tees through this program provides a more reliable system that has more sectionalizing capability. Additionally,

tees can fail violently (*e.g.,* tee failure could lead to an arc flash), which poses a serious safety risk to our field personnel.

H. SDG&E-4-C8: Replacement of Live Front Equipment – Reactive

"Live front" equipment is equipment that has primary connections exposed, with no insulation covering. Live front equipment contains electric components enclosed in a protective (usually steel) cabinet that does not have additional protective barriers. Thus, when the cabinet is opened, energized (or live) electric connections are exposed. Live front equipment was primarily installed on SDG&E's electric distribution system during the 1960's and 1970's, has since become obsolete, and is now being replaced by 'dead-front' equipment with additional safety barriers such as removable fiberglass or composite plates, protective covers or additional compartmentalization. SDG&E's Live Front Terminator Replacement Project replaces live front pad-mounted distribution equipment with dead front pad-mounted distribution equipment, when it is encountered during normal SDG&E work.

I. SDG&E-4-C9: DOE Switch Replacement - Underground

SDG&E's "do not operate energized" (DOE) Switch Replacement Program for underground switches aims to systematically replace switches that are deemed unsafe for energized operation of the internal mechanical units. SDG&E utilizes inspection programs to identify these types of switches. These inspections include visual inspections, infrared (IR) inspection to detect points of potential overheating, measurement of 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 improves worker safety while operating these switches and prevents premature failures of these assets, avoiding potential for injuries and damages to adjacent facilities.

J. SDG&E-4-C10: Vegetation Management (Non-HFTD)

SDG&E's Vegetation Management Program is responsible for inspecting and maintaining an inventory of approximately 450,000 trees that have the potential to encroach within the minimum required compliance distance between vegetation and overhead power lines. This work includes pruning healthy trees growing into overhead power lines as well as the pruning or removal of dead, dying, diseased, or structurally unsound trees that have the potential

to fall into overhead lines. SDG&E is responsible for compliance with CPUC GO 95, Rule 35; Public Resources Code, sections 4292 and 4293; and NERC FAC-003. Compliance with these rules and regulations mandate a minimum clearance between vegetation and SDG&E facilities and are the primary cost drivers of the program.

SDG&E's vegetation activities are coordinated through a centralized Vegetation Management Program within the Construction Services department, under the Electric Operations organization. The Vegetation Program Manager and staff set the standards, guidelines, and processes for the overall program to see that the company is in compliance with all rules, laws, and regulations governing SDG&E practices. There are two types of work that drive the tree program costs: 1) routine work and 2) field memos and hazard tree work. Routine work includes annual-cycle pruning and removal of trees. Pre-inspection contractors perform the overhead power line patrols which identify trees to be pruned and removed. Routine tree pruning and removal is typically done by a contractor and is compensated on a unit price basis. Field memos and/or unscheduled tree pruning are reactive work, and include customer refusals, hazard tree pruning and removal, environmentally or culturally sensitive pruning activities, trees which require priority pruning, district requests, and customer safety checks.

To confirm the above activities are completed in accordance with the company's contracted scopes of work, SDG&E has a quality control program to verify the completion and certification of each work activity. An automated random sampling method is used to create audit work packages, and then the auditor field reviews records for adherence to contract specifications, quality, and compliance. In conjunction with the post-prune audit, auditing activity includes a patrol of all spans of overhead power lines for any trees that may have encroached the minimum clearance zones since the last pre-inspection activity. This activity provides a higher level of compliance for the duration of the annual cycle.

K. SDG&E-4-C11: GO165 Distribution Inspect and Repair Program – Underground Capital Asset Replacement

Short- and long-term deterioration of underground equipment could increase likelihood of asset failure (*e.g.*, a broken cable rack) and cause potential risks, including injury or death, to the public and workers. Degraded equipment would also increase volume and frequency of forced distribution outages, creating risks for public safety. As this program is mandated per GO

165, non-compliance poses risk of regulatory action, including fines. Underground connectors are inspected by infrared technology per ESP 120 (upon entry of facility) and replaced accordingly.

This inspection of AGDF/AGLF (Above ground, dead front and live front pad-mounted equipment) consists of a detailed external and internal inspection of pad-mounted facilities to identify conditions out of compliance with GO 128. The most obvious types of condition that presents a significant hazard to the public and employees are severe corrosion, possible wire entry, and identifying oil leaks. These are the types of conditions that SDG&E is continually looking for.

SDG&E performs this type of inspection on approximately 25,000 structures per year. The top five conditions found on this type of inspection are as follows:

- EXT/INT High Voltage Sign Missing;
- External Working Space Sign Missing;
- Weeds/Trees/Bushes/Dirt or Obstacle;
- Possible Wire Entry to Energized/Exposed Parts; and
- Weeds/Grass/Dirt Inside Unit.

L. SDG&E-4-C12: GO 165 Distribution Inspect and Repair Program – Underground Structure Repair

Short- and long-term structural deterioration of manholes and degradation of distribution switches cause potential risks, including the risk of injury or death, to the public and workers. Degraded equipment would also increase the volume and frequency of forced distribution outages, creating risks for public safety. As this program is mandated per GO 165 (Inspection Requirements for Electric Distribution and Transmission Facilities), non-compliance poses risk of regulatory action, including fines.

This program includes detailed inspection of subsurface structures (manholes, vaults, primary hand-holes and subsurface enclosures) containing electric distribution equipment. Structures with only cable taps, splices or pass-throughs are excluded, as they are not required by GO 165. The program's detailed inspection of these facilities identifies conditions out of compliance with GO 128 (Rules for Construction of Underground Electric Supply and Communication Systems). The most obvious examples of a condition that could present a

significant hazard to the public and employees are severe structural corrosion, an unsecure entry way, and the presence of oil leaks. These are the types of conditions that SDG&E is continually looking for.

On average, SDG&E performs this type of detailed inspection on approximately 400 structures per year. The top five conditions found on this type of inspection are as follows:

- Weeds/Trees/Bushes/Dirt or Obstacle;
- EXT/INT High Voltage Sign Missing;
- Weeds/Grass/Dirt Inside Unit;
- ID/Circuit/Switch Number Missing or Incorrect; and
- External Working Space Sign Missing.

M. SDG&E-4-C13: Management of Underground Distribution Service (Non-CMP)

This project is required to reinforce the electric underground distribution system infrastructure by responsive action to system damages, deterioration and unsafe conditions outside normal restoration of service. The overall objective is to maintain continuity of safe and reliable customer service.

This project provides for the reconstruction of existing underground distribution facilities as necessary to:

- Correct improper voltage conditions;
- Replace overloaded overhead facilities;
- Make emergency repairs not normally associated with restoration of service;
- Repair or replace deteriorated or unsafe equipment not found through the Corrective Maintenance Program; and
- Install fault indicators, fusing, or switching equipment as necessary to maintain service reliability.

N. SD&E-4-C14: Field SCADA RTU Replacement

Older SCADA Remote Terminal Units (RTUs) that support communication to distribution field devices such as switches, regulators and capacitors have poor reliability often complicating outages or requiring field crews to manually switch devices that could normally be switched remotely. SDG&E's Field SCADA RTU Replacement Project replaces distribution

field-deployed RTUs (outside substations), which are past their useful life and no longer supported by the vendor.

This project resolves issues with the current SCADA system, thereby allowing SDG&E to move away from legacy communication protocols that are no longer supported and improving communication reliability. This project also allows for a more transparent view to the grid, which will enhance SDG&E's reliability. Proactively modernizing SDG&E's SCADA RTUs by replacing old legacy equipment will better enable operability of the distribution network, including faster circuit outage restorations.

O. SDG&E-4-C15: Distribution Circuit Reliability

This program helps mitigate electric infrastructure integrity risk by expanding the distribution SCADA-switching infrastructure and removing reliability deficiencies. This program allows for the addition of equipment necessary to improve service reliability of electric customers and maintain reliability standards. The electric service reliability will deteriorate in the absence of comprehensive remedial solutions offered by these projects.

P. SDG&E-4-C16: Emergency Substation Equipment

This project provides funding to support the restoration of service to our customers following outages caused by equipment failures by purchasing emergency spare and mobile equipment. The number of aging transformers and switchgear on the SDG&E system is at the level that additional failures are expected, despite efforts to replace the equipment before failure. In addition, there can be lengthy lead times for replacement units, during which time the spares are necessary. Currently, the requested funding for this budget is for two 69/12 kV transformers to maintain the level of spare equipment required to support the aging fleet of transformers.

Q. SDG&E-4-C17: Reactive Substation Reliability and Repair for Distribution Components

SDG&E's Reactive Substation Reliability and Repair for Distribution Components program allows for necessary safety related improvements and replacement of failed equipment. Work authorized under this program includes replacements on structures, replacement of obsolete failed substation equipment and obsolete failed communication equipment within the substation footprint.

R. SDG&E-4-C18: GO174: Substation Relay Testing, Inspection and Maintenance Program

SDG&E's Substation System Inspection and Maintenance Program promotes safety for SDG&E personnel and contractors by providing a safe operating and construction environment, within the substation fence. Additional goals include: meeting all of the requirements of GO 174, achieving a level of station availability satisfactory to SDG&E's health and safety programs and maintenance standards, and assuring compliance with all sections of the California Independent System Operator (CAISO) Transmission Control Agreement (TCA). This is accomplished through routine inspections at reoccurring cycles. A security check is planned once per week, and a more detailed inspection is planned monthly or bimonthly, which takes a visual look at equipment and attempts to identify any problems, like oil leaks.

S. SDG&E-4-C19: Underground Cable Replacement Program – Proactive

SDG&E currently performs reactive replacement of underground cable. There are currently approximately 74 circuit miles of unjacketed feeder cable and 1,423 circuit miles of unjacketed lateral cable remaining on the SDG&E electric distribution system. The reactive program (SDG&E-3-C6) identifies and replaces failed equipment. This program (SDG&E-3-C19) would take a proactive approach by replacing underground cable that has been identified to have a high probability of failure based on electric reliability circuit analysis and cable failure data. It would also provide quality customer service and reliability to existing customers by proactively replacing cable in the underground system before it fails, and an outage occurs.

T. SDG&E-4-C20: Enterprise Asset Management - Substations

SDG&E currently has Conditioned Base Maintenance (CBM) monitoring equipment on electric distribution assets in in substation facilities, such as distribution banks, that support greater asset utilization, longevity of use and asset health indexes. This data, along with maintenance records and other data sources, are combined into a software platform to prioritize maintenance activities and stay informed on situations that might lead to potential outages or failures. Collection of this asset data also allows for long term planning on asset health to support capital investment prioritizations and risk reduction strategies.

SDG&E's Risk Mitigation Plan - Mitigations:

U. SDG&E-4-M1: Overhead Public Safety (OPS) Program

SDG&E is proposing an Overhead Public Safety (OPS) program,[26] which will effectively replace or protect the assets most prone to failure. The OPS 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-HFTD and non-Wire Safety Enhancement (WiSE) circuits provides SDG&E's 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 small wire (*e.g.*, #6 Cu and #4 Cu), 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 and potential for risk reduction.

SDG&E's OPS program aims to proactively replace high-risk overhead conductors prone to wire-down events measured by failure rates, historic wire down events, CMP records and lack of protection (fuse or advanced) that are in proximity to the public (*e.g.,* schools, freeways, high profile areas) that could put the public at risk of energized contact. SDG&E utilizes new construction standards, such as covered conductor, to mitigate the wire-down event (such as foreign object contact) and designs risk mitigation strategies for each circuit to achieve the greatest risk reduction for energized wire downs by reconductoring, deploying advanced protection and/or detection schemes. This program will replace existing assets with assets that have been designed to current and updated construction standards. The assets targeted in this

[26] As previously stated in Section I of this Chapter, SDG&E's OPS program was identified in SDG&E's previous RAMP and GRC filings as the WiSE Central program. With the Commission's recent rulemaking on Wildfire Mitigation Plan (R.18-10-007), SDG&E reduced the scope of the WiSE program to align with wildfire mitigation activities outside of SDG&E's HFTD. Therefore, the OPS program is separate and distinct form the WiSE program. Additional details on WiSE is located within the Wildfire Mitigation chapter (SDG&E-1) of this RAMP Report.

tranche (typically small wire copper spans) were designed and constructed decades ago. Therefore, replacement of these assets with those designed to current construction standards provides the benefit of improved design techniques, modern equipment and construction methods.

This program will also evaluate overhead distribution lines that cross major or high-traffic freeways. Overhead distribution crossings that have poor structural integrity or high-risk conductors will be hardened to avoid a wire down in the roadway that could put motorists at risk.

One of the primary concerns of SDG&E with respect to its overhead equipment is when a piece of overhead equipment (*e.g.*, wire) 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 foreign object contact or introducing extreme stress, aged infrastructure, and degradation of connectors. The most notable and consistently contributing driver of wire-down events is the failure of small wire.

The main scope of program is to replace remaining small wire with conductor that is known to be statistically less prone to failure, such as #2 5/2 AWAC conductor and depending on vegetation in the area covered conductor. In other areas, where small wire may not feasibly be replaced, at-risk connectors, sleeves, and single-phase spans of small wire (*i.e.,* commonly known failure points) will be replaced as needed. In addition to the OPS infrastructure replacement program, SDG&E is also presenting as part of this RAMP filing a program to add a more robust public safety awareness campaign to address wire-down situations. This enhanced public safety communication campaign (SDG&E-5-M2) is further addressed in SDG&E's Customer and Public Safety Chapter of this RAMP Report (SDG&E-5) and aims to educate and provide a deeper level of understanding to the public with respect to safe practices around electric infrastructure. Associated costs for SDG&E-5-M2 are included in the Customer and Public Safety RAMP Chapter and are not included herein.

V. SDG&E-4-M2: Replacement of Live Front Equipment – Proactive

As described above in SDG&E-4-C-8, "live front" equipment having the primary connections exposed with no insulative covering. Thus, when the equipment is opened, there are energized (or live) conductors present. SDG&E has a current live front terminator replacement program that is reactive; *i.e.*, when there is a job on the SDG&E distribution system that involves working with live front equipment, the equipment that is involved will be replaced with dead front equipment at that time. This incremental mitigation aims to proactively identify and replace live front equipment before employees are deployed to the job, thereby further reducing the potential for employee injury and/or outage.

Continued use of live front terminators causes risks to workers who rely on limited tools to operate the live equipment. As an alternative to using this equipment, switching plans can consider operating dead-front or remote-operated equipment elsewhere on the system to create electric isolation for a job or for safe operation of the live front equipment, however this would likely cause unnecessary outage exposure to additional customers. If the limited switching tools are insufficient, workers may be dangerously exposed to live primary voltage, potentially resulting in serious risks for injury or death.

W. SDG&E-4 M3: Proactive Substation Reliability and Repair for Distribution Components

SDG&E's proactive substation reliability and repair program consists of the following projects:

i. Streamview Bank 30 Project
ii. Pacific Beach 12 kV Replacement Project
iii. Ash 12 kV Capacitor Bank and Circuit Breaker Replacement Project
iv. New Substation

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.

These projects will focus primarily on distribution substation bank transformers and circuit breaker replacements. Substations are essential to the operation of the electric system and must be kept in reliable condition, as the consequences of a failure are extreme. Proactive planning is required for the replacement of equipment that has exhausted its useful life.

The New Substation project will mitigate outage impacts to the transmission and distribution system by offloading demand from neighboring substations through the distribution tie capacity, thus enhancing reliability in the downtown San Diego area. Outages could be unplanned as well as planned due to the foreseeable need to rebuild existing substations in the area. This will, as a result, allow the distribution system to continue operating at optimum conditions, which, as a result, maintains reliability, shortens outage times, and allows for operational flexibility to the system.

X. SDG&E-4-M4: Substation Breaker Replacements

SDG&E's Substation Breaker Replacement projects consist of the following:

i. San Ysidro Breaker Replacement – Replace 12kV breakers and 12kV relaying at San Ysidro Substation.

ii. Murray Breaker Replacement – Replace 12kV breakers and 12kV relaying at Murray Substation.

The Substation Breaker Replacement projects are necessary to modernize substation equipment that will help provide safe, reliable, and quality customer service by enabling the deployment of Fault Locations, Isolation, and Restoration (FLISR) technology. With FLISR technology, fault location, fault isolation, and customer restoration on a distribution circuit occurs automatically, without the intervention of a distribution system operator. This results in safely improving the distribution system reliability.

Y. SDG&E-4-M5: Enterprise Asset Management – Distribution

In 2017, SDG&E formed an Asset Management program team, as a central group, to develop and implement a holistic and sustainable asset management system for electric infrastructure assets with an integrative approach for governance, strategy, analytics and continuous improvement. The new asset management system is being developed to conform with ISO 55000, an international standard that specifies the requirements for the establishment, implementation, maintenance, and improvement of an asset management system. Benefits of

such a system may include enhanced asset safety, improved performance, managed risk, demonstrated compliance, and improved efficiencies and effectiveness of asset utilization and operations.

As further discussed in SDG&E's Safety Culture Chapter (RAMP-F), Enterprise Asset Management is a critical element of SDG&E's focus on creating sustainable and high-quality asset safety and management for electric operations, and optimizing asset utilization, while mitigating asset-related risks. This is also one element of SDG&E's vision for an electric safety management system. A comprehensive asset management system will provide the access to and integration of data throughout the asset life cycle to develop analysis and a health index for critical assets.

SDG&E is developing an asset health index (AHI) on its assets to identify and compare assets based on its likelihood of failure. An AHI is a score designed to track the condition and performance of an asset by applying predictive analytics to multiple sources of data and used as a basis for asset management strategies. The key benefits of employing AHI include the ability to measure overall health of assets, recognize asset data parameters associated with failure modes, detect failures, relatively compare between assets of same class in a consistent manner, and utilize analytics to measure operational conditions.

Asset risk is determined when AHI and the associated likelihood of failure consequence are jointly considered. Based on this information, asset strategies would be evaluated, prioritized and implemented to manage the asset in a manner that aligns with SDG&E's overall risk management strategy, supports risk-informed platform for managing assets, and reinforces safe operations, maintenance and proactive replacement strategies. Integrating this asset risk information with other inputs, such as circuit risk index for situational awareness, will inform the appropriate asset-related operational decision-making and strategies for enhanced reliability and safe operations of assets on given current and expected conditions.

SDG&E believes asset management will provide a means to optimize the Company's risk, performance, and investments while meeting or exceeding safety and regulatory objectives. A comprehensive asset management system will provide the access to and integration of data throughout the asset life cycle to develop analysis and a health index for critical assets. Using a health index of its assets, SDG&E can identify which assets have a likelihood of failure and the

respective consequence(s) of the failure(s). Based on this information, asset strategies would be evaluated and implemented to manage the asset in a manner that aligns with SDG&E's overall risk management strategy.

SDG&E's Power Quality (PQ) 12kV Bus Monitor Deployment and Replacement project, which is part of the Enterprise Asset Management proposal, is the continued deployment of substation bus power quality monitors that can remotely monitor and capture data that support distribution and substation asset management and power quality investigations. Future use cases with better analytic software could support momentary or incipient fault detection for better asset management and reliability functions.

This project provides an incremental expansion to our substation power quality monitoring system (PQ Nodes) and associated communication system. SDG&E will:

- Provide local wiring and network connections to existing monitors;
- Upgrade existing PQ nodes and support equipment;
- Install new IT integration and interface for new equipment;
- Install field and substation relay and communication systems;
- Install new PQ support communication equipment; and
- Provide time synchronization for existing monitors.

The substation PQ monitoring system provides benefits as follows:

- Distribution system health information. System parameters including RMS voltage , voltage & current transient events, system harmonics (including spectra), real & reactive power flow, power factor, flicker, and others.
- Event logging and notification for events occurring on transmission, distribution and customer systems that are perceptible at the distribution substation.
- Advanced analytics processes including incipient fault detection (fault anticipation) and advanced fault locating.
- A data source with analytics for historical events and steady state trends.
- Data collected via the substation PQ monitoring system is regularly utilized by several groups within the company including Commercial and Industrial (C&I) Services, Electric Transmission, and Distribution Engineering and Planning.

Continued deployment of substation bus power quality monitors that can remotely monitor and capture data will support distribution and substation asset management and power quality investigations. Future use cases with better analytic software could support momentary or incipient fault detection for better asset management and reliability functions.

Because asset management efforts benefit SDG&E's entire service territory, for purposes of SDG&E's RAMP showing, costs for this activity has been allocated between SDG&E's Wildfire (SDG&E-1) and this Electric Infrastructure Integrity risk chapter based on HFTD (60% Wildfire) and non-HFTD (40% EII) percentages.

VI. POST-MITIGATION ANALYSIS OF RISK MITIGATION PLAN

As described in Chapter RAMP-D, SDG&E has performed a Step 3 analysis where necessary, pursuant to the terms of the SA Decision. SDG&E has not calculated an RSE for activities beyond the requirements of the SA Decision but provides a qualitative description of the risk reduction benefits for each of these activities in the section below. Mitigation Tranches and Groupings

The Step 3 analysis provided in the SA Decision[27] instructs the utility to subdivide the group of assets or the system associated with the risk into tranches. As defined in the SA Decision, a tranche is "a logical disaggregation of a group of assets (physical or human) or systems into subgroups with like characteristics for purposes of risk assessment."[28] Therefore, risk reduction and RSEs from Controls and Mitigations are determined at the tranche level. For purposes of the risk analysis, each tranche is considered to have homogeneous risk profiles (*i.e.*, the same LoRE and CoRE). SDG&E's rationale for the determination of tranches is presented in the section below.

Table 7: Summary of Mitigation Tranches

ID	Mitigation/Control	Tranche	Tranche ID
SDG&E-4-C1	GO 165: Distribution Inspect and Repair program	Non-HFTD	SDG&E-4-C1
SDG&E-4-C2	4 kV Modernization and System Hardening Program– Distribution	Non-HFTD	SDG&E-4-C2

[27] D.18-12-014 at Attachment A, A-11 ("Definition of Risk Events and Tranches").

[28] *Id.* at Attachment A, A-4.

ID	Mitigation/Control	Tranche	Tranche ID
SDG&E-4-C3	Distribution Overhead Switch Replacement Program	Hook stick switches and solid blades in Contamination District One (coast)	SDG&E-4-C3-T1
		Tie switches (gang or hook stick) in Contamination District One	SDG&E-4-C3-T2
		Switches in Contamination District One with large customer count that could benefit from SCADA	SDG&E-4-C3-T3
SDG&E-4-C4	Management of Overhead Distribution Service (Non-CMP)	Non-HFTD	SDG&E-4-C4
SDG&E-4-C5	Restoration of Service	Service territory-wide	SDG&E-4-C5
SDG&E-4-C6	Underground Cable Replacement Program - Reactive	Service territory-wide	SDG&E-4-C6
SDG&E-4-C7	Tee Modernization Program - Underground	Service territory-wide	SDG&E-4-C7
SDG&E-4-C8	Replacement of Live Front Equipment – Reactive	Service territory-wide	SDG&E-4-C8
SDG&E-4-C9	DOE Switch Replacement - Underground	Service territory-wide	SDG&E-4-C9
SDG&E-4-C10	Vegetation Management (Non-HFTD)	Non-HFTD	SDG&E-4-C10
SDG&E-4-C11	GO165: Distribution Inspect and Repair Program – Underground Capital Asset Replacement	Service territory-wide	SDG&E-4-C11
SDG&E-4-C12	GO165: Distribution Inspect and Repair Program – Underground Structure Repair	Service territory-wide	SDG&E-4-C12
SDG&E-4-C13	Management of Underground Distribution Service (Non-CMP)	Service territory-wide	SDG&E-4-C13
SDG&E-4-C14	Field SCADA RTU Replacement	Service territory-wide	SDG&E-4-C14
SDG&E-4-C15	Distribution Circuit Reliability	Service territory-wide	SDG&E-4-C15
SDG&E-4-C16	Emergency Substation Equipment	Service territory-wide	SDG&E-4-C16

ID	Mitigation/Control	Tranche	Tranche ID
SDG&E-4-C17	Reactive Substation Reliability and Repair for Distribution Components	Service territory-wide	SDG&E-4-C17
SDG&E-4-C18	GO 174: Substation Relay Testing, Inspection and Maintenance program	Service territory-wide	SDG&E-4-C18
SDG&E-4-C19	Underground Cable Replacement Program – Proactive	Unjacketed feeder cable	SDG&E-4-C19-T1
		Unjacketed branch cable	SDG&E-4-C19-T2
SDG&E-4-C20	Enterprise Asset Management – Substation	Substation	SDG&E-4-C20
SDG&E-4-M1	Overhead Public Safety (OPS) program	Small wire conductors in public proximity and those that cross freeways	SDG&E-4-M1
SDG&E-4-M2	Live Front Equipment Replacement - Proactive	Service territory-wide	SDG&E-4-M2
SDG&E-4-M3	Proactive Substation Reliability for Distribution Components	Streamview Bank 30 Project	SDG&E-4-M3-T1
		Pacific Beach 12 kV Replacement Re-build	SDG&E-4-M3-T2
		Ash 12 kV Capacitor Bank and Circuit Breaker Replacement Project	SDG&E-4-M3-T3
		New Substation	SDG&E-4-M3-T4
SDG&E-4-M4	Substation Breaker Replacements - FLISR	San Ysidro Breaker Replacement	SDG&E-4-M4-T1
		Murray Breaker Replacement	SDG&E-4-M4-T2
SDG&E-4-M5	Enterprise Asset Management – Distribution	Distribution	SDG&E-4-M5

A. Post-Mitigation/Control Analysis Results

1. SDG&E-4-C1 - GO165: Distribution Inspect and Repair program

SDG&E's Distribution Inspect and Repair program is conducted throughout SDG&E's entire service territory, and assets within SDG&E's HFTD and non-HFTD have different risk

profiles that warrant separate tranches. However, the activities (and associated costs) included within this EII risk chapter are all performed outside of the HFTD, have the same risk profile, and therefore warrant a single tranche. Mitigation activities performed within SDG&E's HFTD are found in the Wildfire Risk chapter (SDG&E-1).

a. Description of Risk Reduction Benefits

In accordance with CPUC 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 reduces SDG&E's safety and reliability risks through proactive replacement of major assets such as poles in order to prevent forced interruptions and the resulting public safety hazards. SDG&E's Distribution Inspect and Repair Program is a reasonable and effective control for electric infrastructure risks because it implements comprehensive, routine inspections of various components of overhead electric infrastructure, supplemented with timely corrective actions to replace assets prone to premature failure. While the full costs of this activity are captured in this RAMP chapter, it is important to note that this activity also serves to reduce the Customer & Public safety and reliability risk (Chapter SDG&E-5).

SDG&E performs the above-described activities in accordance with CPUC General Order 165. Therefore, this is a mandated program and SDG&E has not performed an RSE analysis because it is not feasible for SDG&E to stop performing this activity and/or to calculate the risk reduction benefits received from performing this activity.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C1 reduces SDG&E's safety and reliability risks through proactive replacement of major assets such as poles in order to prevent forced interruptions and the resulting public safety hazards. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and Appendix A such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment failing with lack of or delayed company insight (DT.5). Addressing such Drivers/Triggers by implementing comprehensive, routine inspections of various components of overhead electric infrastructure, supplemented with timely corrective actions to

replace assets prone to premature failure decreases the likelihood of Potential Consequences such as serious injuries or fatalities (PC.1), or operational and reliability impacts (PC.2).

2. SDG&E-4-C2: 4 kV Modernization and System Hardening Program – Distribution

This program targets specific types of assets (4 kV wire) which all have a similar risk profile. Further, this program includes activities for assets targeted outside of the HFTD. Therefore, a single tranche is appropriate for this activity.

a. Description of Risk Reduction Benefits

The removal and reduction of the 4kV system in SDG&E's electric distribution system will reduce the probability of these assets failing, therefore reducing the safety and reliability risks. The hardening of the overhead system associated with this program also provides an increase in public and employee safety. In addition, the removal of the aging and obsolete substations will increase employee safety as the workforce of electricians who are familiar with and knowledgeable about the operation of these assets are decreasing.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C2 reduces SDG&E's safety and reliability risks through proactive removal and reduction of the 4kV system in SDG&E's electric distribution system. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and Appendix A such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment failing with lack or delayed company insight (DT.5). Addressing such Drivers/Triggers by removal and reduction of the 4kV system decreases the likelihood of Potential Consequences such as serious injuries or fatalities (PC.1), or operational and reliability impacts (PC.2).

c. RSE Inputs and Basis

Scope	Replacing 16 miles of small wire out of 1461 and 6 miles of large wire. The scope includes incidental underground cable segment replacements.
Effectiveness	Per internal SME assessment, replacing these wires could reduce safety, reliability, and financial risk by up to 95%.
Risk Reduction	**Safety**: Approximately 85% of EII safety risk is associated with overhead wires and small wires, representing 75% of the wires down risk, based on assessment of company data and SME estimates. Using these assumptions, this mitigation could reduce EII safety risk by up to 0.7%.

	Reliability: This mitigation addresses approximately 75% of the wires down reliability risk, based on assessment of company data and SME estimates. Incidental underground cable replacements increase the reliability benefit by 2%. This mitigation could reduce EII financial risk by up to up to 0.9%. **Financial:** Based on the assumption that financial risk is proportional to the number of outages, this mitigation could reduce EII financial risk by up to 0.9%.

d. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1198.97**	
	CoRE	2.65	**3.09**	3.83
	Risk Score	3176.54	**3709.42**	4597.55
	RSE	4.11	**12.56**	26.65

3. SDG&E-4-C3 – Distribution Overhead Switch Replacement Program

For purposes of an RSE analysis, SDG&E has separated this Distribution Switch Replacement Program into three tranches. The tranches break apart the various risk profiles based on asset type and customer impact within the same coastal district as distribution switches have a higher propensity for failure or becoming inoperable along the coast (Contamination District One).[29] Tranche 1 is hook stick switches and solid blades in Contamination District One. Tranche 2 is tie switches (gang or hook stick) in Contamination District One. Tranche 3 are manual switches in Contamination District One with large customer counts that could benefit from SCADA. Based on these different risk profiles, SDG&E has performed a separate RSE analysis on each tranche.

[29] "Contamination District One" is the designated area within two miles of the coastline where equipment and/or assets tend to deteriorate due to increased salt particles in the air.

a. Elements of the Risk Bow Tie Addressed

SDG&E-4-C3 reduces SDG&E's reliability risk by replacing distribution switches that have a higher propensity for failure or becoming inoperable. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment failing with lack of or delayed company insight (DT.5). Addressing such Drivers/Triggers by replacing distribution switches with a higher propensity for failure decreases the likelihood of Potential Consequences such as serious injuries or fatalities (PC.1) or operational and reliability impacts (PC.2).

4. SDG&E-4-C3-T1 – Hook Stick Switches and Solid Blades in Contamination District One

a. Description of Risk Reduction Benefits

As further evidenced in the table below, replacing hook stick switches and solid blades in Contamination District One reduces SDG&E's reliability risk. These asset types in a high corrosion area are targeted for replacement to avoid failure and the related safety (inoperable switches pose safety risks to field operating personnel due to potential flash hazards) and reliability (prolonged outage) risks. While outside of the scope of the risk definition covered in this RAMP chapter, this program also provides an increase to customer and public safety (SDG&E-5), and employee safety (SDG&E-3).

b. RSE Inputs and Basis

Scope	Replacing 24 hook stick switches and solid blades in coastal Contamination District One of 291 identified.
Effectiveness	Per internal SME assessment, replacing a hook stick switch could reduce reliability and financial risk associated with this asset type by up to 95%. In addition, replacing hook stick switches and solid blades has two times the reliability risk reduction impact versus replacing other switches, as there are two hook sticks per switch location. Additionally, the targeted switches are older and have a correspondingly higher failure rate, estimated at twice the average.
Risk Reduction	**Safety:** While this activity may help reduce safety risk, no direct impact on safety was included as part of this RSE assessment, as it is outside of the scope of the risk definition.

	Reliability: Based on company data assessment, switches represent 0.3% of SAIDI and 1.4% of SAIFI, respectively. Using an average of SAIDI and SAIFI impact, this tranche could reduce EII reliability risk by 0.02%. **Financial:** Based on the assumption that financial risk is proportional to the number of outages this mitigation could reduce EII financial risk by up to 0.02%.

c. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1199.76**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3179.38	**3719.38**	4619.38
	RSE	16.80	**16.80**	16.80

5. SDG&E-4-C3-T2 – Tie Switches (Gang or Hook Stick) in Contamination District One

a. Description of Risk Reduction Benefits

As further evidenced in the table below, replacing tie switches (gang or hook stick switches) in Contamination District One reduces SDG&E's reliability risk. These asset types in a high corrosion area are targeted for replacement to avoid failure and the related safety (inoperable switches pose safety risks to field operating personnel due to potential flash hazards) and reliability (prolonged outage) risks. The switches are targeted for replacement by age and location (*i.e.*, near the coast) since both are indicated drivers for failure. While outside of the scope of the risk definition covered in this RAMP chapter, this program also provides an increase in public and employee safety.

The associated RSE analysis for this tranche looked at the number of switches older than 15 years (3,844 switches) and identified 291 targeted, at-risk switches, and applied a 3x

multiplier since gang switches have three phases, and therefore three times the risk, to develop the following formulas.

b. RSE Inputs and Basis

Scope	Replacing 3 tie switches in Contamination District One of 291 identified.
Effectiveness	Per internal SME assessment, replacing a tie switch could reduce reliability and financial risk associated with this asset type by up to up to 95%. Replacing tie switches has 3 times the reliability risk reduction impact versus replacing other switches, as there are three phases per gang switch. Additionally, the targeted switches are older and have a correspondingly higher failure rate, estimated at twice the average.
Risk Reduction	**Safety:** While this activity may help reduce safety risk, no direct impact on safety was included as part of this RSE assessment, as it is outside of the scope of the risk definition. **Reliability:** Based on company data assessment, switches represent 0.3% of SAIDI and 1.4% of SAIFI, respectively. Using an average of SAIDI and SAIFI impact, this tranche could reduce EII reliability risk by 0.004%. **Financial:** Based on the assumption that financial risk is proportional to the number of outages this mitigation could reduce EII financial risk by up to 0.002%.

c. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1199.96**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3179.89	**3719.89**	4619.89
	RSE	11.81	**11.81**	11.81

6. SDG&E-4-C3-T3 – Switches in Contamination District One with Large Customer Count that Could Benefit From SCADA

a. Description of Risk Reduction Benefits

As further evidenced in the table below, targeting switch replacements with large customer counts in Contamination District One reduces SDG&E's reliability risk. These asset

types in a high corrosion area are targeted for replacement to avoid failure and the related safety (inoperable switches pose safety risks to field operating personnel due doe potential flash hazards) and reliability (prolonged outage) risks. While outside of the scope of the risk definition covered in this RAMP chapter, this program also provides an increase in public and employee safety.

The associated RSE analysis for this tranche looked at the number of switches older than 15 years (3,844 switches) and identified 291 targeted, at-risk switches. For this tranche, it is assumed that partial restoration can be achieved faster with SCADA capabilities and that this functionality will be placed in a spot where more than 1.000 customers will benefit.

b. RSE Inputs and Basis

Scope	Replacing 3 SCADA-enabled switches in Contamination District One of 291 identified.
Effectiveness	Per internal SME assessment, replacing a SCADA switch could reduce reliability and financial risk associated with this asset type by up to up to 95%.
Risk Reduction	**Safety:** While this activity may help reduce safety risk, no direct impact on safety was included as part of this RSE assessment, as it is outside of the scope of the risk definition. **Reliability:** Based on company data assessment, switches represent 0.3% of SAIDI and 1.4% of SAIFI, respectively. An average of SAIDI and SAIFI impact is used to estimate a portion of the reliability benefit. An additional portion is estimated with the assumptions that 45 minutes are saved with 294 customers impacted given automation availability. With these assumptions, this mitigation could reduce EII reliability risk by 0.009%. **Financial:** Based on the assumption that financial risk is proportional to the number of outages this mitigation could reduce EII financial risk by up to 0.001%.

c. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigatio	**LoRE**		**1199.89**	
	CoRE	2.65	**3.10**	3.85

	Risk Score	3179.73	**3719.73**	4619.73
	RSE	20.46	**20.46**	20.46

7. SDG&E-4-C4 - Management of Overhead Distribution Service (Non-CMP)

This program is deployed across SDG&E's entire service territory. However, for purposes of this RAMP filing, SDG&E has included activities for assets targeted within the designated HFTD within the Wildfire Risk chapter (SDG&E-1) and activities for assets targeted outside of the HFTD within this EII Risk chapter. Therefore, a single tranche is appropriate for this activity, since the assets within these two distinct risk profiles have already been segregated.

a. Description of Risk Reduction Benefits

The activities under this mitigation are responsive actions to system damage, deterioration, and unsafe conditions found outside of normal restoration of service or outside the Corrective Maintenance Program inspection cycles. Activities include replacing overloaded underground equipment beyond acceptable limits that could accelerate to failure, correction of voltage issues reported by customers, and repairs not associated with restoration of service. The overall objective is to maintain continuity of safe and reliable service.

This program reduces risk by reinforcing electric overhead distribution system infrastructure to maintain safe and reliable service. SDG&E's electric overhead distribution system can become damaged or deteriorated due to several factors such as age, environmental conditions or contact, resulting in unsafe conditions. This program therefore addresses those conditions (in a reactive manner) to reduce the risk of possible injury or fatality or operational and reliability impacts.

SDG&E has not conducted an RSE analysis on this baseline control. This program represents mandated compliance activity per CPUC General Order 95; Cal. Pub. Util. Code §§ 451, 761, 762, 768, and 770 (Obligation to Serve). Therefore, it is not feasible for SDG&E to stop performing these activities or calculate the associated risk reduction benefits received in lieu of not performing these activities.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C4 reduces SDG&E's safety and reliability risks by reinforcing electric overhead distribution system infrastructure. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment failing with lack or delayed company insight (DT.5). Addressing such Drivers/Triggers by reinforcing electric overhead distribution system infrastructure decreases the likelihood of Potential Consequences such as serious injuries or fatalities (PC.1), or operational and reliability impacts (PC.2).

8. SDG&E-4-C5 - Restoration of Service

A single tranche is appropriate for this program because SDG&E has an obligation to serve and restore service in a timely and safe manner across its entire service territory. Therefore, restoring electrical service has a single risk profile that does not warrant separate tranches.

a. Description of Risk Reduction Benefits

This program reduces risk by restoring electrical service and reinforcing electric overhead distribution system infrastructure to maintain safe and reliable service. SDG&E's electric overhead distribution system can become damaged or deteriorated due to factors such as environmental conditions or contact, resulting in unsafe conditions. This program therefore addresses those conditions (in a reactive manner) to reduce operational and reliability impacts.

SDG&E, as a public utility, has an obligation to serve as a provider of last resort. This program represents mandated compliance activity per CPUC General Order 95; Cal. Pub. Util. Code §§ 451, 761, 762, 768, and 770 (Obligation to Serve). SDG&E therefore has not performed an RSE analysis because it is not feasible for SDG&E to stop performing this activity or to calculate the risk reduction benefits received from performing this activity.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C5 reduces SDG&E's reliability risk by restoring electrical service and reinforcing electric distribution system infrastructure. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in

Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment failing in large volume due to acute climates or environmental conditions (DT.7). Addressing such Drivers/Triggers by restoring electrical service and reinforcing electric distribution system infrastructure decreases the likelihood of Potential Consequences such as operational and reliability impacts (PC.2) and findings of non-compliance (PC.3).

9. SDG&E-4-C6: Underground Cable Replacement Program - Reactive

A single tranche is appropriate for this program because SDG&E has an obligation to serve and restore service in a timely and safe manner across its entire service territory

a. Description of Risk Reduction Benefits

This program reduces risk by replacing cable following loss of electrical service from outages related to electric distribution primary underground cabling, in order to maintain safe and reliable service. SDG&E's electric underground distribution system can become damaged or deteriorated, resulting in unsafe conditions or forced outages. This program therefore addresses those conditions (in a reactive manner) to reduce the risk of possible operational and reliability impacts.

SDG&E has not performed an RSE analysis on this baseline control. SDG&E has an obligation to serve and this program replaces underground cable necessary to restore service to customers. This program represents mandated compliance activity per CPUC General Order 95; Cal. Pub. Util. Code §§ 451, 761, 762, 768, and 770 (Obligation to Serve). Therefore, it is not feasible for SDG&E to stop performing this activity or to calculate the risk reduction benefits received from performing this activity.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C6 reduces SDG&E's reliability risks by replacing underground cable necessary to restore service to customers. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment failing in large volume due to acute climates or environmental conditions (DT.7). Addressing such Drivers/Triggers replacing underground

cable necessary to restore service to customers decreases the likelihood of Potential Consequences such as operational and reliability impacts (PC.2).

10. SDG&E-4-C7: Tee Modernization Program

"Tee" connectors used for electric primary distribution underground feeder cabling pose an equivalent reliability risk and pose no risks to wildfire. Therefore, a single tranche is appropriate for this activity since the assets have an equivalent risk profile.

a. Description of Risk Reduction Benefits

As further evidenced in the table below, targeting and replacing 137 at-risk tees, which are prone to failure, would reduce reliability risk. These tee failures, which often occur along feeder cables near the substation, cause forced outages to large customer counts and require extensive reconstruction in order to permanently restore the outage.

To derive the RSE score, SDG&E determined the number of tees in scope. Total tees are the sum of manhole, handhole, and vault tees. The below RSE analysis applies a condition multiplier for an assumed 50-year life, a failure rate that is flat for up to 40 years then exponentially rising by a factor of 14 over the following decade. The below formula also assumes that tees are randomly selected from worst 20% in terms of risk. Failures per year were set to the 5-year average of 75 tee outages.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C7 reduces SDG&E's reliability risk by targeting and replacing at-risk tees. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1) or in-service equipment failing prematurely (DT.3). Addressing such Drivers/Triggers by proactive replacement of at-risk tees decreases the likelihood of Potential Consequences such as operational and reliability impacts (PC.2).

c. RSE Inputs and Basis

Scope	Replacing 137 at-risk tees, out of 33,713 tees in the system total (0.4%).
Effectiveness	Per internal SME assessment, replacing tees could reduce reliability and financial risk associated with this asset type by up to 95%. Each location generally has 3 tees that are replaced, one per phase, thus the impact is tripled per location.

Risk Reduction	**Safety:** While this activity may help reduce safety risk, no direct impact on safety was included as part of this RSE assessment, as it is outside of the scope of the risk definition. **Reliability:** Based on company data assessment, tees represent 11% of SAIDI and 13% of SAIFI, respectively. Using an average of SAIDI and SAIFI impact, this mitigation could reduce EII reliability risk by up to 0.1%. **Financial:** Based on the assumption that financial risk is proportional to the number of outages this mitigation could reduce EII financial risk by up to 0.1%.

d. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1198.38**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3175.77	**3715.77**	4615.77
	RSE	16.06	**16.06**	16.06

11. SDG&E-4-C8: Replacement of Live Front Equipment - Reactive

Live front equipment, consisting of transformers and terminator cabinets, have the primary connections exposed with no insulative covering. All live front equipment poses the same safety risk and a single tranche is appropriate.

a. Description of Risk Reduction Benefits

SDG&E continues its routine removal of "live front" terminators and transformers, as they are not designed in accordance with modern safety protocols. This program replaces these devices with dead front devices, which enable workers to maintain and 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 concerns to electric workers and/or contractors who build and maintain these assets.

Continued use of live front terminators causes risks to workers who maintain and operate the live equipment. To perform switching on live front terminators, additional and more experienced personnel are required. As an alternative to using this equipment, switching plans can consider operating dead front or remote operated equipment to isolate the job and allow for safe operation of the live front equipment. Use of this approach, however, would likely cause unnecessary outage exposure to additional customers. If the limited switching tools are insufficient, workers may be dangerously exposed to live primary voltage, causing serious risks for injury or death. While outside of the scope of the risk definition covered in this RAMP chapter, this program also mitigates SDG&E's Employee Safety risk (Chapter SDG&E-3).

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C8 reduces SDG&E's safety and reliability risks by removal of devices not designed in accordance with modern safety protocols. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as serious injuries or fatalities (PC.1) or operational and reliability impacts (PC.2).

c. RSE Inputs and Basis

Scope	Replacing 38 live front transformers, out of 2,952 live front transformers in the system total (1.3%).
Effectiveness	Per internal SME assessment, replacing live front transformers could reduce safety, reliability, and financial risk associated with this asset type by up to 100%. As efforts are focused on targeting riskier assets, a factor of 2 times is applied to account for more consequential circumstances.
Risk Reduction	**Safety:** Assuming that most contacts with energized equipment occur on the overhead system (10% underground), and assuming that transformers are a fraction (25%) of the situations where flashover or direct contact can take place on underground devices, company SMEs estimate that this mitigation could reduce EII safety risk by up to 0.06%. **Reliability:** Internal calculations estimated the impact and rate of transformer failure. Based on that analysis, live front transformers represent 0.002% of combined SAIDI and SAIFI contributions. With these assumptions, this mitigation could reduce EII reliability risk by up to 0.004%.

	Financial: Based on the assumption that financial risk is proportional to the number of outages, this mitigation could reduce EII financial risk by up to 0.006%.

d. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1199.96**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3179.84	**3719.50**	4618.92
	RSE	2.63	**8.44**	18.13

12. SDG&E-4-C9: DOE Switch Replacement - Underground

"Do not operate Energized" switches are determined not safe for operation when energized. Therefore, all identified DOE switches pose the same safety risk and a single tranche is appropriate.

a. Description of Risk Reduction Benefits

Distribution switches have a propensity for failure and/or inoperability during an outage (or may extend 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 closed or 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.

Replacing 90 "do not operate energized" (DOE) distribution switches will reduce switch inoperability and improve electric reliability by approximately 0.1% by reducing customer impact (smaller area of outage impact and higher effectiveness of fault isolation/switching plan). Worker safety is at high risk for arc flash, causing injury or death, if DOE switches are not properly addressed in a timely manner. While outside of the scope of the risk definition covered

in this RAMP chapter (and therefore not included as part of the RSE analysis, as further described below), this program also helps to mitigate SDG&E's Employee Safety risk (Chapter SDG&E-3).

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C9 reduces SDG&E's reliability risk by replacement of distribution switches that have a high propensity for failure and/or inoperability during an outage. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences, such as serious injury or fatality (PC.1), or operational and reliability impacts (PC.2).

c. RSE Inputs and Basis

Scope	Replacing 90 DOE switches out of 126 DOE switches in the system total (71%).
Effectiveness	Per internal SME assessment, replacing DOE switches could reduce reliability and financial risk associated with this asset type by up to 95%.
Risk Reduction	**Safety:** While this activity helps reduce employee safety, no direct impact on safety was included as part of this RSE assessment, since the identified employee safety risk (as described above) is outside of the scope of the EII risk definition. **Reliability:** Internal SMEs calculated the potential ramifications (on estimated time to restoration and customers impacted) of adjusting service restoration efforts to work around DOE switches. Based on that analysis, DOE switches represent a SAIDI savings of 0.1%. With these assumptions, this mitigation could reduce EII reliability risk by up to 0.1%. **Financial:** No direct impact on financial risk is anticipated from this mitigation.

d. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigatio	**LoRE**		**1198.67**	
	CoRE	2.65	**3.10**	3.85

	Risk Score	3176.68	**3716.68**	4616.68
	RSE	7.00	**7.00**	7.00

13. SDG&E-4-C10: Vegetation Management (Non-HFTD)

SDG&E's vegetation management program is deployed throughout its entire service territory. For purposes of this RAMP filing, vegetation management activities performed within the HFTD are captured within the Wildfire Risk Chapter (SDG&E-1). The activities and associated costs presented within this EII Risk chapter only include those outside of the HFTD (*i.e.*, non-HFTD, 40%). Therefore, a single tranche for this activity is appropriate.

a. Description of Risk Reduction Benefits

The activities associated with this program include pruning healthy trees growing into overhead power lines and the pruning or removal of dead, dying, diseased, or structurally unsound trees with the potential to fall into overhead lines. These collective activities reduce vegetation contact that could lead to a wire-down incident and/or customer outages.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C10 reduces SDG&E's safety and reliability risks by reducing vegetation contact that could potentially lead to a wire-down incident and/or customer outage. This program reduces SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment failing prematurely (DT.1) and/or in-service equipment failing with lack of or delayed company insight (DT.5). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as serious injuries or fatalities (PC.1) or operational and reliability impacts (PC.2).

c. RSE Inputs and Basis

Scope	About 20% of the vegetation management areas are being targeted, representing 47% of the tree work.
Effectiveness	Based on quality assurance estimates, vegetation management activities are 99% effective in addressing the scope of inspections and remediations. Also, based on historical information, it is assumed that without vegetation management safety and reliability issues associated with vegetation would be 7 times more frequent.
Risk Reduction	**Safety:** This component is associated with wires-down events. It is estimated that 18% of these are related to tree causes. This mitigation is

	estimated to reduce safety risk in the amount of 59% of the baseline amount. **Reliability:** SMEs calculated the potential SAIDI and SAIFI impacts of these improvements. Based on that analysis, this mitigation could reduce EII reliability risk by up to 14% of the baseline amount. **Financial:** The financial impact is assumed to be directly connected to the number of experienced electrical interruptions. Based on this assumption, this mitigation could reduce EII financial impacts by up to 9% of the baseline amount.

d. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1027.85**	
	CoRE	2.63	**2.85**	3.21
	Risk Score	2703.93	**2927.34**	3299.69
	RSE	39.34	**65.50**	109.10

14. SDG&E-4-C11: GO165: Distribution Inspect and Repair Program – Minor Capital Asset Replacement

SDG&E performs inspections and associated repair of minor overhead and underground equipment assets within its entire service territory, as mandated by GO 165. Therefore, a single tranche is appropriate.

a. Description of Risk Reduction Benefits

Inspection and repair of deteriorated or damaged overhead and underground minor assets helps reduce SDG&E's reliability and safety risk. Deteriorated or damaged equipment increases the likelihood of asset failure and the potential for injury or fatality to the public, employees and contractors. Deteriorated or damaged equipment also increases the volume, length, and frequency of forced outages. Since this program is mandated, non-compliance also poses risk of regulatory action, fines, and penalties (PC.4). Therefore, performing this activity reduces the risk of those Potential Consequences.

SDG&E has not conducted an RSE analysis on this baseline control. SDG&E performs this program in compliance with CPUC General Order 165. Therefore, it is not feasible for SDG&E to stop performing these activities or to calculate the risk reduction benefits received for performing these activities.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C11 reduces SDG&E's safety and reliability risks by inspection and repair of deteriorated or damaged overhead and underground assets. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as serious injuries or fatalities (PC.1), or operational and reliability impacts (PC.2).

15. SDG&E-4-C12: GO165: Distribution Inspect and Repair Program – Underground Structure Repair

SDG&E performs inspections and associated repair of underground structures within its entire service territory, as mandated by GO 165. Therefore, a single tranche is appropriate.

a. Description of Risk Reduction Benefits

Inspection and repair of deteriorated or damaged underground structures, such as manholes and handholes, helps reduce SDG&E's reliability and safety risk. Deteriorated or damaged underground structures increases the likelihood of asset failure and the potential for injury or fatality to the public, employees and contractors. Deteriorated or damaged equipment also increase the volume, length and frequency of forced outage. Since this program is mandated, non-compliance also poses risk of regulatory action, fines and penalties. Therefore, performing this activity reduces the risk of those Potential Consequences.

SDG&E has not conducted an RSE analysis on this baseline control. SDG&E performs this program in compliance with CPUC General Order 165. Therefore, it is not feasible for SDG&E to stop performing these activities or to calculate the risk reduction benefits received for performing these activities.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C12 reduces SDG&E's safety and reliability risks by inspecting and repairing deteriorated or damaged underground infrastructure. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as serious injuries or fatalities (PC.1) or operational and reliability impacts (PC.2).

16. SDG&E-4-C13: Management of Underground Distribution Service (Non-CMP)

This program is deployed across SDG&E's entire service territory and SDG&E has an obligation to restore service to all customers. Therefore, a single tranche is appropriate for this risk mitigation activity.

a. Description of Risk Reduction Benefits

The activities under this mitigation are responsive actions to system damages, deterioration and unsafe conditions found outside of normal restoration of service or outside the Corrective Maintenance Program inspection cycles. Activities include replacing overloaded underground equipment beyond acceptable limits that could accelerate to failure, correction of voltage issues reported by customers, and repairs not associated with restoration of service. The overall objective is to maintain continuity of safe and reliable service.

SDG&E has not conducted an RSE analysis on this baseline control. This program is a mandated compliance activity per CPUC General Order 128; Cal. Pub. Util. Code §§ 451, 761, 762, 768, and 770 (Obligation to Serve). Therefore, it is not feasible for SDG&E to stop performing this activity.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C13 reduces SDG&E's safety and reliability risks by responding to system damages, deterioration and/or unsafe conditions. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing

prematurely (DT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as serious injuries or fatalities (PC.1), or operational and reliability impacts (PC.2).

17. SDG&E-4-C14: Field SCADA RTU Replacement

A fleet of obsolete remote terminal units (RTUs) that provide communications to distribution field equipment have poor reliability and lack modern features to support automated switching and/or situational awareness. Replacement will better allow for remote operation of devices that supports reliability and avoids dispatching personnel for manual switching. This program targets like assets (*i.e.*, RTUs) with similar risk profiles. Therefore, a single tranche is appropriate.

a. Description of Risk Reduction Benefits

Distribution switches in the field have outdated RTUs and limited communication capabilities. Some of the current equipment is end of life and/or does not benefit from newer technology features. The replacement of 72 distribution SCADA RTUs in substations is designed to replace old RTUs with updated technology, resulting in better and more reliable communication. Moving from a manual switch to a SCADA system allows SDG&E to know where the outages are and to open and close the switches remotely, thereby reducing the length of outages. Moving to a SCADA system also helps eliminate cyber risk, which could lead to higher risk consequences.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C14 reduces SDG&E's reliability risk by targeting and replacing outdated RTUs. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1) and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as operational and reliability impacts (PC.2).

c. RSE Inputs and Basis

Scope	Replacing 72 distribution SCADA RTUs in substations, out of 172 total potential sites in the system (42%).

Effectiveness	Per internal SME assessment, replacing old RTUs could reduce reliability and financial risk associated with this asset type by up to 95%.
Risk Reduction	**Safety:** No direct impact on safety. **Reliability:** Internal SMEs calculated the time savings per interruption to be approximately 45 minutes with SCADA-enabled RTUs. Based on that analysis, SCADA RTU replacements represent 0.2% in SAIDI savings. Using these estimates, this mitigation could reduce EII reliability risk by up to 0.2%. **Financial:** No direct impact on financial risk is anticipated from this mitigation.

d. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1197.68**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3174.20	**3714.20**	4614.20
	RSE	26.65	**26.65**	26.65

18. SDG&E-4-C15: Distribution Circuit Reliability

Through identified opportunities to improve system reliability or the review of outage events with significant impacts to the system reliability, remediation projects are designed involving the placement of distribution field switches that would mitigate or reduce the severity of a future or potential outage. Due to this comprehensive review, projects are only approved with high reliability benefits with the risk profile being consistent. Therefore, a single tranche is warranted.

a. Description of Risk Reduction Benefits

As further evidenced in the table below, this project helps reduce SDG&E's reliability risk by increasing sectionalizing and communication based on historic outage data, thereby reducing the length and impact of a customer interruption. This project aims to reduce customer

impact in the event of an outage and prevent reoccurrence. As described below, SMEs estimate a 45-minute savings per interruption affecting 294 customers, on average.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C15 reduces SDG&E's reliability risk by reducing customer impact in the event of an outage. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1) and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as operational and reliability impacts (PC.2).

c. RSE Inputs and Basis

Scope	The number targeted for improvement is 57 units.
Effectiveness	Per internal SME assessment, these improvements are 100% effective in reducing associated reliability risk.
Risk Reduction	**Safety:** No direct impact on safety. **Reliability:** SMEs calculated the potential SAIDI impact of these improvements and estimated a 45-minute savings per interruption affecting 294 customers, on average. This mitigation could therefore reduce EII reliability risk by up to 0.2%. **Financial:** The financial impact is minimal and not quantified.

d. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1198.07**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3175.17	**3715.17**	4615.17
	RSE	40.25	**40.25**	40.25

19. SDG&E-4-C16: Emergency Substation Equipment

This program supports substation asset replacements across SDG&E's entire service territory. A single tranche is appropriate for this risk mitigation activity since the assets are within a distinct risk profile.

a. Description of Risk Reduction Benefits

This control is focused on purchasing additional emergency spare and mobile equipment. In an incident where equipment, such as a transformer, circuit breaker, or switchgear fails, the additional emergency spare and mobile equipment would provide the Company with the ability to restore service more efficiently, enhancing customer reliability. Furthermore, as the lead time for replacement of failed transformed and switchgear has increased, the stocking of spare equipment may decrease the number of lengthy and unexpected outages. The two transformers requested for replenishing are both at a year's lead time. SDG&E has not performed an RSE analysis as the function of the control is to perform a routine operation and restore service from the emergency conditions.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C16 reduces SDG&E's safety and reliability risks by ensuring emergency and spare equipment is available to support restoration efforts. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as operational and reliability impacts (PC.2).

20. SDG&E-4-C17: Reactive Substation Reliability and Repair for Distribution Components

This control is required to maintain the safety, reliability and integrity of the distribution substations by replacing obsolete or failed equipment and making necessary small capital additions. This program is required to restore service in case of outages due to the aging equipment and/or unexpected failure of equipment and is utilized when outage(s) occur. Since this is a reactive program designed to aid in service restoration after an outage occurs, a single

tranche is appropriate. SDG&E has not performed an RSE analysis on this activity, given that the function of this control is to restore service in the event of an outage.

a. Elements of the Risk Bow Tie Addressed

SDG&E-4-C17 reduces SDG&E's reliability risk by restoring service due to aging equipment or unexpected failure. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as operational and reliability impacts (PC.2).

21. SDG&E-4-C18: GO 174: Substation Relay Testing, Inspection and Maintenance Program

This program is performed service territory wide. Since this program inspects equipment service territory wide and repairs and/or replaces the equipment before failure, the inspected equipment therefore has a homogenous risk profile. Therefore, a single tranche is appropriate for this risk mitigation activity.

a. Description of Risk Reduction Benefits

The main goal of the Substation System Inspection and Maintenance Program is to promote reliability and safety for SDG&E personnel and contractors by providing a safe operating and construction environment. This testing, inspection and maintenance program mitigates the risk of equipment failure by identifying equipment deterioration to make the repair/replacement before failures occur. SDG&E's Substation Relay Testing, Inspection and Maintenance Program is mandated by CPUC General Order 174. SDG&E therefore has not performed an RSE analysis, since it is not feasible for SDG&E to stop performing this activity or to calculate the risk reduction benefits in comparison to not performing this activity.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C18 reduces SDG&E's safety and reliability risks by providing a safe operation and construction environment for SDG&E employees and contractors. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), or

in-service equipment failing with lack or delayed company insight (DT.5). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as serious injuries or fatalities (PC.1) or operational and reliability impacts (PC.2).

22. SDG&E-4-C19: Underground Cable Replacement Program – Proactive

SDG&E has separated this program into two tranches for purpose of an RSE analysis – unjacketed feeder (tranche 1) and unjacketed branch (tranche 2). Unjacketed cable has a higher failure rate and therefore poses a greater reliability risk. Therefore, given the two different risk profiles, the RSE analysis for this program has applied two separate tranches, as described below.

a. Elements of the Risk Bow Tie Addressed

SDG&E-4-C19 reduces SDG&E's reliability risk by replacement of underground cable that is identified to have a high propensity for failure. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as serious injuries or fatalities (PC.1) or operational and reliability impacts (PC.2).

23. SDG&E-4-C19-T1 –Unjacketed Cable - Feeder

a. Description of Risk Reduction Benefits

As further evidenced in the table below, this program would reduce reliability risk by targeting replacement of underground unjacketed cable that is identified to have a high probability of failure and proactively replacing the cable before a failure/outage occurs.

b. RSE Inputs and Basis

Scope	Replacing 6.3 miles of underground unjacketed feeder cable out of 201 miles of underground unjacketed feeder cable in the system (3.1%). Of this scope, 2.5 miles are connected to a critical airport improvement project.
Effectiveness	Per internal SME assessment, replacing a segment of underground unjacketed feeder could reduce reliability and financial risk associated with this asset type by up to 95%. Also, replacing unjacketed feeder has 2 times the reliability risk reduction impact versus replacing unjacketed branch cable, based on analysis of

	company failure rates and SAIDI impact per fault on feeder versus branch cable. Finally, the value of reliability for the airport has been estimated as being 8.1 times higher than that of the average customer based on Lawrence/Livermore surveys.
Risk Reduction	**Safety:** While this activity may help reduce safety risk, no direct impact on safety was included as part of this RSE assessment, as it is outside of the scope of the risk definition. **Reliability:** Cables represent 14.8 SAIDI and 0.079 SAIFI, out of the SDG&E system SAIDI and SAIFI of 77.8 and 0.486, respectively, based on assessment of company data. Using an equally weighted average of SAIDI and SAIFI impact, this tranche could reduce EII reliability risk by 0.2%. **Financial:** 16% of EII financial risk is associated with unjacketed cable based on the assumption that financial events are proportional to the number of outages. This tranche could reduce EII financial risk by up to 0.04%.

c. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1197.93**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3174.79	**3714.79**	4614.79
	RSE	10.39	**10.39**	10.39

24. SDG&E-4-C19-T2 –Unjacketed Cable - Branch

a. Description of Risk Reduction Benefits

This program would reduce reliability risk by targeting replacement of underground unjacketed cable that is identified to have a high probability of failure and proactively replacing the cable before a failure/outage occurs.

b. RSE Inputs and Basis

Scope	Replacing 127 miles of underground unjacketed branch cable out of 4,281 miles of underground unjacketed feeder cable in the system (3%).
Effectiveness	Per internal SME assessment, replacing a segment of underground unjacketed branch could reduce reliability and financial risk associated with this asset type by up to 95%. Replacing unjacketed feeders has 2 times the risk reduction

	impact versus replacing unjacketed branches, based on analysis of company failure rates and SAIDI impact per fault of feeder versus branches.
Risk Reduction	**Safety:** While this activity may help reduce safety risk, no direct impact on safety was included as part of this RSE assessment, as it is outside of the scope of the risk definition. **Reliability:** Cables represent 14.8 SAIDI and 0.079 SAIFI, out of the SDG&E system SAIDI and SAIFI of 77.8 and 0.486, respectively, based on assessment of company data. Using an equally weighted average of SAIDI and SAIFI impact, this tranche could reduce EII reliability risk by 0.5%. **Financial:** 16% of EII financial risk is associated with unjacketed cable, based on the assumption that financial events are proportional to the number of outages. This tranche could reduce EII financial risk by up to 0.4%.

c. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1194.56**	
	CoRE	2.65	**3.10**	3.86
	Risk Score	3165.89	**3705.89**	4605.89
	RSE	25.32	**25.32**	25.32

25. SDG&E-4-C20: Enterprise Asset Management – Substation

SDG&E's Enterprise Asset Management activities for electric substation critical assets are conducted throughout SDG&E's entire service territory. However, for purposes of this RAMP report, SDG&E has included mitigation activities performed within its HFTD in the Wildfire Risk chapter (SDG&E-1). Assets within SDG&E's HFTD and non-HFTD have different risk profiles. However, the activities (and associated costs)[30] included within this EII risk chapter only includes activities performed outside of the HFTD, and therefore warrants a single tranche.

[30] Costs have been allocated based on HFTD and non-HFTD percentages, with 60% of the project costs allocated to the Wildfire Chapter SDG&E-1 and 40% of the costs allocated to this EII Chapter.

a. Description of Risk Reduction Benefits

Integrating asset data from various enterprise sources and real-time Condition Based Maintenance monitors will provide SDG&E with consistent data analysis and dynamic analytics to inform asset health indexes for better prioritization of maintenance, repair, and replacement strategies. Optimizing these investment strategies will expand risk reduction efforts by identifying proactive mitigation activities to prevent asset failures that lead to safety and reliability risk events.

SDG&E has not performed an RSE analysis, as this activity is seen to support the larger portfolio of controls and mitigations rather than having a direct safety or reliability impact. Asset management efforts enhance SDG&E's identified controls and mitigations by providing data (such as, which assets have a higher propensity for failure), but it does not provide any direct reduction in risk without the associated activity, such as pole replacement. Without such activity, the selection of assets to maintain or replace (outside compliance requirements) is subject to models that take effort to validate data, which is subject to change due to field conditions and limitations of analytics that cannot see larger data trends.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-C20 reduces SDG&E's safety and reliability risks by providing SDG&E with data and analytics to inform asset health indices, to allow for prioritization of maintenance, repair and replacement and to target the most at-risk assets. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as serious injuries or fatalities (PC.1), or operational and reliability impacts (PC.2).

26. SDG&E-4-M1 – Overhead Public Safety (OPS) program

This project targets assets more prone to failure and also targets assets that are in proximity to the public (*i.e.,* freeway crossings, schools and public areas). Therefore, this program is assessed in a single tranche.

a. Description of Risk Reduction Benefits

This program will proactively replace high risk overhead conductors prone to wire down events, as measured by failure rates and historic data. SDG&E's OPS program also targets assets in proximity to the public and that could put a greater number of people at risk of contact with energized wire. One of SDG&E's primary concerns with respect to its overhead electric distribution system is an energized wire down. Accordingly, SDG&E continues to take proactive measures to determine the cause of such events and puts forth this OPS program to further target and reduce the risk of serious injury or fatality, as well as operational and reliability impacts.

For purposes of RSE analysis, spans with higher population density landmarks are assumed to have up to ten times the human exposure of a typical residential or commercial area – an elementary school or shopping center, for example. Therefore, SDG&E's RSE analysis assumes that that freeways and public proximity areas have a ten times greater risk of other small wire areas.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-M1 reduces SDG&E's safety and reliability risks by proactive replacement of high-risk overhead conductors prone to wire-down events. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences, such as serious injuries or fatalities (PC.1) or operational and reliability impacts (PC.2).

c. RSE Inputs and Basis

Scope	Replacing 24 miles of small wire over freeways and public proximity areas out of 150 miles (16%). At the time of this assessment, SDG&E's electric distribution system has 1,461 miles of overhead small wire.
Effectiveness	Per internal SME assessment, replacing these overhead small wires could reduce safety, reliability, and financial risk associated with this asset type by up to 95%. Replacing small wires over freeways and/ or near public proximity areas have a safety risk reduction impact of 10 times versus replacing other segments, as

	those areas could have up to 10 times the human exposure during busy times of the day (based on internal estimates).
Risk Reduction	**Safety**: Based on assessment of company data and SME estimates, approximately 85% of EII safety risk is associated with overhead wires, and small wires represent 75% of the wires down risk. Using these assumptions, this mitigation could reduce EII safety risk by up to 5.2%. **Reliability:** Based on assessment of company data and SME estimates, small wires represent approximately 75% of the wires down reliability risk. This mitigation could reduce EII financial risk by up to up to 1.2%. **Financial:** Based on the assumption that financial events are proportional to the number of outages, this mitigation could reduce EII financial risk by up to 1.2%.

d. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1198.65**	
	CoRE	2.65	**3.07**	3.79
	Risk Score	3173.40	**3685.51**	4539.02
	RSE	9.09	**47.54**	111.63

27. SDG&E-4-M2: Replacement of Live Front Terminator Equipment - Proactive

Live front terminators are a specific subset of live front equipment that have the primary connections exposed with no insulative covering. These terminators have a readily available dead front replacement option that mitigates the risk and helps plan proactive replacement. All live front terminators pose the same safety risk, and a single tranche is appropriate.

a. Description of Risk Reduction Benefits

As further evidenced in the table below, this mitigation would reduce SDG&E's safety and reliability risk. Proactive removal and replacement of live front equipment would reduce the potential for injury and or outage. As stated above, SDG&E continues to implement the routine removal of live front terminators and transformers, which are devices not designed in accordance with modern safety protocols. These devices are 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.

Crews need to take special precautions to work safely when encountering live front equipment. This equipment is inherently unsafe and poses risk to employees. Even when following proper procedures and precautions, this equipment still poses a risk to employee safety. Although the primary driver is employee safety, this mitigation is not included in the Employee Safety RAMP Chapter (SDG&E-3), because the activity to mitigate risk is infrastructure replacement (whereas mitigation of employee safety risk focuses on policies, procedures and training of employees).

b. Elements of the Bow Tie Addressed

SDG&E-4-M2 reduces SDG&E's safety and reliability risks by proactive removal and replacement of live front equipment. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences, such as serious injuries or fatalities (PC.1) or operational and reliability impacts (PC.2).

c. RSE Inputs and Basis

Scope	Replacing 29 live front terminators, out of 2,024 (1.4%). The scope includes incidental underground cable segment replacements.
Effectiveness	Per internal SME assessment, replacing live front terminators could reduce safety, reliability, and financial risk associated with this asset type by up to 100%. As efforts are focused on targeting riskier assets, a multiplier of 2 is applied to the effectiveness.
Risk Reduction	**Safety:** Assuming that most contacts with energized equipment occur on the overhead system (10% underground), and assuming that terminators are a fraction (25%) of the situations where flashover or direct contact can take place on underground devices, company SMEs estimate that this mitigation could reduce EII safety risk by up to 0.07%. **Reliability:** Internal calculations estimated the impact and rate of terminator failure. Based on that analysis, live front terminators represent 0.003% and 0.002% of system SAIDI and SAIFI, respectively. In addition, incidental

	underground cable replacements increase the reliability benefit by 2%. Using a SAIDI and SAIFI impact average, this mitigation could reduce EII reliability risk by up to 0.005%. **Financial:** Based on the assumption that financial impact is proportional to the number of outages, this mitigation could reduce EII financial risk by up to 0.004%.

d. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1199.94**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3179.80	**3719.42**	4618.77
	RSE	4.15	**12.29**	25.85

28. SDG&E-4-M3: Proactive Substation Reliability for Distribution Components

Substations are essential to the operation of the electric system and must be kept in reliable condition, because the consequences of a failure can potentially lead to cascading outages in our system. Taking initiatives to prevent outages and minimize impact in case of an outage is fundamental to our efforts, and this mitigation allows SDG&E to take initiatives on maintaining reliability to our substations. For Substation Projects, condition assessment process and evaluation criteria are created using probability, risk analysis, financial impacts, and present value analysis to justify projects. Several variables that are weighed into the analysis is the age of equipment, safety risk with replacement of the equipment, and impact posed to the system due to the failure of equipment in a substation. The ranking of substation equipment is an ongoing process and involves identifying equipment. The following three projects, Streamview Bank 30 Replacement, Pacific Beach 12kV Breaker Replacement, and Ash 12kV Capacitor Bank Replacement, were the three substations that pose the highest risk based on the result of the condition assessment. These three projects are included as separate tranches below.

a. Elements of the Bow Tie Addressed

SDG&E-4-M3 reduces SDG&E's reliability risk by replacing substation equipment that pose the highest risk based on the result of SDG&E's condition assessment. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (CT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as operational and reliability impacts (PC.2).

29. SDG&E-4-M3-T1 – Streamview Bank 30 Re-build

a. Description of Risk Reduction Benefits

Currently, there are two transformers in the Streamview Substation, Bank 30 and 31. The current Streamview Bank 30 is roughly 55 years old and statistical data suggests that Bank 30 should be replaced within 5 years, because a typical transformer has a 60-year lifespan. If Bank 30 were to fail, all loads shared between the two Banks would be transferred to one, causing an overload. The potential customers affected by an outage would be high compared to other locations. As a result, there would be significant reliability consequences and potential for the entire substation to be out of service.

b. RSE Inputs and Basis

Scope	Replacing one transformer that is at end-of-life.
Effectiveness	Based on analysis of company historical work orders, the financial risk impact of a transformer is 105 times greater than the estimated outage cost contained in MAVF assumptions. Therefore, a multiplier of 105 is applied to financial risks. The direct effectiveness of the mitigation is assumed to be 100%.
Risk Reduction	**Safety**: No direct impact on safety. **Reliability:** Based on company data and study, SDG&E estimates this project provides 0.16 SAIDI and 0.015 SAIFI savings. With these assumptions, this project improves EII reliability risk by up to 0.1%. **Financial:** Based on the assumption that financial impact is proportional to the number of outages, this project improves EII financial risk by up to 7.3%.

c. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1199.31**	
	CoRE	2.64	**3.09**	3.84
	Risk Score	3169.56	**3709.56**	4609.56
	RSE	225.33	**225.33**	225.33

30. SDG&E-4-M3-T2 –Pacific Beach 12 kV Replacement Re-build

a. Description of Risk Reduction Benefits

There are nine 12kV Circuit Breakers in Pacific Beach Substation. The average age of the circuit breakers is roughly 45 years old. Failure on any of these circuit breakers may remove service from the respective circuit, causing outages downstream and affecting a significant number of customers. The main function of the circuit breaker is to protect any electrical circuit from damaging other assets (*e.g.*, transformers) during an unexpected overload or a short circuit within the substation. This mitigation sees that obsolete circuit breakers are replaced with new circuit breakers that are compatible with the latest technology. This will in effect, enhance the protection of other assets in the substation and minimize the impact from any electrical fault.

b. RSE Inputs and Basis

Scope	Replacing nine 12kV Circuit Breakers.
Effectiveness	Based on analysis of company historical work orders, the financial risk impact of a circuit breaker is 8 times greater than the estimated outage cost contained in MAVF assumptions. Therefore, a multiplier of 8 is applied to financial risks. The direct effectiveness of the mitigation is assumed to be 100%.
Risk Reduction	**Safety**: No direct impact on safety. **Reliability:** Based on company data and study, SDG&E estimates this provides 0.03 SAIDI and 0.0003 SAIFI savings. With these assumptions, this project improves EII reliability risk by up to 0.01%. **Financial:** Based on the assumption that financial impact is proportional to the number of outages, this project improves EII financial risk by up to 0.1%.

c. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1199.91**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3179.70	**3719.70**	4619.70
	RSE	82.20	**82.20**	82.20

31. SDG&E-4-M3-T3 – Ash 12 kV Cap Replacement Re-build

a. Description of Risk Reduction Benefits

The Ash 12kV project involves replacing two existing circuit breakers and two capacitor banks and replacing the two oil cap fuse switches with a new circuit breaker. Replacement of the capacitor banks allows maintaining power quality across the various circuits. In addition, the replaced circuit breakers will provide protection from fault current to minimize outage time in the case of a fault current traveling through the substation.

b. RSE Inputs and Basis

Scope	Replacing 2 capacitor banks, oil switches with breaker, and 2-12kV Breakers.
Effectiveness	Based on analysis of company historical work orders, the financial risk impact of a circuit breaker is 8 times greater than the estimated outage cost contained in MAVF assumptions. Therefore, a multiplier of 8 is applied to financial risks. The direct effectiveness of the mitigation is assumed to be 100%.
Risk Reduction	**Safety**: No direct impact on safety. **Reliability:** Based on company data and study, SDG&E estimates this project provides 0.006 SAIDI and 0.00006 SAIFI savings. With these assumptions, this project improves EII reliability risk by up to 0.002%. **Financial:** Based on the assumption that financial impact is proportional to the number of outages, this project improves EII financial risk by up to 0.02%.

c. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1199.97**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3179.90	**3719.90**	4619.90
	RSE	12.20	**12.20**	12.20

32. SDG&E-4-M3-T4 – New Substation

a. Description of Risk Reduction Benefits

SDG&E's existing Station B Substation and Urban Substation will approach or exceed their normal operating life in several years, and SDG&E has determined that rebuilds will be needed to address reliability concerns and to serve the electric distribution load. Building the New Substation will remove the limitations and operational constraints on neighboring substations by adding ties to allow for substation rebuilds and to maintain the level of reliability in the downtown area. The need to obtain optimum operating conditions that maintain substation reliability and reduce outage times is a key driver for this project. Without having the capability to transfer loads between these substations, reliability is at risk in the advent of a transformer, bus, (or substation) outage (either planned or unplanned).

b. RSE Inputs and Basis

Scope	This is a new substation that greatly impacts the configuration of the electrical network by increasing reliability to a location with aging infrastructure. It also allows for reconstruction and improvements on these impacted assets.
Effectiveness	Per internal SME assessment, the addition of these assets could reduce associated reliability risk by up to 100%.
Risk Reduction	**Safety:** No direct impact on safety. **Reliability:** The reliability impact on the electrical network is complex as multiple substations benefit from the construction of this asset. SDG&E estimates the long-term reliability impact to be 1.3% of

	the baseline amount considering the future in-service date of the substation. **Financial:** The financial impact on the electrical network is minimal.

c. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1184.00**	
	CoRE	2.65	**3.11**	3.87
	Risk Score	3140.00	**3680.00**	4580.00
	RSE	21.36	**21.36**	21.36

33. SDG&E-4-M4: Substation Breaker Replacements

a. Description of Risk Reduction Benefits

By modernizing substation equipment, SDG&E's substation system will help provide safe, reliable, and quality customer service by enabling the deployment of Fault Locations, Isolation, and Restoration (FLISR) technology. The FLISR technology allows for automation without the intervention of a distribution system operator. This results in safely improving the distribution system reliability in substations through faster faulted circuit identification, faster isolation of faulted electric distribution circuits, faster load restoration when system disturbances occur, and better system performance by mitigating electric system deficiencies. As a result, this will directly improve SDG&E's system reliability, as FLISR will reduce the number of customers affected by an outage and reduce the outage duration for those affected. SDG&E's two projects are included as separate tranches below.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-M4 reduces SDG&E's reliability risk by modernizing substation equipment through deployment of FLISR technology. This program reduces SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and Appendix A, such as in-service equipment past its useful life (DT.1) or in-service equipment and associated

components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences such as operational and reliability impacts (PC.2).

34. SDG&E-4-M4-T1 – San Ysidro Breaker Replacement

a. Description of Risk Reduction Benefits

The San Ysidro Breaker project replaces seven 12 kV circuit breakers and adds new 12kV switchgear to relocate the circuits for one of the transformers. The average age of these circuit breakers is roughly 40 years old, and their internal relay system is outdated. The new circuit breakers will contain modernized internal relays that are compatible with the FLISR technology. On top of FLISR, the addition of the switchgear will provide flexibility to the system by providing more than one source to feed the various circuits. Thus, the new equipment will provide reliability to the system by minimizing outage time and will maintain service to other circuits when short-circuit and overload fault currents occur on any circuits.

b. RSE Inputs and Basis

Scope	Remove and replace seven 12kV breakers.
Effectiveness	Based on analysis of company historical work orders, the financial risk impact of a circuit breaker is 8 times greater than the estimated outage cost contained in MAVF assumptions. Therefore, a multiplier of 8 is applied to financial risks. The direct effectiveness of the mitigation is assumed to be 100%.
Risk Reduction	**Safety**: No direct impact on safety. **Reliability:** Based on company data and study, SDG&E estimates this project provides 0.02 SAIDI and 0.0002 SAIFI savings. With these assumptions, this project improves EII reliability risk by up to 0.01%. **Financial:** Based on the assumption that financial impact is proportional to the number of outages, this project improves EII financial risk by up to 0.04%.

c. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigatio	**LoRE**		**1199.92**	
	CoRE	2.65	**3.10**	3.85

	Risk Score	3179.75	**3719.75**	4619.75
	RSE	3.55	**3.55**	3.55

35. SDG&E-4-M4-T2 – Murray Breaker Replacement

a. Description of Risk Reduction Benefits

The Murray Breaker project involves replacement of sixteen 12kV circuit breakers. Much like the replacement project in San Ysidro, this project also replaces aged, outdated breakers with new, modernized breakers with FLISR compatibility. Since each breaker is associated with a circuit, the failure of a breaker potentially would impact the entire circuit unless field ties are available for offloading.

b. RSE Inputs and Basis

Scope	Replace 16 - 12kV Circuit Breakers.
Effectiveness	Based on analysis of company historical work orders, the financial risk impact of a circuit breaker is 8 times greater than the estimated outage cost contained in MAVF assumptions. Therefore, a multiplier of 8 is applied to financial risks. The direct effectiveness of the mitigation is assumed to be 100%.
Risk Reduction	**Safety**: No direct impact on safety. **Reliability:** Based on company data and study, SDG&E estimates this project provides 0.04 SAIDI and 0.0003 SAIFI savings. With these assumptions, this project improves EII reliability risk by up to 0.01%. **Financial:** Based on the assumption that financial impact is proportional to the number of outages, this project improves EII financial risk by up to 0.1%.

c. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1199.84**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3179.48	**3719.48**	4619.48
	RSE	16.53	**16.53**	16.53

36. SDG&E-4-M5: Enterprise Asset Management – Distribution

SDG&E's Enterprise Asset Management activities for electric distribution are conducted throughout SDG&E's entire service territory. However, for purposes of this RAMP report, SDG&E has included mitigation activities performed within its HFTD in the Wildfire Risk chapter (SDG&E-1). Assets within SDG&E's HFTD and non-HFTD have different risk profiles. However, this EII risk chapter only includes activities (and associated costs) performed outside of the HFTD; therefore, these program activities warrant a single tranche.

a. Description of Risk Reduction Benefits

Asset management is a critical element of SDG&E's focus on creating sustainable and high-quality asset safety for electric operations, and optimizing asset utilization, while mitigating asset-related risks. This is also one element of SDG&E's vision for an electric safety management system. A comprehensive asset management system, which includes process improvements, data analytics and system solutions, will provide the access to and integration of data throughout the asset life cycle to develop analysis and a health index for critical assets.

Benefits of such a system may include enhanced asset safety, improved performance, managed risk, demonstrated compliance, and improved efficiencies and effectiveness of asset utilization and operations. Integrating asset data from various enterprise sources will provide consistent data analysis and dynamic analytics to be informed on asset health indexes for better prioritization of maintenance, repair and replacement strategies. Optimizing these investment strategies will expand risk reduction efforts by identifying proactive mitigation activities to prevent asset failures that lead to safety and reliability risk events.

A separate RSE calculation was not performed on this mitigation as a stand-alone risk mitigation activity. Instead, SDG&E views this project as increasing the effectiveness of other mitigations and controls directly related asset replacement or maintenance. In the RSE analysis, a mitigation effectiveness percentage is a variable in the larger measure of risk reduction. Therefore, an activity that only mitigates 50% of the risk doesn't see the full risk reduction figure. This proposal would provide SDG&E with better data and asset health information, allowing SDG&E to target which assets to replace, therefore increasing the mitigation effectiveness of other projects presented herein. For example, without this mitigation, one might see a reduction in mitigation effectiveness for other projects in the absence of data to target "at

risk" assets. Therefore, this risk mitigation activity is seen to support SDG&E's larger portfolio of controls and mitigations rather than having a direct safety or reliability impact. Without this mitigation, the selection of assets to maintain or replace outside compliance requirements, is subject to models that take effort to validate data that is subject to change due to field conditions and limitations of analytics that cannot see larger data trends.

b. Elements of the Risk Bow Tie Addressed

SDG&E-4-M5 reduces SDG&E's safety and reliability risks by providing SDG&E with data and analytics to inform asset health indices to allow for prioritization of maintenance, repair and replacement and to target the most at-risk assets. This program addresses SDG&E's risk of an electric asset failure by targeting the Drivers/Triggers noted above in Figure 1 and in Appendix A, such as in-service equipment past its useful life (DT.1), in-service equipment failing prematurely (DT.3), and/or in-service equipment and associated components failing to operate as designed (DT.4). Addressing such Drivers/Triggers decreases the likelihood of Potential Consequences, such as serious injuries or fatalities (PC.1) or operational and reliability impacts (PC.2).

VII. SUMMARY OF RISK MITIGATION PLAN RESULTS

SDG&E's Risk Mitigation Plan takes into account recent data and trends related to electric infrastructure, technology, affordability impacts, possible labor constraints and the feasibility of mitigations. SDG&E has performed RSEs, in compliance with the SA Decision, but ultimate mitigation selection can be influenced by other factors including funding, labor resources, technology, planning, compliance requirements, permitting, and operational and execution considerations.

While SDG&E plans to present the risk mitigation activities presented herein in its TY 2022 GRC Application, SDG&E's Risk Mitigation Plan may be subject to constraints. For instance, activities in this Risk Mitigation Plan can have significant lead times (more than a year) to get materials or approval prior to work commencing. SDG&E's ability to timely implement its Risk Mitigation Plan may be dependent on factors such as permitting, landowner agreements, and weather. In addition, SDG&E is experiencing a shortage of available, qualified contractors to perform work. For example, there is already significant competition in the State to obtain qualified design, engineering, and construction resources. SDG&E expects this trend to continue

in future years. This is also true in Vegetation Management. Further, SDG&E strives to balance implementing EII risk mitigation measures with the associated costs of such measures. To that end, SDG&E is strategic about its mitigation programs and takes affordability into consideration.

Table 8 below provides a summary of the Risk Mitigation Plan, including Controls and Mitigation activities, associated costs, and RSEs by tranche.

SDG&E does not account for and track costs by activity; rather, SDG&E tracks costs by cost center and capital budget code. Thus, the costs shown in Table 8 were estimated using assumptions provided by SMEs and available accounting data.

Table 8: Risk Mitigation Plan Summary[31]
(Direct 2018 $000)[32]

ID	Mitigation/Control	Tranche	2018 Baseline Capital[33]	2018 Baseline O&M[34]	2020-2022 Capital[35]	2022 O&M[36]	Total[37]	RSE[38]
SDG&E-4-C1	GO165: Distribution Inspect and Repair program	T1	10,000	0	18,000-21,000	0	18,000-21,000	-
SDG&E-4-C2	4kV Modernization and System Hardening Program - Distribution	T1	0[39]	0	20,000-24,000	0	20,000-24,000	4.11 – 26.65

31 Recorded costs and forecast ranges were rounded. Additional cost-related information is provided in workpapers. Costs presented in the workpapers may differ from this table due to rounding.

32 The figures provided are direct charges and do not include company loaders, with the exception of vacation and sick. The costs are also in 2018 dollars and have not been escalated to 2019 amounts.

33 Pursuant to D.14-12-025 and D.16-08-018, the Company provides the 2018 "baseline" capital costs associated with Controls. The 2018 capital amounts are for illustrative purposes only. Because capital programs generally span several years, considering only one year of capital may not represent the entire activity.

34 SDG&E does not currently track all O&M costs at the RAMP activity level and was unable to impute O&M historical costs for all activities.

36 The capital presented is the sum of the years 2020, 2021, and 2022 or a three-year total. Years 2020, 2021 and 2022 are the forecast years for SDG&E's Test Year 2022 GRC Application.

36 SDG&E is not currently proposing associated O&M cost forecasts for activities where costs are not currently tracked at the level of detail presented in this 2019 RAMP Report. SDG&E will address this issue in its TY 2022 GRC Application.

37 Total = 2020, 2021 and 2022 Capital + 2022 O&M amounts.

38 RSE ranges are further discussed in Chapter RAMP-C and in Section VI above. Risk mitigation activities that do not have a direct safety impact included as part of the RSE assessment do not have a range.

39 Historical capital spend exists for years 2015, 2016 and 2017, as evidenced in the cost workpapers.

ID	Mitigation/Control	Tranche	2018 Baseline Capital[33]	2018 Baseline O&M[34]	2020-2022 Capital[35]	2022 O&M[36]	Total[37]	RSE[38]
SDG&E-4-C3	Distribution Overhead Switch Replacement Program – Hook Stick Switches	T1	60[40]	0	320-390	0	320-390	16.80
SDG&E-4-C3	Distribution Switch Replacement Program – Tie Switches	T2	0	0	230-280	0	230-280	11.81
SDG&E-4-C3	Distribution Switch Replacement Program – Large Customer Count	T3	0	0	880-1100	0	880-1100	20.46
SDG&E-4-C4	Management of Overhead Distribution Service (Non-CMP)	T1	7,000	0	17,000-20,000	0	17,000-20,000	-
SDG&E-4-C5	Restoration of Service	T1	9,200	0	25,000-30,000	0	25,000-30,000	-
SDG&E-4-C6	Underground Cable Replacement Program - Reactive	T1	10,000	0	21,000-25,000	0	21,000-25,000	-
SDG&E-4-C7	Tee Modernization Program - Underground	T1	2,200	0	5,200-6,300	0	5,200-6,300	16.06
SDG&E-4-C8	Replacement of Live Front Equipment - Reactive	T1	510	0	1,400-1,700	0	1,780-2,200	2.63 – 18.13

[40] SDG&E is currently unable to separate historical costs by tranche. This figure represents the full Distribution Overhead Switch Replacement Program costs.

ID	Mitigation/Control	Tranche	2018 Baseline Capital[33]	2018 Baseline O&M[34]	2020-2022 Capital[35]	2022 O&M[36]	Total[37]	RSE[38]
SDG&E-4-C9	DOE Switch Replacement - Underground	T1	10,000	0	11,000-14,000	0	11,000-14,000	7.00
SDG&E-4-C10	Vegetation Management (Non-HFTD)	T1	0	11,000	0	11,000-13,000	11,000-13,000	39.34 – 109.10
SDG&E-4-C11	GO165: Distribution Inspect and Repair Program – Underground Capital Asset Replacement	T1	8,700	0	35,000-43,000	0	35,000-43,000	-
SDG&E-4-C12	GO165: Distribution Inspect and Repair Program – Underground Structure Repair	T1	4,800	0	6,900-8,300	0	6,900-8,300	-
SDG&E-4-C13	Management of Underground Distribution Service (Non-CMP)	T1	3,500	0	9,600-12,000	0	9,600-12,000	-
SDG&E-4-C14	Field SCADA RTU Replacement (Underground)	T1	2,100	0	3,000-3,600	0	3,000-3,600	26.65
SDG&E-4-C15	Distribution Circuit Reliability	T1	2,500	0	8,100 – 9,900	0	8,100 – 9,900	40.25
SDG&E-4-C16	Emergency Substation Equipment	T1	250	0	1,700-2,100	0	1,700-2,100	-

ID	Mitigation/Control	Tranche	2018 Baseline Capital[33]	2018 Baseline O&M[34]	2020-2022 Capital[35]	2022 O&M[36]	Total[37]	RSE[38]
SDG&E-4-C17	Reactive Substation Reliability and Repair for Distribution Components	T1	1,900	0	4,700-5,700	0	4,700-5,700	-
SDG&E-4-C18	GO 174: Substation Relay Testing, Inspection and Repair Program	T1	0	180	0	160-190	160-190	-
SDG&E-4-C19	Underground Cable Replacement Program – Proactive – Unjacketed Feeder Cable	T1	0	0	11,000 – 13,000	0	11,000 – 13,000	10.39
SDG&E-4-C19	Underground Cable Replacement Program – Proactive – Unjacketed Branch Cable	T2	0	0	12,000 – 15,000	0	12,000 – 15,000	25.32
SDG&E-4-C20	Enterprise Asset Management – Substations	T1	70	0	360-440	830-850	1,190 – 1,290	-
SDG&E-4-M1	Overhead Public Safety (OPS) Program	T1	0	0	17,000-21,000	0	17,000-21,000	9.09 – 111.63
SDG&E-4-M2	Replacement of Live Front Equipment - Proactive	T1	0	0	1,100-1,400	0	1,100-1,400	4.15 – 25.85
SDG&E-4-M3	Proactive Substation Reliability for Distribution Components - Streamview Bank 30 Project	T1	0	0	200-240	0	200-240	225.33

ID	Mitigation/Control	Tranche	2018 Baseline Capital[33]	2018 Baseline O&M[34]	2020-2022 Capital[35]	2022 O&M[36]	Total[37]	RSE[38]
SDG&E-4-M3	Proactive Substation Reliability for Distribution Components - Pacific Beach 12 kV Replacement Re-build	T2	0	0	90-110	0	90-110	82.20
SDG&E-4-M3	Proactive Substation Reliability for Distribution Components - Ash 12 kV Capacitor Bank and Circuit Breaker Replacement Project	T3	0	0	200-240	0	200-240	12.20
SDG&E-4-M3	Proactive Substation Reliability for Distribution Components - New Substation	T4	10	0	34,000-41,000	0	34,000-41,000	21.36
SDG&E-4-M4	Substation Breaker Replacements: San Ysidro Breaker Replacement	T1	0	0	1,300-1,600	0	1,300-1,600	3.55
SDG&E-4-M4	Substation Breaker Replacements: Murray Breaker Replacement	T2	0	0	580-700	0	580-700	16.53
SDG&E-4-M5	Enterprise Asset Management – Distribution	T1	0	0	5,800-7,100	270-320	6,100-7,400	-
TOTAL COST			**73,000**	**11,000**	**273,0000 – 330,000**	**12,000 – 14,000**	**280,000 – 345,000**	

It is important to note that SDG&E is identifying potential ranges of costs in this Risk Mitigation Plan and is not requesting funding herein. SDG&E will integrate the results of this proceeding, including requesting approval of the activities and associated funding, in the next GRC.

SDG&E notes that there are non-CPUC jurisdictional mitigation activities performed that further mitigate the EII risk, but the costs associated with these activities are not presented herein, as they will not be carried over to the GRC. Such non-CPUC jurisdictional activities include, but are not limited to:

- Transmission projects
- Transmission substation projects

SDG&E is not calculating RSEs on the following activities:

Table 9: Summary of Activities without RSE Calculations

Control/Mitigation ID	Control/Mitigation Name	Reason for No RSE Calculation
SDG&E-4-C1	GO 165: Distribution Inspect and Repair program – Overhead	Mandated activity per CPUC General Order 165
SDG&E-4-C4	Management of Overhead Distribution Service (Non-CMP)	Mandated activity per CPUC General Order 95; Cal. Pub. Util. Code §§ 451, 761, 762, 768, and 770 (Obligation to Serve)
SDG&E-4-C5	Restoration of Service	Mandated activity per Cal. Pub. Util. Code §§ 451, 761, 762, 768, and 770 (Obligation to Serve)
SDG&E-4-C6	Underground Cable Replacement Program - Reactive	Mandated activity per Cal. Pub. Util. Code §§ 451, 761, 762, 768, and 770 (Obligation to Serve)
SDG&E-4-C11	GO 165: Distribution Inspect and Repair Program – Underground Capital Asset Replacement	Mandated activity per CPUC General Order 165
SDG&E-4-C12	GO 165: Distribution Inspect and Repair Program – Underground Structure Repair	Mandated activity per CPUC General Order 165
SDG&E-4-C13	Management of Underground Distribution Service (Non-CMP)	Mandated activity per CPUC General Order 128; Cal. Pub. Util. Code §§ 451, 761, 762, 768, and 770 (Obligation to Serve)

Control/Mitigation ID	Control/Mitigation Name	Reason for No RSE Calculation
SDG&E-4-C16	Emergency Substation Equipment	Mandated activity per Cal. Pub. Util. Code §§ 451, 761, 762, 768, and 770 (Obligation to Serve)
SDG&E-4-C17	Reactive Substation Reliability and Repair for Distribution Components	Mandated activity per Cal. Pub. Util. Code §§ 451, 761, 762, 768, and 770 (Obligation to Serve)
SDG&E-4-C18	GO 174: Substation Relay Testing, Inspection and Repair Program	Mandated activity per CPUC General Order 174; NERC Reliability Standards
SDG&E-4-C20	Enterprise Asset Management – Substations	No direct safety or reliability impact; mitigation effectiveness incorporated into activities that directly impact safety or reliability
SDG&E-4-M5	Enterprise Asset Management – Distribution	No direct safety or reliability impact; mitigation effectiveness incorporated into activities that directly impact safety or reliability

VIII. ALTERNATIVE MITIGATION PLAN ANALYSIS

Pursuant to D.14-12-025 and D.16-08-018, SDG&E considered alternatives to the Risk Mitigation Plan for the Electric Infrastructure Integrity risk. Typically, analysis of alternatives occurs when implementing activities to obtain the best result or product for the cost. The alternatives analysis for this risk plan also considered modifications to the presented plan and constraints such as budget and resources.

A. Alternative Mitigation Plan 1 – Customer Owned E-Structure Reconfigure

1. Description of Risk Reduction Benefits

"Enclosed" structures are electric facilities that contain a non-pad mount transformer located at ground level on customer property enclosed by a customer fence. They vary in state of repair but generally have exposed or aged components. Moving these transformers to pad mount or overhead facilities will mitigate the risk of exposed components. This project is not currently included in SDG&E's Risk Mitigation Plan given the minimal history of issues, challenges with requiring modifications by customers, obtaining property easements, and minimal reliability benefit.

This project focuses on replacement of 14 structures out of the identified 42 in the system. Risk of E-structures involve contact with energized equipment. Approximately 85% of

the EII safety risk is associated with overhead wires and small wires, representing 75% of the wires down risk, based on assessment of company data and SME estimates. Therefore, the RSE analysis for this alternative mitigation assumed that the risk presented here is part of the 15% EII safety risk associated with non-wire down events. Given the configuration of e-structures, described above in Section V, e-structures are considered to be 20% riskier than other structures for purposes of the RSE analysis.

a. RSE Inputs and Basis

Scope	Mitigating 14 energized structures on customer-owned property out of 42 identified in the system.
Effectiveness	Per internal SME assessment, mitigating these structures could reduce safety, reliability, and financial risk associated with this asset type by up to 100%. Replacing energized structures on customer-owned property has an estimated 20% more risk reduction impact versus replacing other overhead structures, as there is an increased likelihood of contact due to asset placement.
Risk Reduction	**Safety:** Based on company data assessment and SME estimates, approximately 85% of EII safety risk is associated with overhead wires; therefore, an estimated 15% of EII safety risk is associated with other assets. Using these assumptions, this mitigation could reduce EII safety risk by up to 0.001%. **Reliability:** Reliability risk is calculated as proportional to safety risk. Using that assumption, this mitigation also has a potential impact of 0.001% on reliability risk. **Financial:** Financial risk is calculated as proportional to safety risk. Using that assumption, this mitigation also has a potential impact of 0.001% on financial risk.

b. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1199.98**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3179.96	**3719.95**	4619.94
	RSE	1.28	**1.50**	1.86

B. Alternative Mitigation Plan 2 – ABB Distribution Relay Replacement

1. Description of Risk Reduction Benefits

A fleet of 38 distribution relays manufactured by ABB that belong to step down banks and distribution circuit breakers have become end of life by the manufacturer and are no longer supported with firmware or spare parts. This mitigation would plan to replace those relays to mitigate the chance of them failing to operate if an outage event was to occur at the 12kV bus or on the connected distribution circuit. This project is not currently included in SDG&E's Risk Mitigation Plan given it does not impact public safety, the rarity of the occurrence and protection redundancy inside the substation limits the overall reliability impact and the high cost to replace.

a. RSE Inputs and Basis

Scope	Replacing 38 relays at risk of failure out of 2,230 total distribution relays (1.7%).
Effectiveness	Per internal SME assessment, replacing overhead relays could reduce safety, reliability, and financial risk associated with this asset type by up to 100%.
Risk Reduction	**Safety**: No direct impact on safety. **Reliability:** SMEs calculated the potential SAIDI and SAIFI impacts of a relay-related outage. Based on that analysis, relays may contribute 0.06 SAIDI, and 0.006 SAIFI to unreliability. Using an average of the SAIDI and SAIFI impacts, this mitigation could reduce EII reliability risk by up to 0.01%. **Financial:** Based on the assumption that financial impact is proportional to the number of outages, this project could reduce EII financial risk by up to 0.001%.

b. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1199.85**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3179.61	**3719.61**	4619.61
	RSE	3.15	**3.15**	3.15

C. Alternative Mitigation Plan 3 – Modernize Manual Switches

1. Description of Risk Reduction Benefits

To increase reliability on the distribution system and see that every customer has optimal reliability, SDG&E considered a program that would replace every overhead and underground manual distribution switch within its system with a SCADA switch. These enhancements would provide further visibility of the distribution system and improve situational awareness. The program would consist of prioritizing work by starting with circuits that have the highest customer count and replacing every single manual switch to a SCADA switch. This project is not currently included in SDG&E's Risk Mitigation Plan given it does not directly impact public safety, and the associated cost to perform such a replacement on every switch would provide diminishing returns for reliability and in many situations be redundant. Rather than proposing a program to replace all manual distribution switches at this time, SDG&E instead put forth a plan for strategic, prioritization-targeted replacement. SDG&E's Enterprise Asset Management - Distribution program (SDG&E-4-M5), as presented in the Risk Mitigation Plan, will allow SDG&E to identify which assets have a higher likelihood of failure. Based on this information, asset replacement strategies would be evaluated, prioritized and implemented to manage the asset in a manner that aligns with SDG&E's overall risk management strategy, supports risk-informed platform for managing assets, and reinforces safe operations, maintenance and proactive replacement strategies.

D. SDG&E-3-A3-T1 – Overhead Switches

1. RSE Inputs and Basis – Overhead Switches

Scope	Installing 297 switches in various overhead circuit locations.
Effectiveness	Per internal SME assessment, installing these switches could improve reliability in 100% of applicable instances. However, these installations are not expected to be as effective as those that target spots with large customer counts; thus, impact has been reduced to one-third per SME assessment. Additionally, the switch is not expected to see all outages taking place between the substation and the circuit endpoint; thus, outages seen have been reduced by half of the total per SME assessment.
Risk Reduction	**Safety:** While this activity may help reduce safety risk, no direct impact on safety was included as part of this RSE assessment, as it is outside of the scope of the risk definition.

	Reliability: Based on SME assessment, these switches save an average of 45 minutes of outage time per instance. Also, no SAIFI impact is expected from these installations. Based on these assumptions, this tranche could reduce EII reliability risk by 0.1%. **Financial:** the financial risk is assumed proportional to the number of saved outages; thus, no financial impact is expected.

a. Summary of results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1198.32**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3175.80	**3715.80**	4615.80
	RSE	3.14	**3.14**	3.14

E. SDG&E-4-A3-T2 – Underground Switches

1. RSE Inputs and Basis – Underground Switches

Scope	Installing 165 switches in various underground circuit locations.
Effectiveness	Per internal SME assessment, installing these switches could improve reliability in 100% of applicable instances. However, these installations are not expected to be as effective as those that target spots with large customer counts, thus impact has been reduced to one-third per SME assessment. Additionally, the switch is not expected to see all outages taking place between the substation and the circuit endpoint thus outages seen have been reduced to one quarter of the total per SME assessment.
Risk Reduction	**Safety:** No direct impact on safety considered, as it is outside the scope of this risk description. **Reliability:** Based on SME assessment, these switches save an average of 45 minutes of outage time per instance. Also, no SAIFI impact is expected from these installations. Based on these assumptions, this tranche could reduce EII reliability risk by 0.04%. **Financial:** the financial risk is assumed proportional to the number of saved outages; thus, no financial impact is expected.

a. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1199.53**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3178.83	**3718.83**	4618.83
	RSE	1.75	**1.75**	1.75

F. Alternative Mitigation Plan 4 – Avian Protection Program

1. Description of Risk Reduction Benefits

Bird and other wildlife contact on overhead distribution facilities must closely be managed to protect wildlife from accidental death, prevent electric outages and utility facility damage, and to prevent regulatory impacts (*e.g.*, fines). Expand avian protection equipment installation and related procedures to install mitigations on all overhead equipment. This project is not currently included in SDG&E's Risk Mitigation Plan, given it does not impact public safety, and SDG&E already requires installing covers in specific locations (*e.g.*, the Avian Protection Zone), in compliance with federal and state law.

a. RSE Inputs and Basis

Scope	All overhead poles that do not have existing avian protection.
Effectiveness	Per internal SME assessment, installing protective equipment could reduce associated reliability and financial risk by up to 95%.
Risk Reduction	**Safety:** No direct impact on safety considered, as it is outside the scope of this risk description. **Reliability:** Based on company data assessment, avian events represent 0.8% of SAIDI impacts and 1.3% of SAIFI impacts, respectively. Using an average of SAIDI and SAIFI impacts, this mitigation could reduce EII reliability risk by 0.06%. **Financial:** Based on the assumption that financial risk is proportional to the number of outages, this mitigation could reduce EII financial risk by up to 0.07%.

b. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**1200**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3180.00	**3720.00**	4620.00
Post-Mitigation	**LoRE**		**1199.29**	
	CoRE	2.65	**3.10**	3.85
	Risk Score	3178.15	**3718.15**	4618.15
	RSE	2.53	**2.53**	2.53

Table 10: Alternative Mitigation Summary

(Direct 2018 $000)[41]

ID	Mitigation	2020-2022 Capital[42]	2022 O&M	Total[43]	RSE[44]
SDG&E-4-A1	Customer Owned E-Structure Reconfigure	500-600	0	500-600	1.28 – 1.86
SDG&E-4-A2	ABB Distribution Relay Replacement	2,800-3,300	0	2,800-3,300	3.15
SDG&E-4-A3-T1	Modernize manual switches – Overhead	32,000-38,000	0	32,000-38,000	3.14

[41] The figures provided are direct charges and do not include company loaders, with the exception of vacation and sick. The costs are also in 2018 dollars and have not been escalated to 2019 amounts.

[42] The capital presented is the sum of the years 2020, 2021, and 2022, for a three-year total.

[43] Total = 2020, 2021 and 2022 Capital + 2022 O&M amounts.

[44] RSE ranges are further discussed in Chapter RAMP-C and shown in Section VI above. Risk mitigation activities that do not have a direct safety impact for purposes of the RSE analysis, as described in the RSE Inputs and Basis tables above in Section VI, do not show a range.

ID	Mitigation	2020-2022 Capital[42]	2022 O&M	Total[43]	RSE[44]
SDG&E-4-A3-T2	Modernize manual switches – Underground	16,000-19,000	0	16,000-19,000	1.75
SDG&E-4-A4	Avian Protection Program	17,000 – 21,000	0	17,000 – 21,000	2.53

APPENDIX A: SUMMARY OF ELEMENTS OF THE RISK BOW TIE ADDRESSED

ID	Control/Mitigation Name	Elements of the Risk Bow Tie Addressed
SDG&E-4-C1	GO165: Distribution Inspect and Repair program – Overhead	DT.1, DT.2, DT., DT.5, DT.6, DT.7 PC.1, PC.2, PC.3, PC.4, PC.5, PC.6
SDG&E-4-C2	4 kV Modernization and System Hardening – Distribution	DT.1, DT.2, DT.3, DT.4, DT.5, DT.6, DT.7 PC.1, PC.2
SDG&E-4-C3	Distribution Overhead Switch Replacement Program	DT.1, DT.2, DT.3, DT.4 PC.1, PC.2
SDG&E-4-C4	Management of Overhead Distribution Service (Non-CMP)	DT1, DT.2, DT.3, DT.6, DT.7 PC.1, PC.2
SDG&E-4-C5	Restoration of Service	DT.1, DT.2, DT.3, DT.5, DT.6, DT.7 PC.2, PC.3, PC.6
SDG&E-4-C6	Underground Cable Replacement Program - Reactive	DT.1, DT.2, DT.3, DT.7 PC.2, PC.6
SDG&E-4-C7	Tee Modernization Program - Underground	DT.1, DT.2, DT.3, DT.5, DT.7 PC.2, PC.6
SDG&E-4-C8	Replacement of Underground Live Front Equipment – Reactive	DT.1, DT.6 PC.1, PC.2
SDG&E-4-C9	DOE Switch Replacement – Underground	DT.1, DT.2, DT.3 PC.1, PC.2
SDG&E-4-C10	Vegetation Management (Non-HFTD)	DT.3, DT.7 PC.2, PC.3, PC.4
SDG&E-4-C11	GO165: Distribution Inspect and Repair Program – Underground Capital Asset Replacement	DT.1, DT.2, DT.3, DT.5, DT.7 PC.1, PC.2
SDG&E-4-C12	GO165: Distribution Inspect and Repair Program – Underground Structure Repair	DT.1, DT.1, DT.3, DT.5, DT.7 PC.1, PC.2, PC.3, PC.4
SDG&E-4-C13	Management of Underground Distribution Service (Non-CMP)	DT.1, DT.2, DT.3, DT.5, DT.7 PC.1, PC.2
SDG&E-4-C14	Field SCADA RTU Replacement	DT.1, DT.2 PC.2
SDG&E-4-C15	Distribution Circuit Reliability	DT.1, DT.2 PC.2
SDG&E-4-C16	Emergency Substation Equipment	DT.1, DT.2, DT.3, DT.4, DT.5 PC.2
SDG&E-4-C17	Reactive Substation Reliability and Repair for Distribution Components	DT.1, DT.2, DT.3, DT.4, DT.5 PC.2
SDG&E-4-C18	GO 174: Substation Relay Testing, Inspection and Repair Program	DT.1, DT.2, DT.3, DT.4, DT.5, PC.1, PC.2
SDG&E-4-C19	Underground Cable Replacement Program – Proactive	DT.1, DT.2, DT.3, DT.5, DT.7 PC.2
SDG&E-4-C20	Enterprise Asset Management – Substation	DT.1, DT.2, DT.3, DT.4, DT.5

		PC.1, PC.2, PC.3, PC.4, PC.5, PC.6
SDG&E-4-M1	Overhead Public Safety (OPS) Program	DT.1, DT.2, DT.3, DT.6 PC.1, PC.2
SDG&E-4-M2	Replacement of Underground Live Front Equipment – Proactive	DT.1, DT.6 PC.1, PC.2
SDG&E-4-M3	Proactive Substation Reliability for Distribution Components	DT.1, DT.2, DT.3, DT.4, DT.5 PC.2
SDG&E-4-M4	Substation Breaker Replacements – FLISR (Fault Locations, Isolation, and Restoration)	DT.1, DT.2, DT.3, DT.4, DT.5 PC.2
SDG&E-4-M5	Enterprise Asset Management – Distribution	DT.1, DT.2, DT.3, DT.4, DT.5 PC.1, PC.2, PC.3, PC.4, PC.5, PC.6