Risk Assessment Mitigation Phase

(Chapter SDG&E-6)

Medium Pressure Gas Pipeline Incident (Excluding Dig-in)

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SDGE
A Sempra Energy utility

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Risk: Medium Pressure Gas Pipeline Incident

I. INTRODUCTION

The purpose of this chapter is to present the Risk Mitigation Plan for San Diego Gas and Electric Company's (SDG&E or Company) Medium Pressure Gas Pipeline Incident 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 its 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 the 2019 RAMP Report, the baseline costs are the 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 TY 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 the 2019 RAMP Report, activities are delineated between controls and mitigations, which is

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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).

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 Medium Pressure Gas Pipeline Incident 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 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 mandated activities. Mandated activities are defined as activities conducted in order to meet a mandate or law, such as a Code of Federal Regulation (CFR), Public Utilities Code statute, or General Order. Activities with no RSE score presented in this 2019 RAMP Report are identified in Section VI 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 California Public Utilities Commission (CPUC or 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.

SDG&E and Southern California Gas Company (SoCalGas), collectively the "Companies," own and operate an integrated natural gas system. The Companies collaborate to develop policies and procedures that pertain to the engineering and operations management of the gas system operated in both the SoCalGas and SDG&E territory to maintain consistency. However, execution of such policies and procedures are the responsibility of the employees at respective geographically delineated operating unit headquarters. Accordingly, there are similar mitigation plans presented in the 2019 RAMP Report across the Companies' gas pipeline incident related chapters.[5]

A. Risk Definition

For purposes of this RAMP Report, the Medium Pressure Gas Pipeline Incident risk is the risk of damage, caused by a medium pressure pipeline[6] event, which results in serious injuries or fatalities. This risk concerns a gas public safety event on a medium-pressure distribution plastic or steel pipeline and/or its appurtenances (*e.g.*, valves, meters, regulators, risers).

B. Summary of Elements of the Risk Bow Tie

Pursuant to the SA Decision,[7] 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	Corrosion
DT.2	Natural forces (natural disasters, fires, earthquakes)
DT.3	Other outside force damage (excluding dig-in)
DT.4	Pipe, weld or joint failure
DT.5	Equipment failure

[5] The other gas pipeline incident related chapters in the 2019 RAMP Report include: SCG-5 – High Pressure Gas Pipeline Incident; SCG-1 – Medium Pressure Gas Pipeline Incident; and SDG&E-8 – High Pressure Gas Pipeline Incident.

[6] Maximum Allowable Operating Pressure (MAOP) at or lower than 60 psig.

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

DT.6	Incorrect operations
DT.7	Incorrect /inadequate asset records
PC.1	Serious injuries and/or fatalities
PC.2	Property damage
PC.3	Adverse litigation
PC.4	Penalties and Fines
PC.5	Erosion of public confidence

C. Summary of Risk Mitigation Plan

Pursuant to the SA Decision,[8] SDG&E has performed a detailed pre- and post-mitigation analysis of controls and mitigations for the risks included 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

ID	Control Name
SDG&E-6-C1	Cathodic Protection
SDG&E-6-C2	Assessment of Buried Piping in Vaults
SDG&E-6-C3	Regulator & Valve Inspection and Maintenance
SDG&E-6-C4	Plastic Pipe Replacement
SDG&E-6-C5	Leak Repair
SDG&E-6-C6	Pipeline Monitoring: Leak Mitigation, Bridge & Span Inspections, Unstable Earth Inspections, Pipeline Patrol.
SDG&E-6-C7	Utility Conflict Review (Right of Way)
SDG&E-6-C8	Meter Inspection and Maintenance

SDG&E will continue the 2018 controls identified above. Additional activities are being forecasted within the existing controls for Cathodic Protection and Plastic Pipe replacement and SDG&E is also projecting to increase annual activity levels within existing controls. SDG&E also forecasts additional projects and/or programs (*i.e.,* mitigations) as follows:

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

Table 3: Summary of Mitigations

ID	Mitigation Name
SDG&E-6-M1-T1	Early Vintage Program (Pipeline): Early Vintage Threaded Main Replacement
SDG&E-6-M1-T2	Early Vintage Program (Pipeline): Early Vintage Steel Replacement
SDG&E-6-M1-T3	Early Vintage Program (Pipeline): Oil Drip Removal
SDG&E-6-M2-T1	Early Vintage Program (Fittings): Dresser Mechanical Coupling Removal
SDG&E-6-M2-T2	Early Vintage Program (Fittings): High/Medium Valve Separation Removal

Finally, pursuant to the SA Decision,[9] SDG&E presents in Section VIII alternatives to the described mitigation plan for this risk and summarizes the reasons that the alternatives were not included in the mitigation plan in Section VII.

II. RISK OVERVIEW

Typically, medium-pressure distribution systems use a series of mains (pipes with larger diameter) to feed service lines, regulator stations, meters and other appurtenance piping. Service lines are smaller diameter pipes which feed customer homes, businesses, and some commercial applications. Medium-pressure pipelines are made of steel or plastic material.

For safety and compliance, Title 49 of the CFR 192, General Order (GO) 58, and GO 112 are the leading sources of requirements for SDG&E's medium-pressure pipelines (among other legal and regulatory provisions). 49 CFR 192 prescribes safety requirements for pipeline facilities and the transportation of gas at the federal level. GO 112 and GO 58 complement and enhance the requirements of 49 CFR 192 at a state level.

With regard to medium pressure pipelines, SDG&E currently operates almost 8,000 miles of medium pressure main with approximately 3,200 miles being steel and approximately 4,500 being plastic. These medium-pressure pipelines serve over 3.6 million SDG&E consumers.

[9] *Id.* at 34.

Table 4: Medium-Pressure Pipelines

Medium Pressure Pipelines	SDG&E Mains	SDG&E Services
Miles of Steel	3258	2622
Miles of Plastic	4596	3770
Total Miles Medium Pressure Pipelines	7881	6392

Various causes and events can lead to medium pressure pipeline incidents. Drivers can range from natural forces (such as natural disasters, fires, earthquakes), improper installation techniques, material defects, aging/environmental factors such as corrosion and material fatigue, improper operations, and inadequate maintenance of the pipeline infrastructure. For the purposes of this chapter, the Medium-Pressure Pipeline Incident risk focuses on risk events that result in serious injuries or fatalities.

SDG&E notes that when the loss of gas cannot be resolved by lubing, tightening or adjusting, it is defined as a "leak." A leak in and of itself may cause little-to-no risk of serious injury or fatality. Risk to the public and employees can increase when leaks are in close proximity to an ignition source and/or where there is a potential for gas to migrate into a confined space. The safety concern of the leak is addressed by SDG&E's leak indication prioritization and repair schedule procedures. In most cases, a pipe with a leak will continue to transport gas, and therefore is not considered a pipeline "failure" using the definition in American Society of Mechanical Engineering B31.8S.[10]

Additionally, although not included in this RAMP filing, SDG&E is currently in the very preliminary stages of organizing and modeling a Facilities Integrity Management Program (FIMP) based on principles developed by the Canadian Energy Pipeline Association (CEPA) and

[10] American Society of Mechanical Engineering standard B31.8S: Managing System Integrity of Gas Pipelines. B31.8S is specifically designed to provide the operator with the information necessary to develop and implement an effective integrity management program utilizing proven industry practices and processes.

the Pipeline Research Council International (PRCI). The FIMP is not intended to duplicate any systems, processes, or information that may already exist, but rather to supplement the already existing programs to enhance the safety and integrity of the integrated gas pipeline system.[11] FIMP will be a documented program, specific to the facilities portion of a pipeline system,[12] that identifies the practices used by the operator for purposes of "safe, environmentally responsible, and reliable service."[13] While SDG&E is currently in the preliminary stages of organizing and modeling a FIMP approach based on the principles of CEPA, FIMP is anticipated to be included in the next GRC. Although this concept of an overarching program is still maturing in the industry, SDG&E's intention of a FIMP is to better identify and reduce risks of facility assets, extend the life of assets, and achieve operational excellence, in alignment with both the principles of RAMP and the Company's existing Transmission and Distribution, Integrity Management Programs (TIMP, DIMP respectively).[14] Consistent with the SA Decision, a supplemental analysis will be conducted in the GRC for FIMP if it ultimately meets the criteria for inclusion in that proceeding.

III. RISK ASSESSMENT

In accordance with the SA Decision,[15] this section describes the Risk Bow Tie, possible drivers, and potential consequences of the Medium Pressure Gas Pipeline Incident risk.

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[11] SDG&E notes that there are certain facilities management systems and processes in place, for example Pipeline Research Council International (PRCI) – Facility Integrity Management Program Guidelines – PRCI IM-2-1 Contract PR-186-113718.

[12] "Pipeline system" is defined by Pipeline Research Council International (PRCI) - Facility Integrity Management Program Guidelines – PRCI IM-2-1 Contract PR-186-113718 as "*Pipeline System is comprised of pipelines, stations, and other facilities required for the measurement, processing, gathering, transportations, and distribution of oil or gas industry fluids*."

[13] Canadian Energy Pipeline Association (CEPA), Facilities Integrity Management Program, Recommended Practice, 1st Edition (May 2013) at 7-8.

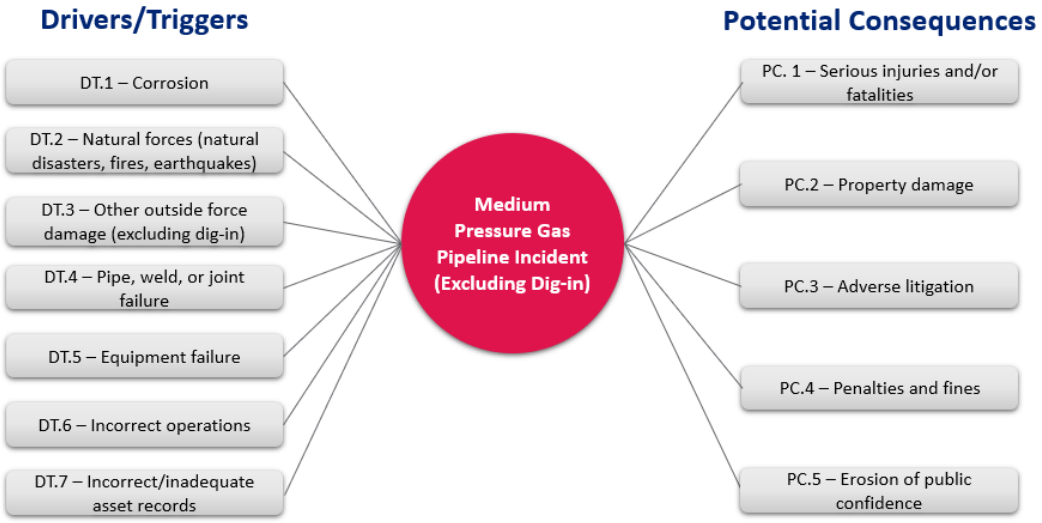
[14] Based on industry definitions, there are a variety of types of facilities; facilities are highly complex; a variety of equipment/asset types exist within facilities; and in this context facilities are not considered building structures.

[15] D.18-12-014 at 33 and Attachment A, A-11 (Bow Tie).

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 or Systems Subject to the Risk

The SA Decision[16] directs the utilities to endeavor to identify all asset groups or systems subject to the risk.

The Natural Gas Pipeline Distribution System consists of SDG&E's medium and high-pressure distribution pipeline system is comprised of plastic and steel pipelines and its appurtenances *(e.g.*, meters, regulators, risers). As discussed in RAMP-G, the tracking of costs by SDG&E is not logically disaggregated by high/medium pressure, and therefore costs with some controls for high pressure assets are captured within this chapter.

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

SDG&E's Medium Pressure Gas Pipeline Incident risk impacts all of SDG&E's natural gas infrastructure and assets in the medium pressure pipeline system. The medium pressure pipeline system is comprised of plastic and steel pipelines and its appurtenances (*e.g.*, valves, meters, regulators, risers) operating at or less than 60 psig.[17] The large size of the system means a high volume of related appurtenances for example the system includes more than 892 thousand meters and approximately 500 regulator stations to distribute and regulate pressure.

C. Risk Event Associated with the Risk

The SA Decision[18] 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 (center of the bow tie) is a pipeline 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.

D. Potential Drivers/Triggers[19]

The SA Decision[20] instructs the utility to identify which element(s) of the associated bow tie each mitigation addresses. When performing the risk assessment for Medium Pressure Gas Pipeline Incident, SDG&E identified potential leading indicators, referred to as drivers. These include, but are not limited to:

- **D.T1 – Corrosion:** External corrosion is a naturally occurring phenomenon commonly defined as the deterioration of a material (usually a metal) that results from a chemical or electrochemical reaction with its environment.[21] External corrosion occurs to the outside of a pipe. Internal corrosion is the deterioration of metal that results from an electrochemical

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17 Due to cost tracking limitations, the cost reflects a small percentage of miles of high-pressure pipelines maintained by Distribution Operations.

18 D.18-12-014 at Attachment A, A-11 (Bow Tie).

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

20 D.18-12-014 at Attachment A, A-11 (Bow Tie).

21 L.S. Van Delinder, *Corrosion Basics, An Introduction* (1984); *see also* U.S. Department of Transportation, *Fact Sheet: Internal Corrosion*, *available at* https://primis.phmsa.dot.gov/comm/FactSheets/FSInternalCorrosion.htm.

reaction with its immediate surroundings. This reaction causes the iron in the steel pipe or other pipeline appurtenances to oxidize (rust). Internal corrosion results in metal loss in the inside of the pipe. Over time and if left unmitigated, corrosion can cause the steel to lose its strength and possibly render it unable to contain the fluid in the pipeline at its operating pressure. The loss of material from corrosion can eventually result in "pinhole" leakage, or a crack, split, or rupture of the pipeline unless the corrosion is repaired, the affected pipe section is replaced, or the operating pressure of the pipeline is reduced.[22] In pipelines, corrosion can occur internally and/or externally, both potentially resulting in a pipeline incident; therefore, will be referred to as "corrosion" in the remainder of this chapter, unless otherwise needed.

- **DT.2 – Natural forces (natural disasters, fires, earthquakes):** Attributable to causes not involving **humans**, but includes effects of climate change such as earth movement, earthquakes, landslides, subsidence, heavy rains/floods, lightning, temperature, thermal stress, frozen components, wildfires and high winds.
- **DT.3 – Other outside force damage (excluding dig-in):** Attributable to outside force damage other than excavation damage or natural forces such as damage by car, truck or motorized equipment not engaged in excavation, etc.
- **DT.4 – Pipe, weld, or joint failure:** Attributable to material defect within the pipe, component or joint due to faulty manufacturing procedures, design defects, improper construction or fabrication or in-service stresses such as vibration, fatigue and environmental cracking.
- **DT.5 – Equipment failure:** Similar to DT.4, but unrelated to pipe (main and services). These failures are attributable to the malfunction of a

[22] *Id.*

component including, but not limited to, regulators, valves, meters, flanges, gaskets, collars, and couples. This driver/trigger is specific to the material properties related to the manufacturing process or post installation of the equipment.

- **DT.6 – Incorrect operations**: May include a pipeline incident attributed to insufficient or incorrect operating procedures or the failure to follow a procedure.
- **D.T7 – Incorrect /inadequate asset records:** The use of inaccurate or incomplete information that could result in the failure to: (1) construct, operate, and maintain SDG&E's pipeline system safely and prudently; or, (2) to satisfy regulatory compliance requirements.

E. Potential Consequences

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 and/or fatalities;
PC.2 – Property damage;
PC.3 – Adverse litigation;
PC.4 – Penalties and fines; and
PC.5 – Erosion of public confidence.

These potential consequences were used in the scoring of the Medium Pressure Gas Pipeline Incident risk during the development of SDG&E's 2018 Enterprise Risk Registry.

IV. RISK QUANTIFICATION FRAMEWORK

The SA Decision sets minimum requirements for risk and mitigation analysis in RAMP,[23] including enhancements to D.16-08-018.[24] 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

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

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

the Pre-Mitigation Risk Score, Likelihood of Risk Event (LoRE), and Consequence of Risk Event (CoRE) are calculated.

Table 5: Pre-Mitigation Analysis Risk Quantification Scores[25]

Medium Pressure Gas Pipeline Incident (Excluding Dig-in)	Low Alternative	Single Point	High Alternative
Pre-Mitigation Risk Score	47	**252**	594
LoRE	**101**		
CoRE	0.5	**2.5**	5.9

F. Risk Scope & Methodology

The SA Decision requires a pre- and post-mitigation risk calculation.[26] The below section provides an overview of the scope and methodologies applied for the purpose of risk quantification. 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.

In Scope for purposes of risk quantification:	The risk of damage, caused by a medium pressure pipeline (maximum allowable operating pressure - MAOP at or lower than 60 psig) failure event, which results in consequences such as injuries or fatalities or outages.
Out of Scope for purposes of risk quantification:	The risk of damage caused by a non-medium-pressure pipeline failure event or third-party dig-ins which results in consequences such as injuries or fatalities or outages.

[25] The term "pre-mitigation analysis," in the language of the SA Decision (Attachment A, A-12), refers to required pre-activity analysis conducted prior to implementing control or mitigation activity.

[26] D.18-12-014 at Attachment A, A-11 (Calculation of Risk).

Pursuant to Step 2A of the SA Decision, the utility is instructed to use actual results, available and appropriate data (*e.g.*, Pipeline and Hazardous Materials Safety Administration (PHMSA) data).[27]

Historical PHMSA data and internal SME input was used to estimate the frequency of incidents. To determine the incident rate per year for SDG&E, the national average incident rate per mile per year was applied to the medium-pressure pipeline miles at SDG&E.

The safety risk assessment primarily utilized data from the PHMSA, the reliability risk assessment was based on internal data, and the financial risk assessment was estimated based on both PHMSA and internal data. Internal SME input, based on recent damage repair costs, was used to estimate the financial consequence of incidents. Historical PHMSA medium-pressure gas incidents were also used in estimating financial and safety consequences. The reliability incident rate per year was estimated using internal data. Additionally, Monte Carlo simulation was performed to understand the range of possible consequences.

G. Sources of Input

The SA Decision[28] 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.

- Annual Report Mileage for Natural Gas Transmission & Gathering Systems
    - Agency: Pipeline and Hazardous Materials Safety Administration (PHMSA)
    - Link: https://cms.phmsa.dot.gov/data-and-statistics/pipeline/annual-report-mileage-natural-gas-transmission-gathering-systems
- Annual Report Mileage for Gas Distribution Systems

[27] *Id.* at Attachment A, A-8 (Identification of Potential Consequences of Risk Event).

[28] *Id.* at Attachment A, A-8 (Identification of the Frequency of the Risk Event).

- Agency: Pipeline and Hazardous Materials Safety Administration (PHMSA)
- Link: https://cms.phmsa.dot.gov/data-and-statistics/pipeline/annual-report-mileage-gas-distribution-systems

- Distribution, Transmission & Gathering, LNG, and Liquid Accident and Incident Data
  - Agency: Pipeline and Hazardous Materials Safety Administration (PHMSA)
  - Link: https://www.phmsa.dot.gov/data-and-statistics/pipeline/distribution-transmission-gathering-lng-and-liquid-accident-and-incident-data
- SDG&E Medium-Pressure Pipeline Miles are 2017 Internal SME Data
- Gas Industry Sales Customers
  - Agency: AGA (2016Y)
  - Link: https://www.aga.org/contentassets/d2be4f7a33bd42ba9051bf5a1114bfd9/section8divider.pdf
- SDG&E End User Natural Gas Customers
  - Source: SNL (2016Y, from the FERC From 2/2-F, 3/3-A or EIA 176)
  - Link: https://platform.mi.spglobal.com/web/client?auth=inherit&newdomainredirect=1&#company/report?id=4057146&keypage=325311

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."[29]

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

This section describes SDG&E's Risk Mitigation Plan by each selected mitigation and control for this risk, including the rationale supporting each selected Control and Mitigation.

As stated above, the Medium Pressure Gas Pipeline Incident risk is the risk of damage, caused by a medium pressure pipeline event, which results in serious injuries or fatalities. The Risk Mitigation Plan includes both controls that are expected to continue and projected mitigations for the period of SDG&E's Test Year 2022 General Rate Case (GRC) cycle. The controls are those activities that were in place as of 2018, most of which are compliance driven and have been implemented over decades plus the addition of the Distribution Integrity Management Program (DIMP) that has been developed over recent years, to address this risk. SDG&E's mitigation plan for this risk consists of controls based on 42 CFR Part 192, GO 58, GO 112-F and forecasted enhancements within existing controls. Overall the compliance requirements are set forth within the regulations (although considered minimum requirements.) The compliance requirements are robust in that they provide prescriptive preventative and maintenance guidance for the medium pressure assets. In addition, the DIMP regulations have allowed operators to identify risks specific to their system and address them through additional controls and mitigations.

For this RAMP chapter, the makeup of the portfolio of controls is a combination of compliance requirements and additional programs implemented by DIMP within the last 7 years. The DIMP is continually evaluating the system threats and risk to determine if additional mitigations are appropriate. The threat and risk evaluation leverages leak repair, incident data and SME input to evaluate and rank risk. As programs are developed, available data sets are leveraged to develop specific risk ranking for each, which allows higher priority remediations to be completed first. For example, the Distribution Risk Evaluation and Monitoring System (DREAMS) steel replacement programs utilize leak rates, condition of the pipe, soil and other factors to prioritize medium pressure segments for replacement. Another example is the introduction of the Damage Program Analyst specifically covered within the Third Party Dig-In on a Medium Pressure Pipeline Chapter SDG&E-7. The incremental request within existing

controls for Cathodic Protection and Meter and Regulations[30] are the first steps to evaluating the need for larger programs and further analysis will aid in the overall prioritization given the size of the system.

Other programs and activities also mitigate the Medium Pressure Gas Pipeline Incident risk, but they are not included in this Risk Mitigation Plan. For example, the Mobilehome Park Utility Upgrade Program (MHP) is converting master-metered/sub-metered natural gas and/or electric services to direct utility services in mobile home parks and manufactured housing communities to improve the safety and reliability of service for residents of mobile home parks currently served by master-metered gas systems. The MHP is not included in this mitigation plan because MHP costs are not anticipated to be forecasted in SDG&E's next GRC.[31] Another example is SDG&E's methane emissions reduction activities in compliance with Senate Bill (SB) 1371 and the resulting Gas Leak Abatement OIR (R.15-01-008). In addition to the federally mandated leak survey requirements described in the Pipeline Monitoring Control (SDG&E-6-C6) below, SDG&E proposed transitioning pre-1986 plastic to annual survey as part of the GRC to an annual survey per the SB 1371 proceeding. SB 1371 requires the adoption of rules and procedures to minimize natural gas leakage from Commission-regulated natural gas pipeline facilities consistent with Public Utilities Code section 961(d) and 49 CFR § 192.703(c). SDG&E has been an active participant in the rulemaking and has provided comments as well as met the reporting requirements set forth under SB 1371. SDG&E' first Leak Abatement Compliance Plan and accompanying Advice Letter were approved in 2018 and the Plan is being implemented by the Emissions Strategy Project Management Organization to implement 26 Mandatory Best Practices. Although the focus of SB 1371 activities is to reduce methane emissions, the activities may result in collateral safety benefits as a reduction in the number of leaks reduces the potential opportunity for ignition. However, the risk reduction analysis and the costs tied to the implementation of SB 1371 are not reflected in the Mitigation Plan for this chapter because the

[30] Continued incremental request because 2019 GRC requested funding to increase regulator replacement programs

[31] The Mobile Home Park Conversion Program is a pilot program authorized by and discussed in D.14-03-021 and Resolutions E-4878 (September 28, 2017) and E-4958 (March 14, 2019).

intent of SB 1371 best management practice activities is to reduce methane emissions (and thus it is not primarily focused on addressing safety risk).

A. SDG&E-6-C1: Cathodic Protection

Corrosion is a natural process that can deteriorate steel assets and potentially lead to leaks or damage. If a leak migrates to a confined space and an ignition source is introduced, there is the potential for injuries. Although the SDG&E operations groups immediately respond to these leak situations, they have the potential to lead to a pipeline incident. Cathodic Protection (CP), coating and monitoring can protect and extend the life of a steel asset by mitigating corrosion. The application of a Cathodic Protection current is necessary to overcome local corrosion currents along the pipeline, that left unabated would result in localized corrosion at anodic sites. Cathodic Protection can be achieved by the installation of sacrificial anodes or impressed current systems.[32]

The directives prescribed by 49 CFR 192 Subpart I, include the monitoring of CP areas, remediation of CP areas that are out of tolerance,[33] and preventative installations to avoid out of tolerance areas. The following summarizes the required intervals for completing these preventative measures as prescribed in 49 CFR § 192.465 External Corrosion Control (Monitoring):

- Each pipeline that is under cathodic protection must be tested at least once each calendar year, but with intervals not exceeding 15 months, to determine whether the cathodic protection meets the requirements of § 192.463. However, if tests at those intervals are impractical for

[32] SDG&E utilizes both impressed current and magnesium anode (galvanic) systems to provide CP to existing pipelines. Impressed current systems utilize a rectifier for the generation of the direct current. Both systems utilize sacrificial anodes as a primary component in the system. Anodes are installed in wells drilled into the surrounding soil by third-party drilling contractors. Each protected pipe segment requires multiple anodes, collectively referred to as an "anode bed." The number of anodes needed to achieve the desired level of protection and the average life of the anode bed can vary based on pipeline length, coating effectiveness, soil conditions and interference that may occur on the system.

[33] Out of tolerance areas are defined as areas where CP measures are not efficiently mitigating the effect of the corrosive environment on steel assets.

separately protected short sections of mains or transmission lines, not in excess of 100 feet (30 meters), or separately protected service lines, these pipelines may be surveyed on a sampling basis. At least 10 percent of these protected structures, distributed over the entire system must be surveyed each calendar year, with a different 10 percent checked each subsequent year, so that the entire system is tested in each 10-year period.

- Each cathodic protection rectifier or other impressed current power source must be inspected six times each calendar year, but with intervals not exceeding 2 1/2 months, to insure that it is operating.[34]

SDG&E plans to continue with work according to this schedule.

This incremental work activity supports the safety and integrity of the system and mitigates risks defined in this RAMP chapter.

B. SDG&E-6-C2: Assessment of Buried Piping in Vaults

This control is for the replacement of piping located in underground vaults.[35] SDG&E has a number of valves that are surrounded by a concrete vault to provide access to the valve for emergency operations. Any pipe segment, fitting, or valve exposed within a below grade vault is at risk for accelerated atmospheric corrosion due to the potential for water accumulation, pipe coating failure, and decreased cathodic protection effectiveness as these components within the vault are not buried and are exposed to the atmosphere. This RAMP incremental addition follows the review of existing work orders determining the locations of all vaults containing medium and high-pressure facilities. Once all vaults with exposed valves are identified, the valve will be replaced with a valve appropriate for buried service, and the vault removed and backfilled so that the valve will be protected by cathodic protection. The valve would continue to be accessible so that it could be used for emergency isolation. It is estimated that approximately 50 locations will require replacement. SDG&E will assess the coating and the

[34] 49 CFR § 192.465(a) and (b).

[35] Vaults are rooms that allow for access to piping and piping components.

condition of the above-ground and below-ground facilities within the vaults and prioritize for complete replacement.

C. SDG&E-6-C3: Regulator & Valve Inspection and Maintenance

This control is for inspections and maintenance to regulators. Regulator stations reduce the pressure of gas entering the distribution system from high-pressure pipelines to provide a lower pressure used on the distribution pipeline system. A failure of a regulator station due to mechanical failure, corrosion, contamination or other cause could result in over-pressurization of the gas distribution system, which may compromise the integrity of medium-pressure pipelines and/or jeopardize public safety as evident by recent over-pressure events in the industry.

Regulator stations are critical control elements in the gas distribution system. 49 CFR § 192.739 requires inspections/tests to be conducted done annually, not to exceed 15 months to maintain these devices in good mechanical condition. Functional tests of regulator stations are performed as part of inspections. The pressure checks are done to verify that the station's pressure protection devices perform as designed. If a station does not perform properly, internal maintenance and inspections are conducted. This consists of disassembling the regulator devices and inspecting the internal components for worn or damaged parts. The regulator is cleaned and inspected for corrosion and any faulty parts are replaced.

As regulator stations age, their parts and equipment can begin to wear, malfunction, and become harder to disassemble, increasing maintenance requirements. Modern regulator stations are beginning to be designed with dual-run feeds to maintain continued safe and reliable operation of the station in the event of a failure within either of the two runs. Annual maintenance and inspections are used to record the condition of each station and identify items that require immediate and long-term action. The overall inspection of the station is leveraged to prioritize future regulator station replacement projects. The assessment includes evaluation of the design, condition of the equipment, valves and vaults, and exposure to other outside forces including flooding and traffic conditions.

SDG&E's operating and maintenance practices allow stations to exceed their useful lives. However, it is prudent to proactively replace regulator stations prior to the end of their design life in order to reduce the overall system risk. This risk reduction is achieved through improved

station design of dual-run regulators which will reduce the risk of over-pressure and the stations location can be evaluated to reduce the risk of vehicular damage (outside force) or vandalism. SDG&E operates and maintains approximately 500 regulator stations, of which, on average, two to three stations are replaced or added to the system each year. The average life expectancy of a regulator station is approximately 35 years. SDG&E will evaluate a replacement plan of district regulator stations (DRS) across the operating region. Once developed, this regulator station replacement plan will be used as an example of addressing SDG&E's aging infrastructure and will be used as a model to review other facilities and equipment in a similar fashion. The following summarizes the requirements for completing these preventative measures as prescribed within then 49 CFR § 192.739 Pressure limiting and regulating stations: Inspection and testing:

a) Each pressure limiting station, relief device (except rupture discs), and pressure months, but at least once each calendar year, to inspections and tests to determine that it is—

(1) In good mechanical condition;

(2) Adequate from the standpoint of capacity and reliability of operation for the service in which it is employed;

(3) Except as provided in paragraph (b) of this section, set to control or relieve at the correct pressure consistent with the pressure limits of § 192.201(a); and

(4) Properly installed and protected from dirt, liquids, or other conditions that might prevent proper operation.

Valve Maintenance allows the opportunity to validate that the valves within the system operate at optimum effectiveness which enhances public safety by providing SDG&E with the ability to control the pressure and flow of gas in the system. The maintenance activities may include flushing, lubrication, parts replacement, cleaning and testing of operability. Valves are installed for control of pressure and flow of gas. Their location and purpose determine their criticality: fire valves at regulator stations isolate the high- and medium-pressure systems; emergency valves isolate segments of pipelines in case of pipe damage or for operational purposes; and isolation valves segment portions of the system in the event of a widespread emergency, such as an earthquake and reduce the impact of resulting pipeline damage. A valve

that is operating at its optimum effectiveness means that, for example, in the case of an earthquake or fire where an area needs to be isolated to reduce the risk of incident, these valves will operate as intended and fully isolate the area. A second example, which happens more frequently, when third-party damage occurs, these valves can be operated to allow for a safe environment to complete the repairs and minimize the risk of furthering the incident. The following summarizes the requirements for completing these preventative measures as prescribed within the CFR § 192.747:

> (a) Each valve, the use of which may be necessary for the safe operation of a distribution system, must be checked and serviced at intervals not exceeding 15 months, but at least once each calendar year.
>
> (b) Each operator must take prompt remedial action to correct any valve found inoperable, unless the operator designates an alternative valve.

D. SDG&E-6-C4: Plastic Pipe Replacement

The Vintage Integrity Plastic Plan (VIPP) falls within the umbrella of the Distribution Risk Evaluation and Monitoring System. Plastic pipe manufactured and used for gas service from the 1960s through the early 1980s (1,578 miles) exhibit brittle-like cracking characteristic that could cause a leak to grow and release additional natural gas than would normally be released, increasing the risk of natural gas gathering and igniting causing injuries and/or fatalities. Given the potential for a higher release of gas, the leak survey frequency has been increased to yearly versus every five years for plastic pipelines within this vintage. The initial focus of the VIPP is early vintage plastic manufactured pre-1973. This vintage of plastic exhibits the brittle-like cracking characteristics discussed, but also exhibits a Low Ductile Inner Wall (LDIW) issue that further exacerbates the brittle-like cracking issues since it expedites crack initiation when external loads are applied. This issue in the manufacturing practice has been the focus of earlier notices as issued by the manufacturer DuPont and PHMSA. Therefore, the focus will be a wholesale replacement of pre-1973 plastic pipe with a priority given to poor performing segments by utilizing a relative risk model and dynamic segmentation. The secondary focus will be to leverage the same relative risk model and dynamic segmentation to continue to focus on the replacement of poor performing early vintage plastic for all pre-1986 plastic pipe. SDG&E is on

target to replace the forecasted 19 miles of mains and associated services for replacement above and beyond routine replacements. As SDG&E's infrastructure continues to age and more leak data is accumulated through annual inspections, SDG&E anticipates continuing to increase the level of replacement over the next 6-8 years while monitoring performance to continually review the benefits and risk reduction accomplished through VIPP through indicators such as leak repair and incident rates related to early vintage plastic.

E. SDG&E-6-C5: Leak Repair

SDG&E proactively surveys its gas distribution system for leakage at frequencies determined based on the pipe material involved, the operating pressure, whether the pipe is under cathodic protection, and the proximity of the pipe to various population densities as prescribed within CFR § 192.723. A routine leak survey consists of surveys at intervals of one, three, or five years of steel mains and plastic at intervals of five years. The frequency of this survey is determined by the pipe material involved. Annual surveys are scheduled in business districts, and near public service establishments, such as schools, churches, hospitals and pre-1986 plastic (Aldyl-A). Three-year survey cycles are used for all cathodically unprotected mains and services. Five-year survey cycles are typically used for plastic and cathodically protected steel mains and services installed in residential areas. The results of leak surveys feed into risk models for pipeline replacement.

If a leak is found during a survey of the gas distribution system, SDG&E takes steps to either remediate or monitor the situation depending on the type of leak classification. A leak will be remediated immediately if there is a hazardous condition. If the leak does not create a hazardous situation, SDG&E will monitor the leak. SDG&E has shortened the prescribed timeframe for which leaks will be monitored and scheduled for remediation. The leak survey program has accelerated due to the increased footage for leak surveys, which requires more leak survey activities. SB 1371 requires the adoption of rules and procedures to minimize natural gas leakage from Commission-regulated natural gas pipeline facilities consistent with Public Utilities Code section 961(d) and 49 CFR § 192.703(c). SDG&E has been an active participant in the rulemaking and has provided comments as well as met the reporting requirements set forth under SB 1371. SDG&E's first Leak Abatement Compliance Plan and accompanying Advice Letter

were approved in 2018 and the Plan is being implemented across by the Emissions Strategy Project Management Organization to implement 26 Mandatory Best Practices. This will result in collateral safety benefits. However, the risk reduction analysis and the costs tied to the implementation of SB 1371 are not included as part of this control.

F. SDG&E-6-C6: Pipeline Monitoring (Leak Mitigation, Bridge & Span, Unstable Earth and Pipeline Patrol)

SDG&E conducts pipeline monitoring and inspection activities to proactively target risk factors before operation and safety issues arise. These monitoring activities include pipeline patrols, leak surveys, bridge and span inspections, and unstable earth inspections. These inspections are critical since they are intended to observe assets over time to determine if abnormal conditions exist prior to becoming a concern. For example, a span that no longer is coated appropriately due to recent weather conditions can be identified for re-coating before corrosion begins that could lead to a leak. The leak survey monitoring identifies leaks that require repair.

The monitoring and inspections must follow certain prescribed processes included in the Code of Federal Regulations.[36]

G. SDG&E-6-C7: Utility Conflict Review (Right of Way)

The Land and Right-of-Way group is responsible for managing the necessary property rights that allow for the access, operation, and maintenance of our pipeline infrastructure on public and private properties. Right of way (ROW) access is critical for the overall general safety of employees and the public and includes span painting, pipeline maintenance, storm damage repair, removal of previously abandoned pipelines, vegetation removal, and right-of-way maintenance. Maintenance of access roads is critical to allow pipelines to be accessed in a timely manner, minimizing third party pipeline damages and prevention of wildfire damages. The costs associated with the ROW in this RAMP report refer to the O&M activities required to maintain access to Company assets. These costs do not include costs related to the acquisition of ROW space.

[36] 49 CFR § 192.721.

H. SDG&E-6-C8: Meter Inspection and Maintenance

The Meter Set Assemblies (MSA) reduce the pressure of natural gas and measure the volume of natural gas delivered to the customer. General Order 58-A requires that meters, regulators, and other components be maintained, repaired, and tested periodically to meet customers' capacity requirements, measure gas volume accurately and deliver natural gas at an adequate pressure for the houseline and home appliances. Additionally, if MSAs are housed in vaults, the vaults must be inspected and repaired, if necessary, to protect the MSA. Should the regulators fail a household could potentially see a much higher pressure of natural gas and may lead to an incident. Scheduled inspections of meter set assemblies proactively target the risk of equipment failures, corrosion, and outside force before operation and safety issues arise.

As required by 49 CFR § 192.481, above ground piping facilities must be inspected for atmospheric corrosion no less than once every three calendar years and at intervals not to exceed 39 months.

I. SDG&E-6-M1: Early Vintage Program (Pipeline)

The Early Vintage Program mitigates risk on early vintage pipelines that were installed using construction practices that are no longer considered best practices. The determination of where and when to implement mitigation measures is based on pipe attributes, operational conditions, and potential impacts on populations in the event of an incident. The Early Vintage Program proactively identifies the risk factors for remediation before operational and safety issues arise. As these programs continue to be evaluated, activity may vary between the tranches. SDG&E's Early Vintage Program (Pipeline) consists of the following elements: Early Vintage Threaded Main Replacement, Early Vintage Steel Replacement, Oil Drip Removal, Leak History Replacement. Each control is further described below:

1. SDG&E-6-M1-T1: Early Vintage Threaded Main Replacement.

Prior to 1933, piping in the gas distribution system was joined by treaded couplings. This project aims to proactively remove a total of 152 miles of threaded main pipe over a 10-year period as well as associated services (approx. 153 miles of services have been identified). This is approximately a10-year program which on average would require 15 miles of pipe per year,

however mileage can vary slightly from year-to-year. Threaded pipe has a greater susceptibility to leaks at the joint connections and higher potential for joint failure during a seismic event.

2. SDG&E-6-M1-T2: Early Vintage Steel Replacement.

The Early Vintage Steel Replacement Program focuses on the replacement of poor performing steel. In early vintage steel mains, cold tar asphaltic wrap was used as the first layer of corrosion protection. Over time, the early generation pipe wrap degrades and disbonds from the pipe, causing any cathodic protection current to leave the pipe around the disbonded coating thereby not providing adequate protection. Ultimately, this lack of corrosion protection will lead to increased leakage. In 2019, SDG&E is targeting replacement of 7.4 miles. SDG&E anticipates continuing this program while monitoring performance to continually review the benefits and risk reduction accomplished through Early Vintage Steel Replacement through indicators such as leak repair and incident rates related to steel pipeline.

3. SDG&E-6-M1-T3: Early Vintage Oil Drip Removal.

Pipeline oil drips were installed in low point high volume areas of the system to collect and purge unwanted liquids from the main. These systems were installed in the early days in the downtown areas when coal gasification was used and liquids were traditionally found in the system. Since liquids are no longer an issue for the SDG&E pipeline system, oil drips are obsolete. The buried oil drip piping facilities are at risk of excavation damage as their location and configuration historically were not captured with enough detail to identify them with precision on facility maps. These facilities often were symbolized by a “teardrop” on the maps. Because the feature lengths and attributes were not mapped in detail, it has led to difficulties in marking out as part of locate and mark requests. In recent history, a facility was damaged and caused an uncontrollable release of gas until the pipeline could be shut down. This incident caused a major freeway that serves Southern San Diego County to be shut down for safety. Gas Distribution has gathered partial historical oil drip location data and for 176 sites and marked the approximate location of these facilities in GIS; however, this effort needs additional validation. This capital project will follow the review of 44 work orders and field validation of above ground and buried oil drip lines and containers. Additionally, this capital expenditure will be

associated with an estimated 120 oil drip lines and containers that are no longer necessary and will be removed from the system thus improving the safety and reliability of the system.

J. SDG&E-6-M2: Early Vintage Program (Fitting)

The Early Vintage Program mitigates risk on early vintage fitting. The determination of where and when to implement mitigation measures is based on fitting attributes, operational conditions, and impact on populations in the event of an incident. The Early Vintage Program proactively identifies the risk factors for remediation before operational and safety issues arise. SDG&E's Early Vintage Program (Fitting) consists of Dresser Mechanical Coupling Removal and High/Medium Valve Separation Removal. Each mitigation is further described below:

1. SDG&E-6-M2-T1: Dresser Mechanical Coupling Removal.

The Dresser mechanical coupling joins two pipes together without the need for welding. This type of coupling cannot resist lateral movement, and over time the rubber pressure containing seal degrades. The Early Vintage Program (Fitting) consists of evaluating locations where Dresser mechanical couplings exist, excavating, removing approximately 100 Dresser mechanical couplings, and welding pipes back together. Dresser mechanical couplings require lateral support and are not as strong as modern mechanical coupling which have a rubber mechanical seal. In the event of land movement, pipe separation/rupture may occur and create an incident. These types of incidents are low frequency, but potentially high consequence events because the Dresser mechanical couplings are primarily located in high population density areas. They exist in both the medium and high-pressure systems.

2. SDG&E-6-M2-T2: High/Medium Valve Separation Removal.

SDG&E has identified 130 valves which separate high-pressure from medium-pressure systems. These valves are permanently locked out and tagged out in the closed position to serve as a physical barrier between high pressure and medium pressure. This condition is a result of a MAOP uprating of a pipeline which was previously interconnected to a distribution system and operated at a lower MAOP. Simply closing and locking the valve between high- and medium pressure systems is no longer an acceptable practice as there is inherent risk should the valve be operated in error, operated in an act of sabotage, or the valve leak pressure downstream to the lower MAOP system potentially causing an overpressure condition of the downstream system.

This project will verify valve locations in the field, excavate, and remove the closed and locked valves currently connecting high-pressure piping to medium-pressure piping thus improving the safety and reliability of the system.

VI. POST-MITIGATION ANALYSIS

As described in Chapter RAMP-D, SDG&E has performed a Step 3 analysis where necessary pursuant to the terms of the SA Decision. Unless otherwise specified, all elements of the bow tie concerning Potential Consequences are assumed to be addressed by the below mentioned controls or mitigations. 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.

A. Mitigation Tranches and Groupings

The Step 3 analysis provided in the SA Decision[37] instructs the utility to subdivide the group of assets or the system associated with the risk into tranches. Risk reduction from mitigations and RSEs 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 below.

SDG&E's comprehensive integrity and maintenance programs consist of policies, programs, and efforts designed to reduce the probability of a pipeline incident. The extensive activities SDG&E performs to mitigate pipeline risks have been grouped into the controls presented herein based on the similarity of their risk profiles.

SDG&E does differentiate some programs by asset type (*e.g.*, steel vs. plastic); however, as discussed in RAMP-G, costs are not tracked at a level of detail to allow for the logical disaggregation of assets or systems at a more granular level than the controls described in the mitigation plan.

Outside of the aforementioned groups, The Early Vintage Program has a logical disaggregation for activities as listed in the Summary of Risk Mitigation Plan and was tranched.

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

The Early Vintage Program focuses on assets, pipelines and fittings, and of those assets, specific groups are targeted for remediation and tranched accordingly:

Table 6: Summary of Tranches

ID	Mitigation	Tranche	Tranche ID
SDG&E-6-M1	Early Vintage Program (Pipeline)	Early Vintage Threaded Main Replacement	SDG&E-6-M1-T1
		Early Vintage Steel Replacement	SDG&E-6-M1-T2
		Oil Drip Removal	SDG&E-6-M1-T3
SDG&E-6-M2	Early Vintage Program (Fittings)	Dresser Mechanical Coupling Removal	SDG&E-6-M2-T1
		High/Medium Valve Separation Removal	SDG&E-6-M2-T2

B. Post-Mitigation/Control Analysis Results

As described in RAMP-D and Section 4 above, SDG&E utilized both internal data/modeling as well as PHMSA data to build RSEs for the pipeline incident risk areas. In the determination of inputs for the RSE calculations, SMEs were heavily utilized to confirm and provide data to perform the RSE calculations. Such input included the effectiveness of each control. The effectiveness percentages shown below are the results of discussions with SMEs whose knowledge of the control heavily dictated the values selected.

The below sections detail the Risk Reduction Benefits of each control/mitigation as well as specifically outline the data used in conjunction with said SME input to develop the RSE values.

1. SDG&E-6-C1: Cathodic Protection (CP)

a. Qualitative Description of Risk Reduction Benefits

A steel pipeline can corrode externally and experience a degradation process that can lead to a structural incident. Corrosion control activities, like CP, are meant to manage or arrest structural changes. CP is a method to mitigate external corrosion on steel pipelines thereby extending the life of a steel asset. The activities associated with CP include installation, monitoring, and remediation. SDG&E has installed CP on all of its 3,571 miles of steel gas mains and all of its 266,806 gas services. Given the mandated requirement to continuously

monitor and evaluate the CP areas, the management of this control is cyclical in nature. Distribution Operations manages the implementation of the work associated with this control with engineering oversight from the Pipeline Integrity group.

CP reduces safety risks by controlling pipeline corrosion rates thus reducing the frequency of corrosion-related incidents. Minimizing corrosion has the additional benefits of reducing reconstruction costs from pipeline incidents, reducing risk to property, and the potential benefit of improved service reliability. SDG&E exceeds the minimum safety requirements for CP prescribed by 49 CFR 191 Subpart I, which includes monitoring of CP areas, remediation of CP areas that are out of tolerance, and preventative installations to avoid areas out of tolerance.

b. Elements of the Bow Tie Addressed

Cathodic protection addresses the following elements of the bow tie:

i. [DT.1] – Corrosion

***ii. [DT.4] – Pipe, weld, or* joint failure**

c. RSE Inputs and Basis

Scope	The cathodically protected distribution system running at a pressure of 60 psi or lower.
Effectiveness	Per internal SME assessment, we assume 95% effectiveness. Based on SME analysis, vintage steel segments that are being replaced are 13.2 times more likely to have an incident occur than modern plastic pipe over a lifecycle. We assume a similar deterioration proportion were cathodic protection discontinued.
Risk Reduction	**Safety**: Based on an assessment of PHMSA data, 41 natural gas incidents occurred at SoCalGas and SDG&E starting in 2010. 1 out of the 41 SoCalGas and SDG&E incident samples were corrosion-related events (2%). Using these assumptions, this control tranche could improve safety risk by up to 31% of the current residual risk. **Reliability:** Using these assumptions, this control tranche could improve reliability risk by up to 31% of the current residual risk. **Financial:** Using these assumptions, this control tranche could improve financial risk by up to 31% of the current residual risk.

d. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**101**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.57	**251.78**	593.78
Post-Mitigation	**LoRE**		**131.89**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	60.81	**328.78**	775.40
	RSE	0.77	**4.16**	9.81

2. SDG&E-6-C2: Assessment of Buried Piping in Vaults

a. Qualitative Description of Risk Reduction Benefits

SDG&E has pipeline buried in vaults that may be corroded by above ground facilities and pitting of below ground piping. This activity will identify the locations vaults containing medium and high-pressure facilities and remediate locations where corrosion is found.

Distribution Operations manages the implementation of the work associated with this control with engineering oversight from the Pipeline Integrity group. The assessment and remediation of buried piping in vaults is preventative in nature and is intended to reduce or eliminate conditions that might lead to an incident. These activities increase public and employee safety by mitigating various risk sources, primarily corrosion and degradation of equipment.

b. Elements of the Bow Tie Addressed

Assessing buried piping in vaults addresses the following elements of the bow tie:

i. ***[DT.1] – Corrosion***

ii. ***[DT.2] – Natural forces***

iii. ***[DT.3] – Outside Forces***

iv. ***[DT.4] – Pipe, weld, or joint failure***

c. RSE Inputs and Basis

Scope	There are 289 vaults that will be assessed and repaired, if necessary.
Effectiveness	Per internal SME assessment, the effectiveness of these activities is 95%. It is also assumed that all vaults have the same level of risk.
Risk Reduction	**Safety**: According to PHMSA data, 2 out of 426 significant events were associated with vaults at the national level. Using these assumptions, this control tranche could improve safety risk by up to 0.3%. **Reliability**: Using these assumptions, this control tranche could improve reliability risk by up to 0.3%. **Financial**: Using these assumptions, this control tranche could improve financial risk by up to 0.3%.

d. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**101**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.57	**251.78**	593.78
Post-Mitigation	**LoRE**		**101.33**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.72	**252.61**	595.75
	RSE	0.15	**0.81**	1.91

3. SDG&E-6-C3: Regulator & Valve Inspection and Maintenance

a. Qualitative Description of Risk Reduction Benefits

Regulator stations reduce the pressure of gas entering the distribution system from high-pressure pipelines to provide a lower pressure used on the distribution pipeline system. A failure of a regulator station due to mechanical failure, corrosion, contamination, or other cause could result in over-pressurization of the gas distribution system, which may compromise the integrity of medium-pressure pipelines and/or jeopardize public safety. Regulator maintenance activities are cyclical in nature and are conducted in accordance with 49 CFR § 192 Subpart M which require the annual inspection and maintenance of all of the approximately 500 regulator stations operated by SDG&E in order to maintain these devices in good mechanical condition.

Regulator maintenance activities are preventative in nature and are intended to reduce or eliminate conditions that might lead to an incident by detecting and addressing emergent equipment issues. In addition to addressing emerging issues, regulator maintenance activities provide an opportunity for SDG&E to identify equipment that is at risk of deterioration in the future and procure equipment to address said equipment during the next inspection cycle. Distribution Operations manages the implementation of the work associated with this control with engineering oversight from the Pipeline Integrity group.

Regulator maintenance increases public and employee safety by mitigating various risk sources, including corrosion and degradation (for example). When a regulator station is replaced as part of regulator maintenance, there are additional benefits that improve safety and reliability. The design of new regulator stations includes dual-run feeds which provide redundancy, and there is a financial benefit with the installation of new regulator stations due to ease of maintenance. Modern regulator stations have more monitoring points that feed into the Distribution Operations Control Center (DOCC)[38] which improves response time in the event of an incident. Additionally, when maintenance is required, parts are more readily available compared to older model regulator stations. Minimizing safety threats also provides additional benefits of reducing reconstruction costs from equipment failure, reducing risk to property, and the potential benefit of improved service reliability.

Valves provide the ability to control the pressure and flow of gas in SDG&E's system. Valves are controlled locally or remotely from a central control system. Valve inspections and maintenance validate that the valves within the system operate at optimum effectiveness by detecting and addressing emerging equipment issues. Valve inspections and maintenance are conducted in accordance with 49 CFR § 192 Subpart M, which require that each valve must be checked and serviced at intervals not exceeding 15 months, but at least once each calendar year. Given the mandated requirement to complete valve inspections and maintenance, the

[38] The DOCC is not included in the SDG&E Medium Pressure Incident Chapter. The forecasted capital costs (and Control description) have been included in the SoCalGas Medium Pressure Incident Chapter because it is anticipated to be a SoCalGas owned asset that will also be used by SDG&E. Costs will get allocated to SDG&E through the Shared Asset Billing process.

management of this control is cyclical in nature. Distribution Operations manages the implementation of the work associated with this control with engineering oversight from the Pipeline Integrity group.

Valves that are operating at optimum effectiveness enhance public safety by providing SDG&E with the ability to control the pressure and flow of gas in the system. Valve inspections and maintenance activities are preventative in nature and are intended to reduce or eliminate conditions that might lead to an incident. Valve inspections and maintenance increase public and employee safety by mitigating various risk sources, primarily corrosion and degradation. Minimizing safety threats has the additional benefits of reducing reconstruction costs from equipment failure, reducing risk to property, and the potential benefit of improved service reliability.

b. Elements of the Bow Tie Addressed

Regulator and Valve Inspection and Maintenance addresses the following elements of the bow tie:

i. [DT.1] – Corrosion

ii. [DT.2] – Natural forces

iii. [DT.3] – Outside Forces

iv. [DT.5] – Equipment Failure

v. [DT.6] – Incorrect Operations

4. SDG&E-6-C4: Plastic Pipe Replacement

a. Qualitative Description of Risk Reduction Benefits

The Vintage Integrity Plastic Plan (VIPP) falls within the umbrella of the Distribution Risk Evaluation and Monitoring System. SDG&E utilizes a relative risk model in order to rank and prioritize the risk for plastic pipeline. Starting in 2019, SDG&E plans to target 46 miles of mains and associated services for replacement above and beyond routine replacements in accordance with DIMP regulations for the replacement of vintage plastic as part of the Vintage Integrity Plastic Plan (VIPP). VIPP is conducted in accordance with 49 CFR Part 192. Distribution Operations manages the implementation of the work associated with this control with engineering oversight from the Pipeline Integrity group.

Significant reductions in safety risks are achieved with the replacement of vintage plastic (and steel pipeline with new plastic pipe). Newly installed plastic pipe has a very low leak rate and is not subject to corrosion. A newly installed pipeline has a lower residual risk level and its risk rises on a different path than that of vintage pipe. The difference in deterioration paths is the performance benefit derived from reconstruction. This directly translates into a decrease in safety risk. Minimizing safety threats has the additional benefits of reducing reconstruction costs from equipment failure, reducing risk to property, and the potential benefit of improved service reliability over time.

b. Elements of the Bow Tie Addressed

The Plastic Pipe Replacement program addresses the following elements of the bow tie:

i. [DT.2] – Natural forces

ii. [DT.3] – Outside Forces

iii. [DT.4] – Pipe, weld, or joint failure

iv. [DT.5] – Equipment Failure

v. [DT.6] – Incorrect Operations

c. RSE Inputs and Basis

Scope	SDG&E will be replacing 73 miles of vintage plastic pipe out of 1,239 miles (6%).
Effectiveness	Per internal SME assessment, we assume 100% effectiveness because the failure rate of modern PE plastic pipe is very low. Based on SME analysis, the plastic segments being replaced are 12.5 times more likely for an incident to occur than modern plastic pipe over a lifecycle.
Risk Reduction	**Safety**: Based on an assessment of PHMSA data, 18 out of 426 nationwide significant events were associated with plastic Aldyl-A pipe. Using these assumptions, this mitigation could improve safety risk by up to 3%. **Reliability**: Using these assumptions, this control tranche could improve reliability risk by up to 3%. **Financial**: Using these assumptions, this control tranche could improve financial risk by up to 3%.

d. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**101**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.57	**251.78**	593.78
Post-Mitigation	**LoRE**		**104.14**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	48.02	**259.61**	612.26
	RSE	0.24	**1.28**	3.03

5. SDG&E-6-C5: Leak Repair

a. Qualitative Description of Risk Reduction Benefits

SDG&E proactively surveys its gas distribution system for leakage at frequencies determined based on the pipe material involved, the operating pressure, whether the pipe is under cathodic protection, and the proximity of the pipe to various population densities as prescribed within CFR § 192.723. Leak repair activities are preventative in nature and are intended to reduce or eliminate conditions that might lead to an incident by detecting and addressing emergent issues. Leak repairs increase public and employee safety by mitigating various risk sources. Safety risks are proactively reduced on a regular basis as result of the continual, ongoing nature of leak repair activities. Minimizing safety threats has the additional benefits of reducing reconstruction costs from equipment failure, reducing risk to property, and the potential benefit of improved service reliability.

b. Elements of the Bow Tie Addressed

The Leak Repair program addresses the following elements of the bow tie:

i. ***[DT.1] – Corrosion***

ii. ***[DT.2] – Natural forces***

iii. ***[DT.3] – Outside Forces***

iv. ***[DT.5] – Equipment Failure***

6. SDG&E -6-C6: Pipeline Monitoring: Leak Mitigation, Bridge & Span Inspections, Unstable Earth Inspections, Pipeline Patrol

a. Qualitative Description of Risk Reduction Benefits

SDG&E conducts pipeline monitoring and inspection activities to proactively target risk factors before operation and safety issues arise. These monitoring activities include bridge and span inspections, unstable earth inspections, pipeline patrols, and leak surveys. These inspections are critical since they are intended to observe assets over time to determine if abnormal conditions exist prior to becoming a concern. For example, a span that no longer is coated appropriately due to recent weather conditions can be identified for re-coating before corrosion begins that could lead to a leak. The leak survey monitoring identifies leaks that require repair.

SDG&E will conduct pipeline monitoring and inspections to proactively target risk factors before operational and safety issues arise. Pipeline monitoring activities include bridge and span inspections, unstable earth inspections, pipeline patrols, and leak surveys. Distribution pipeline spans, pipe supported on bridges, aboveground (or jacketed) pipelines, and all other exposed pipeline (as installed) are inspected for atmospheric corrosion or abnormal conditions: Onshore, at least once every 2 calendar years, but with intervals not exceeding 27 months. Offshore, at least once each calendar year, but with intervals not exceeding 15 months. SDG&E will proactively survey its gas distribution system for leakage at frequencies determined based on the pipe material involved, the operating pressure, whether the pipe is under cathodic protection, and the proximity of the pipe to various population densities as prescribed within CFR § 192.723. Distribution Operations will manage the implementation of the work associated with this control with engineering oversight.

Pipeline monitoring activities are preventative in nature and should reduce or eliminate conditions that might lead to an incident by detecting and addressing emergent issues. Pipeline monitoring activities should increase public and employee safety by mitigating various risk sources, including corrosion and degradation, for example. Safety risks will be proactively reduced on a regular basis as result of the continual, ongoing nature of pipeline monitoring activities. Minimizing safety threats has the additional benefits of reducing reconstruction costs

from equipment failure, reducing risk to property, and the potential benefit of improved service reliability.

b. Elements of the Bow Tie Addressed

Pipeline Monitoring addresses the following elements of the bow tie:

i. [DT.1] – Corrosion

ii. [DT.2] – Natural forces

iii. [DT.3] – Outside Forces

iv. [DT.5] – Equipment Failure

7. SDG&E-6-C7: Utility Conflict Review (Right of Way)

a. Qualitative Description of Risk Reduction Benefits

Utility Conflict Review (Right of Way) includes managing property rights that allow for the access, operation, and maintenance of SDG&E's pipeline infrastructure on public and private properties, as well as the maintenance of access roads to allow pipelines to be accessed in a timely manner. Gas Engineering and the Land and Right-of-Way group manage the implementation of the work associated with this control.

Utility Conflict Review (Right of Way) activities are preventative in nature and are intended to increase pipeline visibility and accessibility through vegetation and land management surrounding the immediate vicinity of SDG&E's pipelines. This allows pipelines to be accessed in a timely manner in this event of an incident which then may minimize third-party pipeline damages and reduce wildfire damage. This control increases the public and employee safety and reduces the risk of property damage when an incident does occur.

b. Elements of the Bow Tie Addressed

Right of Way addresses the following elements of the bow tie:

i. [DT.2] – Natural forces

ii. [DT.3] – Outside forces

8. SDG&E-6-C8: Meter Inspection and Maintenance

a. Qualitative Description of Risk Reduction Benefits

The medium and large customers MSAs require routine maintenance of the meters, regulators, and other components to meet customers' capacity requirements and to measure gas volume accurately. MSA inspection and maintenance activities are conducted in accordance with General Order 58-A which requires routine maintenance on medium and large MSAs. Given the mandated requirement to conduct MSA inspections and maintenance, the management of this control is cyclical in nature.

MSA inspection and maintenance activities are preventative in nature and are intended to reduce or eliminate conditions that might lead to an incident by detecting and addressing emergent equipment issues. In addition to addressing emergent issues, MSA inspection and maintenance activities provide an opportunity for SDG&E to identify equipment that is at risk of deterioration in the future and procure equipment to remediate or replace that equipment during the next inspection cycle. Distribution Operations manages the implementation of the work associated with this control with engineering oversight from the Pipeline Integrity group.

MSA inspection and maintenance activities increase public and employee safety by mitigating various risk sources, including corrosion and degradation, for example. Minimizing safety threats has the additional benefits of reducing reconstruction costs from equipment failure, reducing risk to property, and the potential benefit of improved service reliability.

b. Elements of the Bow Tie Addressed

Meter Inspection and Maintenance addresses the following elements of the bow tie:

i. ***[DT.1] – Corrosion***
ii. ***[DT.2] – Natural forces***
iii. ***[DT.3] – Outside Forces***
iv. ***[DT.5] – Equipment Failure***
v. ***[DT.6] – Incorrect Operations***

9. SDG&E-6-M1: Early Vintage Program (Pipeline)

a. Qualitative Description of Risk Reduction Benefits

SDG&E's Early Vintage Program (Pipeline) consists of Early Vintage Threaded Main Replacement, Early Vintage Steel Replacement, Oil Drip Removal, Leak History Replacement. The Early Vintage Program increases public safety by mitigating risk associated with early vintage equipment before operational and safety issues arise. The risk reduction associated with each mitigation tranche is further described below:

i. SDG&E-6-M1-T1: Early Vintage Threaded Main Replacement:

There is a reduction in safety risks with the replacement of early vintage threaded mains. Eliminating this classification of pipe and replacing it with state-of-the-art polyethylene pipe, the threat of corrosion and threaded joint failure will be eliminated. Polyethylene pipe also is also much more flexible and therefore less susceptible to failure during a seismic event. Minimizing safety threats has the additional benefits of reducing reconstruction costs from equipment failure, reducing risk to property, and the potential benefit of improved service reliability over time.

ii. SDG&E-6-M1-T2: Early Vintage Steel Replacement:

Significant reductions in safety risks are achieved with the replacement of vintage steel pipeline with new plastic pipe. Newly installed plastic pipe has a very low leak rate and is not subject to corrosion. A newly installed pipeline has a lower residual risk level and its risk rises on a different path than that of vintage pipe. The difference in deterioration paths is the performance benefit derived from reconstruction. This directly translates into a decrease in safety risk. Minimizing safety threats has the additional benefits of reducing reconstruction costs from equipment failure, reducing risk to property, and the potential benefit of improved service reliability over time.

iii. SDG&E-6-M1-T3: Early Vintage Oil Drip Removal:

The removal of the oil drip facilities will eliminate any threat that they may be damaged due to the inability to properly locate and mark these features. The ones that will remain in service will have detailed dimensioning of the pipeline features put into the GIS system in which the Locators rely on to accurately mark-out. This will eliminate future pipeline damage events.

b. Elements of the Bow Tie Addressed

The Early Vintage Program (Pipeline) addresses the following elements of the bow tie:

i. [DT.1] – Corrosion

ii. [DT.2] – Natural forces

iii. [DT.3] – Outside Forces

iv. [DT.4] – Pipe, weld, or joint failure

c. RSE Inputs and Basis

i. SDG&E-6-M1-T1: Early Vintage Threaded Main Replacement

Scope	45 miles of threaded main that will be replaced as part of the Early Vintage Program (Pipeline).
Effectiveness	Per internal SME assessment, we assume 100% effectiveness because failure rate of replacement PE plastic pipe is very low. Based on SME analysis, steel segments that are being replaced are 13.2 times more likely for an incident to occur than modern plastic pipe over a lifecycle.
Risk Reduction	**Safety**: 1 out of 41 SoCalGas and SDG&E incidents are associated with steel mains. Based on PHMSA data assessment, 55% of the risk is attributed to early vintage steel, 17.6% to threaded main, and the rest to other pipe types. Using these assumptions, this mitigation tranche could improve safety risk by up to 2%. **Reliability**: Using these assumptions, this mitigation tranche could improve reliability risk by up to 2%. **Financial**: Using these assumptions, this mitigation tranche could improve financial risk by up to 2%.

ii. SDG&E-6-M1-T2: Early Vintage Steel Replacement

Scope	90 miles of early vintage steel will be replaced as part of the Early Vintage Program (Pipeline).
Effectiveness	Per internal SME assessment, we assume 100% effectiveness because the failure rate of replacement PE plastic pipe is very low. Based on SME analysis, steel segments that are being replaced are 13.2 times more likely for an incident to occur than modern plastic pipe over a lifecycle.
Risk Reduction	**Safety**: 1 out of 41 SoCalGas and SDG&E incidents are associated with steel mains. Based on PHMSA data assessment, 55% of the risk is attributed to early vintage steel, 17.6% to threaded mains, and the rest to

	other pipe types. Using these assumptions, this mitigation tranche could improve safety risk by up to 8%. **Reliability**: Using these assumptions, this mitigation tranche could improve reliability risk by up to 8%. **Financial**: Using these assumptions, this mitigation tranche could improve financial risk by up to 8%.

iii. SDG&E-6-M1-T3: Early Vintage Oil Drip Removal

Scope	107 locations will be verified and assessed for oil drip piping removal as part of the Early Vintage Program (Pipeline).
Effectiveness	Per internal SME assessment, the effectiveness of these activities is 90%.
Risk Reduction	**Safety**: The 2 recorded oil drip piping events out of 43 incidents were not significant, so their consequence is deflated by 50%. Using these assumptions, this mitigation could improve safety risk by up to 2%. **Reliability**: Using these assumptions, this mitigation tranche could improve reliability risk by up to 2%. **Financial**: Using these assumptions, this mitigation tranche could improve financial risk by up to 2%.

d. Summary of Results

i. SDG&E-6-M1-T1: Early Vintage Threaded Main Replacement

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**101**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.57	**251.78**	593.78
Post-Mitigation	**LoRE**		**98.94**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	45.62	**246.63**	581.65
	RSE	1.20	**6.51**	15.35

ii. SDG&E-6-M1-T2: Early Vintage Steel Replacement

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**101**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.57	**251.78**	593.78
Post-Mitigation	**LoRE**		**93.37**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	43.05	**232.76**	548.94
	RSE	5.09	**27.53**	64.92

iii. SDG&E-6-M1-T3: Early Vintage Oil Drip Removal

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**101**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.57	**251.78**	593.78
Post-Mitigation	**LoRE**		**98.89**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	45.60	**246.51**	581.36
	RSE	0.98	**5.28**	12.46

10. SDG&E-6-M2: Early Vintage Program (Fitting)

a. Qualitative Description of Risk Reduction Benefits

SDG&E's Early Vintage Program (Fitting) consists of: Dresser Mechanical Coupling Removal and High/Medium Valve Separation Removal. The Early Vintage Program increases public safety by mitigating risk associated with early vintage equipment before operational and safety issues arise. The risk reduction associated with each mitigation tranche is further described below:

i. SDG&E-6-M2-T1: Dresser Mechanical Coupling Removal

The Early Vintage Program (Fittings) consists of evaluating locations where Dresser mechanical couplings exist, excavating, removing the Dresser mechanical couplings, and

welding pipes back together to reduce the risk of pipe separation and rupture in the event of a land movement. Distribution Operations manages the implementation of the work associated with this mitigation with engineering oversight from the Pipeline Integrity group. The pace of the work associated with this program relies on the ability of SDG&E to procure permits in a timely manner.

The Early Vintage Program (Fittings) is preventative in nature and is intended to eliminate conditions that might lead to an incident. This program reduces the frequency of gas leak incidents and eliminates the possibility of a pipeline fitted with a Dresser mechanical coupling rupturing as a result of land movement from seismic activity or third-party construction activity near the pipeline, for example. Minimizing safety threats has the additional benefits of reducing risk to property and the potential benefit of improved service reliability.

ii. SDG&E-6-M2-T2: High/Medium Valve Separation Removal

There is a reduction in safety risks with high/medium valve separation removal. Minimizing safety threats has the additional benefits of reducing reconstruction costs from equipment failure, reducing risk to property, and the potential benefit of improved service reliability over time.

b. Elements of the Bow Tie Addressed

The Early Vintage Program (Fitting) addresses the following elements of the bow tie:

i. [DT.1] – Corrosion

ii. [DT.2] – Natural forces

iii. [DT.3] – Outside Forces

iv. [DT.5] – Equipment Failure

c. RSE Inputs and Basis

i. SDG&E-6-M2-T1: Dresser Mechanical Coupling Removal

Scope	60 locations will be addressed as part of the Early Vintage Program (Fitting)
Effectiveness	Per internal SME assessment, the assumed effectiveness is 75%.

Risk Reduction	**Safety**: 2 significant events out of 426 events at the national level are associated with Dresser mechanical couplings. Using these assumptions, this mitigation tranche could improve safety risk by up to 0.1%. **Reliability**: Using these assumptions, this mitigation tranche could improve reliability risk by up to 0.1%. **Financial**: Using these assumptions, this mitigation tranche could improve financial risk by up to 0.1%.

ii. SDG&E-6-M2-T2: High/Medium Valve Separation Removal

Scope	Removal of valves at 130 interfaces.
Effectiveness	Per SME estimate, we assume 100% effectiveness. These removals eliminate the threat of bringing higher pressure gas into lower pressure systems.
Risk Reduction	**Safety**: nationwide, 2 out of a sample of 765 significant incidents can be attributed to valves based on data reported to PHMSA since year 2010. For analysis purposes, this risk is split evenly between reliability causes and inadvertent openings. Using these assumptions, this mitigation could improve safety risk by up to 0.1%. **Reliability:** Using these assumptions, this mitigation could improve safety risk by up to 0.1%. **Financial:** Using these assumptions, this mitigation could improve safety risk by up to 0.1%.

d. Summary of Results

i. SDG&E-6-M2-T1: Dresser Mechanical Coupling Removal

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**101**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.57	**251.78**	593.78
Post-Mitigation	**LoRE**		**100.88**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.52	**251.49**	593.10
	RSE	0.05	**0.28**	0.65

ii. SDG&E-6-M2-T2: High/Medium Valve Separation Removal

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**101**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.57	**251.78**	593.78
Post-Mitigation	**LoRE**		**100.87**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.51	**251.45**	593.01
	RSE	0.45	**2.45**	5.77

VII. SUMMARY OF RISK MITIGATION PLAN RESULTS

As discussed, the existing controls outlined within this Chapter will continue and certain controls will increase in scope or at an accelerated pace. However, as a diligent operator the controls will be monitored to determine if any adjustments are needed during the implementation period. The programs could be influenced as additional information is gathered or understanding of risk and controls relationship changes. Should controls need to change, consideration will be given to available technology, labor resources, planning and construction lead time, compliance requirements, and operational and execution considerations.

The table below provides a summary of the Risk Mitigation Plan, including controls and forecasted mitigation activities, associated costs, the RSEs by tranche. SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. Thus, the costs shown in the table were estimated using assumptions provided by SMEs and available accounting data.

Table 7: Risk Mitigation Plan Overview[39]
(Direct 2018 $000)[40]

ID	Mitigation/Control	Tranche	2018 Baseline Capital[41]	2018 Baseline O&M	2020-2022 Capital[42]	2022 O&M	Total[43]	RSE[44]
SDG&E-6-C1	Cathodic Protection	T1	12,000	1,600	11,000 – 15,000	1,400 – 1,800	12,000 – 17,000	0.77 – 9.81
SDG&E-6-C2	Assessment of Buried Piping in Vaults	T1	0	0	21,000 – 27,000	0	21,000 – 27,000	0.15 – 1.91
SDG&E-6-C3	Regulator & Valve Inspection and Maintenance	T1	0	1,600	0	1,400 – 1,800	1,400 – 1,800	-
SDG&E-6-C4	Plastic Pipe Replacement	T1	34,000	0	150,000 – 200,000	0	150,000 – 200,000	0.24 – 3.03
SDG&E-6-C5	Leak Repair	T1	7,500	1,200	21,000 – 26,000	1,100 – 1,400	22,000 – 27,000	-
SDG&E-6-C6	Pipeline Monitoring: Leak Mitigation, Bridge & Span Inspections, Unstable Earth	T1	0	2,100	0	1,800 – 2,300	1,800 – 2,300	-

[39] 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.

[40] 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.

[41] 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.

[42] 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.

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

[44] The RSE ranges are further discussed in Chapter RAMP-C and in Section VI above.

	Inspections, Pipeline Patrol.							
SDG&E-6-C7	Utility Conflict Review (Right of Way)	T1	570	51	1,100 – 1,400	58 - 74	1,200 – 1,500	-
SDG&E-6-C8	Meter Inspection & Maintenance	T1	0	110	0	170-220	170-220	-
SDG&E-6-M1	Early Vintage Program (Pipeline) - Threaded Main Replacement	T1	0	0	20,000-25,000	0	20,000-25,000	1.20 – 15.35
SDG&E-6-M1	Early Vintage Program (Pipeline) - Steel Replacement	T2	1,500	0	17,000 – 22,000	0	17,000 – 22,000	5.09 – 64.92
SDG&E-6-M1	Early Vintage Program (Pipeline) - Oil Drip Removal	T3	0	0	25,000 – 32,000	0	25,000 – 32,000	0.98 – 12.46
SDG&E-6-M2	Early Vintage Program (Fittings) - Dresser Mechanical Coupling Removal	T1	0	0	21,000 – 27,000	0	21,000 – 27,000	0.05 – 0.65
SDG&E-6-M2	Early Vintage Program (Fittings) - High/Medium Valve Separation Removal	T2	0	0	3,200 – 4,000	0	3,200 – 4,000	0.45 – 5.77
TOTAL COST			**56,000**	**6,700**	**290,000 – 380,000**	**5,900 – 7,600**	**300,000 – 390,000**	**-**

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.

In addition, as discussed in Section VI above, the table below summarizes the activities for which an RSE is not provided:

Table 8: Summary of RSE Exclusions

Control ID	Control Name	Reason for No RSE Calculation
SDG&E-6-C3	Regulator & Valve Inspection and Maintenance	Mandated activity per 49 CFR 192 Subpart H
SDG&E-6-C5	Leak Repair	Mandated activity per 49 CFR § 192.720 and § 192.723
SDG&E-6-C6	Pipeline Monitoring: Leak Mitigation, Bridge & Span Inspections, Unstable Earth Inspections, Pipeline Patrol	Mandated activity per 49 CFR § 192.705, § 192.722, § 192.723 and § 192.935
SDG&E-6-C7	Utility Conflict Review (Right of Way)	Mandated activity per 49 CFR 192 § 192.705
SDG&E-6-C8	Meter Inspection & Maintenance	Mandated activity per 49 CFR 192 Subpart H

VIII. ALTERNATIVE MITIGATION PLAN ANALYSIS

Pursuant to D.14-12-025 and D.16-08-018, SDG&E considered alternatives to the described mitigations for the Medium Pressure Gas Pipeline Incident 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 Mitigation Plan also took into account modifications to the plan and constraints, including but not limited to operational, compliance and resource constraints.

A. SDG&E-6-A1 – Assessment and Replacement of 10-year Cycle Cathodically Protected Services (CP10s)

SDG&E considered replacing the 58,083 CP10 service rather than continuing to monitor, inspect and maintain them on ten-year cycle. CP10 services are separately protected service lines that are surveyed on a sampling basis where at least 10% of system inventory are sampled

each year, so that the entire system is tested in a 10-year period. However, due to the number of CP10 services in the system, a program targeting complete replacement of CP10 services would exceed $350 million and likely take many decades to complete. As complete replacement is not feasible, further evaluation of CP10 services is required to evaluate and quantify the risk reduction benefits, potentially developing a risk based targeted in replacement program. In the interim CP10s will be replaced based on performance history and current protection levels.

1. RSE Inputs and Basis

Scope	Per SME input, scope is 2.8% or a replacement of 150 units out of 5,400.
Effectiveness	Per internal SME assessment, the effectiveness of this mitigation is 95%.
Risk Reduction	Based on historical information reported to PHMSA, risk addressed is 2%. Using these assumptions, this mitigation could improve storage safety, reliability, and financial risk by up to 0.1%.

2. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**101**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.57	**251.78**	593.78
Post-Mitigation	**LoRE**		**100.93**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.54	**251.61**	593.40
	RSE	0.51	**2.75**	6.49

B. SDG&E-6-A2 - Soil Sampling Program

SDG&E considered expanding its collection of soil property information. SDG&E collects soil properties (rocky, clay, sandy) during excavations and repairs along its pipelines. These soil properties are an element within the relative risk models used for prioritization process of the vintage replacement program for plastic. Expanding the collection of soil properties beyond leak repair excavations may allow SDG&E to further refine its replacement efforts. The cost estimate of sampling the 5,907 miles of distribution pipe is $12.2 million; on average, 14 samples per day will be tested at intervals of 2 samples per mile. SDG&E has not

initiated an expanded soil sampling program since the potential benefit is related to the maturing of the risk assessment. As the risk assessment continues to mature for the corrosion threat the benefit of additional information can be better understood. In the interim SDG&E will be researching available data sets and determining the benefit of additional granularity.

1. RSE Inputs and Basis

Scope	Assuming 100% of soil would be sampled, as a one-time effort: once the soil is sampled, it does not need to be resampled.
Effectiveness	Per internal SME assessment, effectiveness of having additional data for making better pipe replacement decisions will be minimal, at 1%.[45]
Risk Reduction	Per SME guidance, risk addressed is 17%, same as the SDG&E plastic DREAMS program. Using these assumptions, this mitigation could improve storage safety, reliability, and financial risk by up to 0.2%.

2. Summary of Results

		Low Alternative	Single Point	High Alternative
Pre-Mitigation	**LoRE**		**101**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.57	**251.78**	593.78
Post-Mitigation	**LoRE**		**100.83**	
	CoRE	0.46	**2.49**	5.88
	Risk Score	46.49	**251.35**	592.77
	RSE	0.01	**0.03**	0.08

[45] Given the need for more mature data for this alternative, the RSEs calculated here are particularly speculative.

Table 9: Alternative Mitigation Summary
(Direct 2018 $000)[46]

ID	Mitigation	2020-2022 Capital[47]	2022 O&M	Total[48]	RSE[49]
SDG&E-6-A1	Assessment and Replacement of 10-year Cycle Cathodically Protected Services (CP10s)	1,500 – 2,000	0	1,500 – 2,000	0.51 – 6.49
SDG&E-6-A2	Soil Sampling Program	0	2,200 – 2,900	2,200 – 2,900	0.01 – 0.08

[46] 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.

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

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

[49] The RSE ranges are further discussed in Chapter RAMP-C and in Section VI above.

APPENDIX A: SUMMARY OF ELEMENTS OF RISK BOW TIE ADDRESSED

ID	Control / Mitigation Name	Elements of the Risk Bow Tie Addressed
SDG&E-6-C1	Cathodic Protection	DT.1, DT.4
SDG&E-6-C2	Assessment of Buried Piping in Vaults	DT.1, DT.2, DT.3, DT.4
SDG&E-6-C3	Regulator & Valve Inspection and Maintenance	DT.1, DT.2, DT.3, DT.5, DT.6
SDG&E-6-C4	Plastic Pipe Replacement	DT.1, DT.2, DT.3, DT.4, DT.5, DT.7
SDG&E-6-C5	Leak Repair	DT.1, DT.2, DT.3, DT.5
SDG&E-6-C6	Pipeline Monitoring: Leak Mitigation, Bridge & Span Inspections, Unstable Earth Inspections, Pipeline Patrol.	DT.1, DT.2, DT.3, DT.5
SDG&E-6-C7	Utility Conflict Review (Right of Way)	DT.2, DT.3
SDG&E-6-C8	Meter Inspection and Maintenance	DT.1, DT.2, DT.3, DT.5, DT.6
SDG&E-6-M1-T1	Early Vintage Program (Pipeline): Early Vintage Threaded Main Replacement	DT.1, DT.2, DT.3, DT.4
SDG&E-6-M1-T2	Early Vintage Program (Pipeline): Early Vintage Steel Replacement	DT.1, DT.2, DT.3, DT.4
SDG&E-6-M1-T3	Early Vintage Program (Pipeline): Oil Drip Removal	DT.1, DT.2, DT.3, DT.4
SDG&E-6-M2-T1	Early Vintage Program (Fittings): Dresser Mechanical Coupling Removal	DT.1, DT.2, DT.3, DT.5
SDG&E-6-M2-T2	Early Vintage Program (Fittings): High/Medium Valve Separation Removal	DT.1, DT.2, DT.3, DT.5