2025 Risk Assessment Mitigation Phase

(Chapter SCG-Risk-4)

Underground Gas Storage System

May 15, 2025

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I. INTRODUCTION

The purpose of this chapter is to present Southern California Gas Company's (SoCalGas or Company) risk control and mitigation plan for Underground Gas Storage System risk (Underground Storage Risk). This chapter contains information and analysis for this risk that meets the requirements of the California Public Utilities Commission's (Commission or CPUC) Risk-Based Decision-Making Framework (RDF),[1] including the requirements adopted in Decision (D.) 22-12-027 (Phase 2 Decision) and D.24-05-064 (Phase 3 Decision). Although this risk does not meet the minimum requirements for mandatory inclusion under the RDF, this risk is included in the 2025 RAMP Report in response to stakeholder input received during and following SoCalGas's Pre-Filing Workshop on December 17, 2024. This risk chapter describes the basis for the selection of Underground Storage Risk, the controls and/or mitigations put forth to reduce the likelihood or consequence of this risk, a discussion of alternative mitigations considered but not selected, and a graphic to show historical progress. This chapter presents cost and unit forecasts for the risk-mitigating activities, but it does not request funding. Any funding requests for this risk will be made through the Company's Test Year (TY) 2028 General Rate Case (GRC) application. Finally, this chapter describes the methods applied to estimate the risk's monetized, pre-mitigated risk, the estimated risk-reduction benefits of each included control and mitigation, and the calculation of Cost-Benefit Ratios (CBRs) for each control and mitigation consistent with the method and process prescribed for in the RDF.

A. Risk Definition and Overview

1. Risk Definition

For the purposes of this RAMP Report, SoCalGas's Underground Storage Risk is defined as "the risk of failure of an underground gas storage well that results in serious injuries, fatalities, and/or damage to the infrastructure." This chapter considers risks associated with the following storage facility components: storage wells and reservoirs, including casing, tubing, and tree/wellhead.

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[1] As discussed in Volume 1, Chapter RAMP-1, the RDF Framework broadly refers to the recent modifications to the Commission's Rate Case Plan adopted in Rulemaking (R.) 13-11-006, Safety Model Assessment Proceeding A.15-05-002 et al. (cons.), and R.20-07-013 (the Risk OIR), including D.24-05-064, Appendix A.

Certain controls and mitigations presented in this chapter are subject to compliance mandates beyond RDF requirements, such as those from the California Air Resources Board (CARB), the California Geologic Energy Management Division (CalGEM), the United States Department of Transportation's (DOT) Pipeline and Hazardous Materials and Safety Administration PHMSA, including but not limited to subparts of Rule 49 of the Code of Federal Regulation (CFR) and local air quality management districts. A list of compliance requirements applicable to Underground Gas Storage risk is provided in Attachment A. Certain mitigation programs have value beyond the estimated risk reduction calculated under the RDF, such as enhancement of operations, and/or preparing for future capacity needs (such as driven by electrification, energy resilience, or climate impacts).

2. Risk Overview

Underground gas storage assets are a necessary and critical component of California's reliable energy delivery infrastructure, since approximately 90% of natural gas delivered throughout SoCalGas's service territory is imported. Natural gas moves slowly, at approximately 25 miles per hour, so it is vital to have storage assets locally available to support immediate demand. As a supplement to pipeline gas volumes, underground gas storage supports over 21 million customers and approximately half of the electric generation in SoCalGas's territory. SoCalGas operates four underground gas storage facilities: Aliso Canyon, La Goleta, Honor Rancho, and Playa del Rey, with a combined working capacity of approximately 119.5 Bcf and 177 active wells.[2] Active wells include injection/withdrawal, observation, oil production, injection/disposal, gas migration return, relief, and liquid removal.

- **Aliso Canyon** is in Northern Los Angeles County. It is the largest gas storage field that delivers natural gas into the Los Angeles Basin and has a storage reservoir design capacity of 86 Bcf.[3] The current Aliso Canyon storage working capacity is about 68.6 Bcf.[4] Aliso Canyon has 92 active wells and a current

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[2] The volumetric capacity of a natural gas storage field reservoir is measured in units of billion cubic feet (Bcf).

[3] Pipeline and Hazardous Materials Safety Administration (PHMSA), Underground Natural Gas Storage Facility Annual report for Calendar Year 2018 – Supplemental Report (May 20, 2019).

[4] *See* D.20-11-044, Decision Setting the Interim Range of Aliso Canyon Storage Capacity at Zero to 34 Billion Cubic Feet.

maximum withdrawal capability of approximately 1.86 Bcf per day.[5] The facility's surface equipment has a maximum withdrawal design capacity of 1.95 Bcf per day.

- **Honor Rancho** is also in Northern Los Angeles County, about ten miles north of Aliso Canyon, and also delivers natural gas into the Los Angeles Basin. Honor Rancho has a storage reservoir design capacity of 27 Bcf and a working capacity is 27 Bcf. Honor Rancho has 35 active wells and a current maximum withdrawal capability of approximately 1.0 Bcf per day. The facility's surface equipment has a maximum withdrawal design capacity of 1.0 Bcf per day.[6]
- **La Goleta** is in Santa Barbara County and delivers gas into the northern coastal area of SoCalGas's distribution service territory and the Los Angeles Basin. La Goleta has a storage reservoir design capacity of 21.5 Bcf and the current La Goleta working capacity of about 21.5 Bcf. La Goleta has 13 active wells and a maximum withdrawal capability of approximately 0.42 Bcf per day. The facility's surface equipment has a maximum withdrawal design capacity of 0.4 Bcf per day.[7]
- **Playa del Rey**, located in central Los Angeles County and delivers gas into the Los Angeles Basin. Playa del Rey has a design storage reservoir capacity of 2.4 Bcf and a storage working capacity of about 2.4 Bcf. Playa del Rey has 37 active wells and a current maximum withdrawal capability of 0.4 Bcf per day.[8] The facility's surface equipment has a maximum withdrawal design capacity of 0.4 Bcf per day to meet residential, commercial, and industrial loads throughout the western part of Los Angeles, including electric generators and oil refineries.

Underground Storage Risk is evaluated in the context of Federal and State regulations of natural gas storage facilities, including:

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5 Withdrawal capability is dependent on well availability and inventory. Active well count and storage capability is as of March 2025.

6 PHMSA Annual Report, *supra*.

7 *Id.*

8 *Id.*

- PHMSA underground storage regulations, including 49 CFR section 192.12 final rule, which, among other regulations, adopts certain provisions of American Petroleum Industry (API) Recommended Practice 1171 (RP 1171), Functional Integrity of Natural Gas Storage in Depleted Hydrocarbon Reservoirs and Aquifer Reservoirs.
- CalGEM underground gas storage regulations, including 14 California Code of Regulations (CCR) section 1726, which includes requirements for operators to submit project-specific Risk Management Plans, Emergency Response Plans, project data requirements, a Records Management Program, well construction requirements, mechanical integrity testing requirements, and monitoring and reporting requirements.
- CARB's Oil & Gas Rule,[9] which prescribes monitoring requirements for natural gas underground storage facilities. SoCalGas has developed and received approval from CARB and the local air quality management districts for four individual storage field monitoring plans. These include installing continuous air monitoring to measure ambient concentrations of methane and continuous leak screening at each injection/withdrawal wellhead assembly and attached surface piping.

SoCalGas has implemented activities and measures to comply with federal, state, and local regulations and has incorporated additional industry-leading safety enhancements and improvements as part of these efforts. These activities and measures are part of the implementation of SoCalGas's Storage Integrity Management Program (SIMP), discussed further in Section IV. SoCalGas has also introduced a suite of advanced leak-detection technologies and practices that allow for the early detection of leaks and help quickly identify anomalies, such as changes in well pressure. These enhancements include:

- Around-the-clock monitoring of the pressure in all wells from each storage facility's 24-hour operations center;

[9] Title 17, California Code of Regulations, Division 3. Air Resources, Chapter 1. Air Resources Board, Subchapter 10. Climate Change, Article 4. Regulations to Achieve Greenhouse Gas Emission Reductions, Subarticle 13. Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities (17 CCR §§ 95665-95677).

- Continuous ambient air monitoring and meteorological stations at each storage facility;
- Continuous ambient methane monitoring at each storage well's wellhead and adjacent flowline.
- Daily well inspections and/or continuous/real-time wellhead monitoring.

SoCalGas has implemented changes to its standards and practices to incorporate requirements such as those mandated by PHMSA, CARB, and CalGEM. Recently, CARB adopted amendments to its Oil and Gas Rule[10] to shorten leak repair timeframes and include the use of offsite methane sensors such as satellite or aerial equipment. These changes took effect in April of 2024.

The Control and mitigation plan of SoCalGas's Underground Storage Risk is impacted by vendor-related challenges due to the contraction of California's oil and gas industry. SoCalGas is pursuing new vendors who will operate or expand in California. In addition, SoCalGas continues to perform reassessments in compliance with mandated reassessment cycles and extension approvals from CalGEM. SoCalGas meets with CalGEM on a monthly basis to review the Risk Management Plans (RMPs) for its underground storage fields. SoCalGas also continues to monitor and manage information management systems, such as WellView, which is used to track, analyze, and visualize well operations throughout the well lifecycle. Lastly, Subject Matter Experts (SME) knowledge retention and knowledge transfer continue to be a focus of risk management activities.

B. Risk Scope

SoCalGas's Underground Gas Storage Risk analysis considers risk events associated with the failure of an underground gas storage well, which results in serious injuries, fatalities, and/or damage to infrastructure.

C. Data Sources Used to Quantify Risk Estimates[11]

SoCalGas utilized internal data sources to determine an Underground Gas Storage Risk Pre Mitigation Risk Value and calculate risk reduction estimates for mitigation activities (which

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[10] *Id.*

[11] Copies and/or links to these data resources are provided in the workpapers served with this Report on May 15, 2025.

enable estimation of Post Mitigation Monetized Risk Values and Cost Benefit Ratios). Where internal data is deemed insufficient, supplemental industry or national data is used, as appropriate, and adjusted to account for the risk characteristics associated with the Company's specific operating locations and service territory. For example, certain types of incident events have not occurred within the SoCalGas and SDG&E service territories (*i.e.*, a well failure that leads to an explosion resulting in infrastructure damages, injuries, and/or fatalities). Expanding the quantitative data sources to include industry data where such incidents have been recorded is appropriate to establish a baseline of risk and risk addressed by mitigative activities. Attachment B provides additional information regarding these data resources.

II. RISK ASSESSMENT

In accordance with Commission guidance, this section provides a qualitative description of Underground Storage Risk, including a Risk Bow Tie, which delineates Drivers/Triggers and potential Consequences, followed by a description of the Tranches determined for this risk.

A. Risk Selection

Underground Storage Risk was included as a risk in SoCalGas's 2021 RAMP and was included in SoCalGas's 2022, 2023, and 2024 Enterprise Risk Registries (ERR).[12] SoCalGas's ERR evaluation and selection process is summarized in Chapter RAMP-2, Enterprise Risk Management Framework and in Chapter RAMP-3 Risk Quantification Framework.

In accordance with RDF Row 9,[13] SoCalGas assessed the top risks from the Company's 2024 ERR based on the Consequence of a Risk Event (CoRE) Safety attribute. Initially, the Underground Storage Risk was not among the risks presented in SoCalGas's list of Preliminary 2025 RAMP Risks on December 17, 2024 at a Pre-Filing Workshop, as it did not qualify based on the Safety attribute alone. The Underground Storage Risk was selected after careful consideration and based on the input received from the Commission's Safety Policy Division (SPD) and other interested parties during the Pre-Filing Workshop.

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12 In the 2021 RAMP Report this risk was called Incident Related to the Storage System. For 2025, the following was added to the risk definition, to further define high-pressure pipeline: "(including non-line pipe, appurtenances, and facilities) that…"

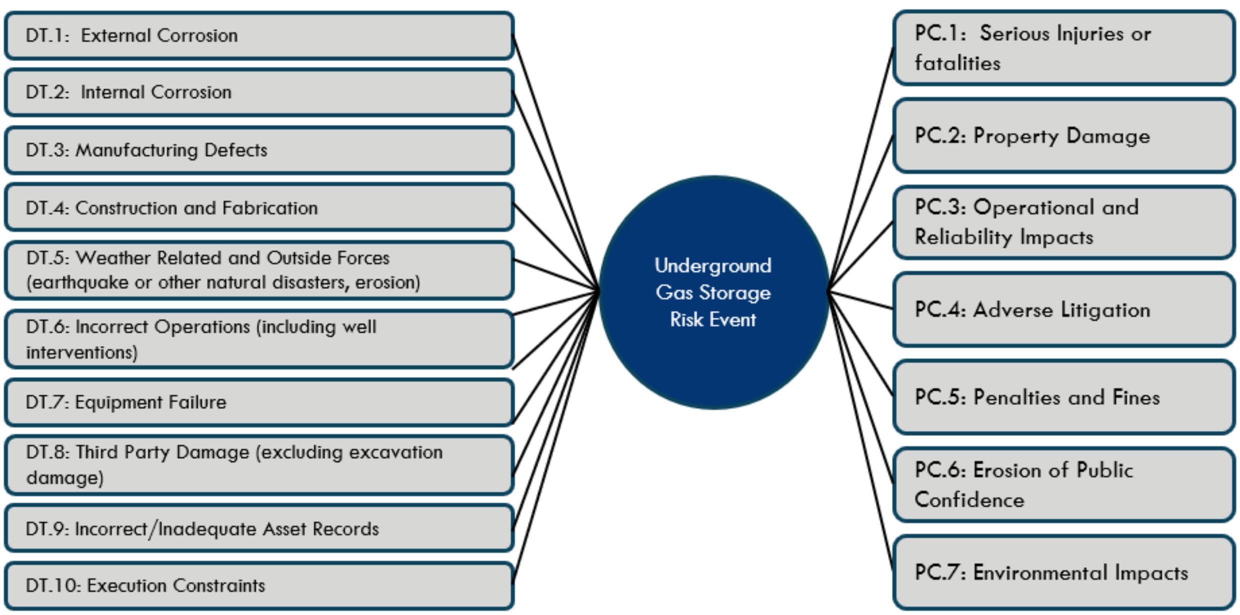
13 D.24-05-064, RDF Row 9 states that risks to be included in the RAMP Report, at minimum, are those identified in the Company's ERR comprising "the top 40% of ERR risks with a Safety Risk Value greater than zero dollars."

B. Risk Bow Tie

In accordance with Commission requirements, this section describes the risk Bow Tie, including identified Drivers/Triggers, Potential Consequences, and a mapping of the elements in the Bow Tie to the mitigation(s) that address it.[14] As illustrated in the Risk Bow Tie shown below in Figure 1, the risk event (center of the Bow Tie) is a Underground Storage Risk event that leads to asset failure, the left side of the Bow Tie illustrates Drivers/Triggers that could lead to the Underground Storage Risk event that could cause asset failure, and the right side shows the Potential Consequences of the Underground Storage Risk event. SoCalGas applies this framework to identify and summarize the information in Figure 1. A mapping of each mitigation to the addressed elements of the Risk Bow Tie is provided in Attachment C.

Figure 1

Underground Storage Risk: Risk Bow Tie



C. Potential Risk Event Drivers/Triggers[15]

When performing a risk assessment for Underground Storage Risk, SoCalGas identifies potential leading indicators, referred to as Drivers or Triggers, that reflect current and/or

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14 D.24-05-064, RDF Row 15.

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

forecasted conditions and may include both external actions as well as characteristics inherent to the asset.[16] These Bow Tie Drivers/Triggers inform the Likelihood of a Risk Event (LoRE) component of the risk value. These include:

- **DT.1 – External Corrosion:** 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.[17] This risk Driver is based on the potential for corrosion on the external surface of such assets as steel tubing, casing, and pipelines exposed to corrosive environments.
- **DT.2 – Internal Corrosion:** Deterioration of the interior of an asset as a result of environmental conditions inside of the pipeline.[18] This risk Driver is based on the potential for erosion/corrosion on the internal surface of such assets as steel tubing, casing, and pipelines. Internal erosion/corrosion may be caused by the corrosive effect of fluid, sand, and/or reactive constituents such as carbon dioxide in the gas withdrawn from the storage formations.
- **DT.3 – Manufacturing Defects:** This risk driver is based on the potential for failure of storage assets due to defects introduced during the manufacturing process. It is attributable to material defects within the pipe, component, or joint due to faulty manufacturing procedures, design defects, or in-service stresses such as vibration, fatigue, and environmental cracking.
- **DT.4 – Construction and Fabrication:** This risk driver is based on the potential for failure of storage assets due to defects introduced during the construction and fabrication process. It is attributable to the construction methodology applied during the installation of pipeline components,

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[16] D.24-05-064, RDF Row 10-11.

[17] *See* American Society of Mechanical Engineers (ASME) B31.8S.

[18] *Id.*

specifically based on the vintage of the construction standards, fabrication techniques (welding, bending, etc.), and governing regulations.

- **DT.5 – Weather Related and Outside Forces (earthquake or other natural disasters, erosion):** This risk driver includes both natural forces and those from external sources that can affect the integrity of the storage facilities. Examples of natural forces include ground movement, landslides, and subsidence from earthquakes.
- **DT.6 – Incorrect Operations (including well interventions):** This risk driver is based on the potential for maintenance or inspection functions to be performed incorrectly by employees or contractors.
- **DT.7 – Equipment Failure:** This risk driver is based on the potential for storage equipment failure not due to manufacturing or construction-related defects. It is attributable to malfunction of components, including but not limited to regulators, valves, meters, flanges, gaskets, collars, couples, etc.
- **DT.8 – Third-Party Damage (excluding excavation damage):** This risk driver is based on the potential for damage to a storage asset by an outside party other than those performing work for SoCalGas.
- **DT.9 – Incorrect/Inadequate Asset Records:** This risk driver is based on the potential for inaccurate or incomplete information that can result in the failure to construct, operate, and maintain SoCalGas's storage assets safely.
- **DT.10 – Execution Constraints:** This risk driver refers to events (excluding those covered by outside force damages) that impact the Company's ability to perform as planned. Examples include, but are not limited to, reduced availability of materials or operational oversight, delays in response and awareness, resource constraints, and/or inefficiencies and reallocation of (human and material) resources, unexpected maintenance, or regulatory requirements.

D. Potential Consequences of Risk Event (CoRE)

Potential Consequences are listed to the right side of the risk Bow Tie. SoCalGas identifies the Potential Consequences of this Risk by analyzing internal data sources, where available, industry data, and subject matter expertise (SME).[19] These Bow Tie Consequences inform the CoRE component of the risk value. If one or more of the Drivers listed above were to result in an incident, the Potential Consequences, in a plausible worst-case scenario, could include:

- **PC.1: Serious Injuries or Fatalities**
- **PC.2: Property Damage**
- **PC.3: Operational and Reliability Impacts**
- **PC.4: Adverse Litigations**
- **PC.5: Penalties and Fines**
- **PC.6: Erosion of Public Confidence**
- **PC.7: Environmental Impacts**

These Potential Consequences were used by SoCalGas in scoring Underground Storage Risk during the development of SoCalGas's 2024 ERR.

E. Evolution of Risk Drivers and Consequences

In the 2025 RAMP, SoCalGas restructured the Underground Gas Storage System Chapter to better align with its risk assessments. Previously, this chapter included both aboveground and underground gas storage assets and associated activities. Based on SoCalGas's evaluations, certain controls and mitigation activities were separated, focusing this chapter exclusively on underground gas storage controls.

As specified in the Phase 3 Decision,[20] the following changes to the previous ERR and/or the 2021 RAMP include:

- The following control activities have been moved from the Underground Gas Storage System Chapter to the High Pressure Gas System Chapter:

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19 D.24-05-064, Row 10.

20 D.24-05-064, RDF Row 8.

- C404: Storage Field Maintenance – Aboveground Facilities (Renamed to C014: Storage HP Field Maintenance – Aboveground Facilities)
- C406: Storage Field Maintenance – Aboveground Piping (Renamed to C016: Storage HP Field Maintenance – Aboveground Piping)
- C412: Storage Upgrade to Purification Equipment (Renamed to C019: Storage HP Retrofits and Upgrades to Purification Equipment)

- The control activities that remain in the Underground Gas Storage System Chapter are:
  - C401: Storage Integrity Management Program (SIMP)
  - C402: Well Abandonment, Replacement, Demo Verification, and Monitoring Practices
  - C408: Storage Field Maintenance – Underground Components
- The following control activity has been removed:
  - C410: Storage Compressor Overhauls

Additional changes include:

1. **Changes to Drivers/Triggers of the Risk Bow Tie**
   - Removed Stress Corrosion Cracking driver, previously included in the 2021 RAMP, since it does not apply to underground gas storage wells.
   - DT.5 – Outside Forces (natural disasters, fire, earthquake) in the 2024 ERR was changed to Weather Related and Outside Forces (earthquake or other natural disasters, erosion) for the 2025 RAMP.
   - DT.6 – Incorrect Operations was changed from the 2024 ERR to Incorrect Operations (including well interventions) for the 2025 RAMP.
   - DT.9 – Third Party Damage in the 2021 RAMP was changed to Third Party Damage (except underground damage) in the 2024 ERR, and Third-Party Damage (excluding excavation damage) for the 2025 RAMP.

2. Changes to Potential Consequences of the Risk Bow Tie

- PC.7 – Added "Environmental Impacts."

F. Summary of Tranches

To determine groups of assets or systems with similar risk profiles, or Tranches, and in accordance with Row 14 of the RDF, SoCalGas applied the Homogeneous Tranching Methodology (HTM) as outlined in Chapter RAMP- 3: Risk Quantification Framework. As a result, the following classes, LoRE-CoRE pairs, and the resulting number of Tranches were determined:

Table 1: Underground Gas Storage System Risk Tranche Identification

Class	Number of LoRE-CoRE Pairs	Number of Resulting Tranches
Full UGS	50	12
TOTAL	**50**	**12**

Attachment D illustrates the derivation of the Tranches, as shown Table 1 above, in accordance with the HTM. The classes were identified by SoCalGas as logical groups of assets and systems based on the Company's operations. These classes also align risk treatments with asset risk profiles reflective of SoCalGas's operations. More detailed Tranche information, including risk quantification by LoRE-CoRE pair, Tranche names, and mitigation associations (*i.e.*, cost mapping and risk reduction) to Tranches is provided in workpapers.

III. Pre Mitigation Risk Value

In accordance with the RDF Row 19, Table 2 below provides the pre-mitigation risk values for the Underground Storage Risk. Further details, including pre-mitigation risk values by Tranche, are provided in workpapers. Explanations of the risk quantification methodology and other higher-level assumptions can are provided in Chapter RAMP-3 Risk Quantification Framework.

Table 2: Underground Gas Storage System Risk
Monetized Risk Values
(Direct, in 2024 $ millions)

LoRE	CoRE [Risk-Adjusted Attribute Values]			Total CoRE	Total Risk [LoRE x Total CoRE]
	Safety	Reliability	Financial		
3.68	$0.39	$0.07	$14.77	$15.24	$56.08

A. Risk Value Methodology

SoCalGas's risk modeling for the Underground Storage Risk follows RDF guidance[21] for implementing a Cost Benefit Approach, as described below:

1. **Cost Benefit Approach Principle 1 – Attribute Hierarchy (RDF Row 2):** Storage Risk is quantified in a combined attribute hierarchy as shown in the table above, such that Safety, Reliability, and Financial are presented based on available, observable, and measurable data.
2. **Cost Benefit Approach Principle 2 – Measured Observations (RDF Row 3):** The Underground Storage Risk used observable and measurable data in the estimation of CoRE values. SoCalGas utilized a combination of internal and external data to estimate consequences in terms of natural units
3. **Cost Benefit Approach Principle 3-Comparison (RDF Row 4):** The Underground Storage Risk quantification did not include any attributes that are not directly measurable, so proxy data, as described in the RDF, was not necessary.
4. **Cost Benefit Approach Principle 4-Risk Assessment (RDF Row 5):** The data sources used for the Underground Storage Risk, as described in the preceding paragraphs, were sufficient to model probability distributions for use in estimating risk values.
5. **Cost Benefit Approach Principle 5-Monetized Levels of Attributes (RDF Row 6):** In accordance with D.22-12-027 and D.24-05-064, RDF Row 6, SoCalGas and SDG&E used a California-adjusted Department of Transportation

[21] D.24-05-064, RDF Rows 2-7.

monetized equivalent to calculate the Safety CoRE attribute at a monetized equivalent of $16.2 million per fatality, and $4.1 million per serious injury;[22] the Gas Reliability CoRE attribute is valued at a monetized equivalent of $3,868 per gas meter outage; and the Financial CoRE attribute is valued at $1 per dollar.[23]

Further information regarding SoCalGas's quantitative risk analyses, including raw data, calculations, and technical references are provided in workpapers.

6. Cost Benefit Approach Principle 6-Adjusted Attribute Level (RDF Row 7):

Table 3: Underground Gas Storage System Risk
Risk Scaled vs Unscaled Value by CoRE Attribute
(Direct, in 2024 $ millions)

	Safety	Reliability	Financial	Total
Unscaled Risk Value	$0.6	$0.1	$12.7	$13.3
Scaled Risk Value	$1.4	$0.3	$54.4	$56.1

The values in the table above are the result of SoCalGas applying the risk scaling methodology described in Chapter RAMP-3 to the CoRE attributes for the Underground Storage Risk. The above table depicts the results of an applied societal risk-averse scaling function, reflecting an increasing aversion to progressively larger CoRE outcomes.

Further information regarding the risk scaling function, including the risk scaling factor and the loss threshold at which the risk scaling factor begins to apply is provided in Chapter RAMP-3.

IV. 2024-2031 CONTROL & MITIGATION PLAN

This section identifies and describes the controls and mitigations comprising the portfolio of mitigations for Underground Storage Risk and reflects any changes to the portfolio expected to occur from the last year of recorded costs at the time of filing this RAMP Report (2024) through the 2028 GRC cycle (2031). For clarity, a current activity that is included in the plan

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[22] *See* D.22-12-027 at 35 ("We adopt Staff's recommendation to require a dollar valuation of the Safety Attribute in the Cost-Benefit Approach in the RDF using the DOT VSL as the standard value.").

[23] *See* Chapter RAMP-3: Risk Quantification Framework, Section II.

may be referred to as either a control and/or a mitigation. Table 4 below shows which control activities are in place in 2024 and which are expected to be ongoing, completed, or new during the 2025-2031 time periods. Because the TY 2024 GRC proceeding established rates through 2027,[24] information through 2027 is calculated as part of the baseline risk, in accordance with D.21-11-009.[25] For the TY 2028 GRC, SoCalGas calculated CBRs beginning with TY 2028 and for each Post-Test Year (2029, 2030, and 2031).[26]

Table 4: Underground Gas Storage System Risk
2024-2031 Control and Mitigation Plan Summary

ID	Control/Mitigation Description	2024 Control	2025-2031 Plan
C401	Storage Integrity Management Program (SIMP)	X	Ongoing
C402	Well Abandonment, Replacement, Demo Verification, and Monitoring Practices	X	Ongoing
C408	Storage Field Maintenance – Underground Components	X	Ongoing

A. Control Programs

In accordance with Commission guidance, this section "[d]escribe[s] the controls or mitigations currently in place"[27] (*i.e.*, the activities in this section were in place as of December 31, 2024. Controls that will continue as part of the risk mitigation plan are identified in Table 4 above.

- **C401 – Storage Integrity Management Program (SIMP):** SoCalGas's SIMP was initially modeled after the federally mandated distribution and transmission integrity management programs and the requirements of RP 1171. It was designed to provide a forward-looking, methodical, and structured approach, using state-of-the-art inspection technologies and risk management disciplines to address storage reservoir and well integrity risks. SoCalGas performs integrity

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24 *See* D.24-12-074.

25 *See,* D.21-11-009 at 136, Conclusion of Law 7 (providing a definition for "baselines" and "baseline risk").

26 In the TY 2028 GRC, the last year of recorded costs, or base year, will be 2025. SoCalGas and SDG&E will forecast information for 2026 through 2031, in accordance with the Rate Case Plan.

27 D.18-12-014 at 33.

inspections on gas storage wells to assess the pressure containing capability of the well, detect possible leaks, and identify metal loss features in tubing and casing. These regular inspections enhance safety by reducing the risk of well failure during operations. Types of inspections include pressure testing, noise and temperature surveys, magnetic flux leakage (MFL) inspection, and ultrasonic testing (UT) inspection. Pressure testing and wall thickness inspections (MFL or UT) are currently required for each gas storage well at a two-year recurring frequency[28] unless otherwise approved by CalGEM. Based on detailed analyses of previous well inspections and the potential risks and benefits of testing at two-year intervals, SoCalGas has submitted well specific requests to CalGEM to extend the reassessment intervals beyond the mandated 24-month interval. In response, CalGEM has granted reassessment interval extensions for up to seven years. Additionally, SoCalGas also obtained approval from CalGEM to utilize the DarkVision HADES Radius/Thickness tool in its downhole inspection tool suite. This tool provides high-resolution imaging and more precise measurements, allowing for enhanced detection and assessment of internal and external metal loss features in well casings. Temperature and noise surveys are also performed per CalGEM regulations.[29] Remediation activities performed during or as a result of SIMP can reduce the risk of failure during operations. These remediation activities may include replacing the wellhead, replacing valves, replacing the tubing and packer, installing an inner casing string or liner, and installing subsurface safety valves. These activities adhere to regulatory standards and enhance safety and operational reliability. Additionally, SoCalGas continuously monitors tubing and casing annulus pressures as required by CalGEM regulations. If sustained casing pressures are detected, SoCalGas performs diagnostic investigations and remediations if needed to address the

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[28] Cal. Code Regs. tit. 14 § 1726.6(a)(3).

[29] *Id.*

integrity of the casing. Remediation activities to address this condition may include casing expansions and/or redrills of the wells.

Well abandonment is also considered for remediation. SoCalGas may abandon a well rather than continue to utilize it for gas storage operations after integrity assessment activities are performed. To abandon a well, SoCalGas isolates the well from the injection and withdrawal operations, removes the wellhead and casing to a certain depth, and fills the wellbore with cement. In addition, SoCalGas has integrated its risk management of Underground Gas Storage Operations into SoCalGas's Integrity Management organization, aligning the underground gas storage integrity management practices with its transmission and distribution management practices. The Integrity Management organization undertakes such responsibilities as developing and implementing processes and procedures to manage storage well integrity and compliance with existing and new underground storage regulations.

Key risk management practices in SIMP include: (1) field-specific Risk Management Plans (RMPs), (2) development of quantitative risk assessment framework for storage wells, (3) well integrity assessments, (4) third party inspections of tubing, (5) abandonments of certain wells, (6) continuous well pressure and methane monitoring, (7) inner string installations, diagnostic logging, and casing expansions, to remediate annular pressure issues, (8) installation of shallow-set SSSVs in certain wells, (9) Cathodic protection for some well casings, (10) well construction and pressure testing requirements (11) inspection, testing, and maintenance of wellhead valves, (12) gas sampling, (13) training, (14) design and operations procedures, (15) emergency response plans, (16) data and records management, and (17) wellsite safety and security.

- **C402 – Well Abandonment, Replacement, Demo Verification, and Monitoring Practices:** SoCalGas performs integrity inspections on storage wells, in addition to activities completed under C401, to verify the well's pressure-containing capability, detect possible leaks, and identify metal loss features in tubing and casing. The various types of wells include observation, oil production, water injection/disposal, gas migration return, relief, and liquid removal. Types of inspections include pressure testing, noise and temperature surveys, magnetic flux leakage, and ultrasonic. Remediation activities performed during integrity testing, verification, and monitoring practices can reduce the risk of failure during operations, enhancing overall safety and reliability. These remediation activities may include replacing the wellhead, replacing valves, replacing the tubing and packer, installing an inner casing string or liner, and installing subsurface safety valves.

Under certain circumstances, SoCalGas may abandon a well rather than continue to utilize it for gas storage operations. The decision to plug and abandon a well is driven by various factors, including, but not limited to, well-specific information, location-specific information, deliverability, operation and maintenance history, and operational needs. To abandon a well, SoCalGas isolates the well from the withdrawal and injection operations, removes the wellhead and casing to a certain depth, and places specifically located cement plugs in the wellbore. Depending on the gas deliverability and injection loss of the abandonments and the resultant effect on the gas transmission system's ability to satisfy customer demand, strategically located new wells may need to be drilled to replace the withdrawal and injection capabilities of the abandoned wells. The distinction between abandonments performed under C401 and C402 is that under C401, it is done shortly after assessment activity, and under C402, it is done not directly following an assessment but after having monitored the well or having the well listed previously for possible abandonment. This activity addresses abandonments of all well types other than gas injection/withdrawal type, such as observation, oil production, and water injection/disposal.

- **C408 – Storage Field Maintenance – Underground Components:** SoCalGas uses its storage assets to withdraw or inject gas to meet gas balancing requirements on its transmission pipeline and distribution system. To satisfy these needs, Gas Control determines injection into storage or withdrawal from storage based on transmission and distribution system balancing requirements. Fluctuating demands may require storage operations to perform gas injection or withdrawal functions at any hour of the day, 365 days per year. This operational flexibility allows SoCalGas to meet varying demands efficiently. Storage fields are continually staffed with operating crews and on-call personnel to support these critical 24/7 operations, allowing SoCalGas to respond to fluctuating demands and maintain a stable supply of natural gas.

Storage is critical to maintaining a reliable energy supply in Southern California, particularly during extreme weather conditions occurring locally or out of state, unforeseen pipeline maintenance, or the temporary reduction of interstate supplies for other reasons. Continuous maintenance activities and ongoing investments are necessary to operate a storage system that can supply during such periods.

Underground operation and maintenance activities include well testing, and materials for repairs. Other costs include administrative salaries and engineering costs associated with the operation of the underground storage fields, studies in connection with reservoir operations, and wells necessary to maintain the integrity of the storage system. Safety, technical training, operator qualifications, and quality assurance functions are other critical components included in these expenses. Other activity costs are those associated with maintaining documentation of wells and creating and maintaining maps related to underground zone rights, as well as fees to government agencies to operate storage fields.

B. Changes from 2024 Controls

SoCalGas plans to continue each of the existing controls discussed above, as reflected in Table 4, through the 2025-2031 period without significant changes.

C. Mitigation Programs

SoCalGas does not currently foresee implementing new mitigations not described above during the 2025-2031 period.

D. Climate Change Adaptation

Pursuant to Commission decisions in the Climate Adaptation OIR (R.18-04-019),[30] SoCalGas performed a Climate Adaptation Vulnerability Assessment (CAVA) focused on years

[30] D.19-10-054; D.20-08-046.

2030, 2050, and 2070, with the aim of identifying asset and operational vulnerabilities to climate hazards across the SoCalGas system. SoCalGas recognizes the need to address climate vulnerabilities to promote the safety and reliability of its services and mitigate the increasing climate-related hazards through innovative and community-centric approaches. Some of the climate hazards that will have short- and long-term ramifications in the Southern California region include extreme temperatures, wildfire, inland flooding, coastal flooding and erosion, and landslides. Climate change is recognized as a factor that can drive, trigger, or exacerbate multiple RAMP risks. Implementing climate change adaptation measures and integrating climate vulnerability considerations into RAMP controls and mitigations can enhance system infrastructure longevity and reduce the severity of long-term negative climate impacts. The controls and mitigations described in further detail in this chapter, as shown below, align with the goal of increasing SoCalGas's physical and operational resilience to the increasing frequency and intensity of climate hazards. Additional information on the CAVA and a list of climate-relevant controls and mitigations included in RAMP, are provided in Chapter RAMP-5: Climate Change Adaptation.

Table 5: Underground Gas Storage System Risk
Controls and Mitigations that Align with Increasing Resilience to Climate Hazards

ID	Relevant Control/Mitigation	Potential Climate Hazard(s)
C401	Storage Integrity Management Program (SIMP)	Inland Flooding, Landslides, and Wildfires
C402	Well Abandonment, Replacement Demo Verification, and Monitoring Practices	Inland and Coastal Flooding, Coastal Erosion, and Landslides
C408	Storage Field Maintenance - Underground Components	Inland Flooding, Landslides, and Wildfires

E. Foundational Programs

Foundational Programs are "[i]nitiatives that support or enable two or more Mitigation programs or two or more Risks but do not directly reduce the Consequences or reduce the Likelihood of safety Risk Events."[31]

This risk chapter does not include any foundational programs.

[31] D.24-05-064, Appendix A at A-4.

F. Estimates of Costs, Units, and Cost-Benefit Ratios (CBRs)

The tables in this section provide a quantitative summary of the risk control and mitigation plan for Underground Gas Storage Risk, including the associated costs, units, and CBRs. Additional information by Tranche is provided in workpapers. The costs shown are estimated using assumptions provided by SMEs and available data. In compliance with the Phase 3 Decision,[32] for each enterprise risk, SoCalGas uses actual results and industry data and when that is not available, supplements the data with SME input. Additional details regarding the data and expertise relied upon in developing these estimates is provided in Attachment B.

Table 6: Underground Gas Storage System Risk Control and Mitigation Plan – Recorded and Forecast Costs Summary (Direct, in 2024 $ thousands)

ID	Control/Mitigation Name	Recorded Costs		Forecast Costs			
		2024 Capital	2024 O&M	2028 O&M	2025-2028 Capital	PTY Capital	PTY O&M
C401	Storage Integrity Management Program (SIMP)	35,882	16,646	19,752	207,008	202,169	60,552
C402	Well Abandonment/Replacement/Demo Verification and Monitoring Practices	60,322	0	0	284,533	186,744	0
C408	Storage Field Maintenance - Underground Components	0	3,483	3,857	0	0	11,571
Total		**96,204**	**20,129**	**23,609**	**491,541**	**388,913**	**72,123**

32 D.24-05-064, RDF Row 10.

Table 7: Underground Gas Storage System Risk Control & Mitigation Plan – Units Summary

Control/Mitigation			Recorded Units		Forecast Units			
ID	**Name**	**Units of measure**	**2024 Capital**	**2024 O&M**	**2028 O&M**	**2025-2028 Capital**	**PTY Capital**	**PTY O&M**
C401	Storage Integrity Management Program (SIMP)[33]	Wells	21	0	0	102	96	0
C402	Well Abandonment/Replacement/Demo Verification and Monitoring Practices	Wells	11	0	0	84	69	0
C408	Storage Field Maintenance - Underground Components	Storage Field	0	4	4	0	0	12

In the table below, CBRs are presented in summary at the mitigation or control level for the TY 2028 GRC cycle. CBRs are calculated based on scaled, expected values unless otherwise noted, and are calculated for each of the three required discount rates[34] in each year of the GRC cycle and for the Post-Test Years in aggregate (2029-2031). Costs and CBRs for each year of the GRC cycle and the aggregated years are provided in workpapers.

[33] SIMP O&M is driven by capital activities. Therefore, units for 2025-2031 O&M cannot be forecasted.

[34] See Chapter RAMP-3: for definitions of discount rates, as ordered in the Phase 3 Decision.

Table 8: Underground Gas Storage System Risk
Cost Benefit Ratio Results Summary (2028-2031)
(Direct, in 2024 $ millions)

ID	Control/Mitigation Name	Capital (2028 – 2031)	O&M (2028 – 2031)	CBR (Societal)	CBR (Hybrid)	CBR (WACC)
C401	**Storage Integrity Management Program (SIMP)**	$269.5	$80.3	1.80	0.75	0.74
C402	**Well Abandonment/ Replacement/Demo Verification and Monitor**	$261.6	$0	4.00	1.65	1.64
C408	**Storage Field Maintenance – Underground Components**	$0	$15.4	10.27	10.38	10.35

***Bold** indicates this control/mitigation includes mandated programs/activities.*

Tranche-level CBRs by year and in aggregate for each mitigation are provided in workpapers.

V. ALTERNATIVE MITIGATIONS

Pursuant to D.14-12-025, D.16-08-018, and D.18-12-014,[35] SoCalGas considered two alternatives to the risk mitigation plan for the Underground Storage Risk. Typically, analysis of alternatives occurs when implementing activities to obtain the best result or product for the cost. The alternatives analysis for this plan considers changes in risk reduction, cost, reasonableness, current conditions, modifications to the plan and constraints, such as budget and resources.

[35] *See, e.g.,* D.18-12-014 at 33-35.

**Table 9: Underground Gas Storage System Risk
Alternative Mitigation Plan –Forecast Costs Summary
(Direct, in 2024 $ millions)**

ID	Alternative Mitigation Name	Forecast Costs			
		2025-2028 Capital	PTY Capital	2025-2028 O&M	PTY O&M
A401 [36]	SIMP With Well Abandonments In Lieu of Inner String Installations	205,299	200,632	0	0
A402	SIMP With Installation of Metal Skin Liners in lieu of Inner String Installations	192,718	189,308	79,726	61,914
Total		**398,017**	**389,940**	**79,726**	**61,914**

**Table 10: Underground Gas Storage System
Risk Alternative Mitigation Cost Benefit Ratio Results Summary
(Direct, in 2024 $ millions)**

ID	Alternative Mitigation Name	Capital TY 2028	O&M TY 2028	CBR (Societal)	CBR (Hybrid)	CBR (WACC)
A401	SIMP With Well Abandonments In Lieu of Inner String Installations	66,833	0	1.80	0.74	0.73
A402	SIMP With Installation of Metal Skin Liners in Lieu of Inner String installations	63,059	20,206	0.99	0.53	0.52

A. Alternative 1: SIMP With Well Abandonments In Lieu of Inner String Installations

SoCalGas is required to conduct mechanical integrity assessments of well casings to comply with CalGEM's regulatory requirements. The production casings of gas storage wells serve as a secondary integrity barrier, which must contain 115% of the maximum allowable operating pressure (MAOP) should a primary barrier (tubing, for example) fail to maintain

[36] For A401, no O&M cost is shown because applying the alternative does not change the O&M forecast in C401.

integrity. Based on the integrity assessment results, if the casing wall thickness is found to have insufficient integrity due to corrosion or other issues, inner strings are installed as a remediation measure to return the well to service. If inner string installation is not a viable option, the well may be abandoned, and a new replacement well may be drilled if required to maintain storage field deliverability and meet customer demand. The decision to install inner strings in a gas storage well considers the anticipated well deliverability post-repair, subsequent maintenance and inspection costs, and the probability that the proposed repair will be successful. Inner strings are new casing strings installed and cemented inside the compromised production casing and can extend the life of storage wells up to 30+ years. Inner string installations enable gas storage wells to be returned to service quickly and at a lower cost than well abandonment and drilling a new well. An alternative mitigation presented herein to an inner string installation is well abandonment (without drilling a new well to replace the abandoned well). When a gas storage well is abandoned, it is permanently removed from service in accordance with CalGEM regulations. Consequently, the deliverability associated with the well is no longer available, reducing field deliverability. Although SoCalGas may choose to abandon a well, instead of installing an inner string to remediate casing wall thickness concerns, abandonment of all such wells will result in a significant decrease in the overall field deliverability, which is why SoCalGas is not currently considering this alternative. In contrast, SoCalGas installs new inner strings to repair production casing enabling SoCalGas to return the wells to service quickly and maintain field deliverability.

B. Alternative 2: SIMP With Installation of Metal Skin Liners In Lieu of Inner String Installations

Metalskin liners (MSL) are engineered to enhance well integrity by adding a protective layer to compromised production casing. MSLs are installed across areas of casing that do not pass the 115% MAOP calculations of the respective storage field. The installation of the MSL can potentially return a well to service. MSLs are widely used in the oil and gas sector.

CalGEM regulations require periodic inspections of gas storage wells to determine the remaining wall thickness of the active second barrier (production casing). When MSLs are installed, downhole inspection tools are no longer able to accurately measure the remaining wall thickness of host casing. Consequently, MSLs must be removed from the casing whenever a SIMP inspection is performed. Removal of MSLs can be a time intensive process that often requires milling the MSL, and if not done carefully, can inadvertently mill the host casing, causing additional wall loss and damage. Further, removal of the MSL lengthens the duration of workovers and increases well entry risk. Lengthy workovers can also damage the reservoir due to extended exposure to workover fluids.

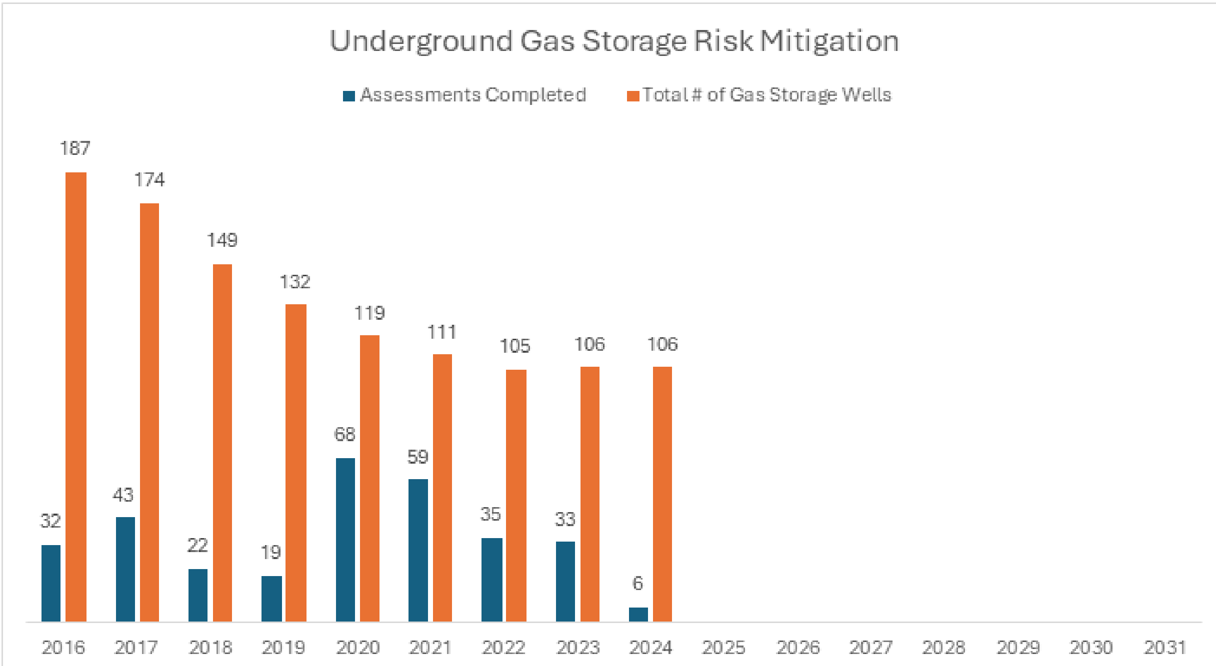
In contrast to this alternative mitigation, SoCalGas installs new inner strings for production casing repair. Inner strings are less complicated than MSL for integrity evaluation and require less well maintenance activity. CalGEM has previously approved seven-year inspection intervals for wells with new inner strings. Compared with MSL, inner string installations reduce well entry risk and enhance well integrity, which is why SoCalGas is not currently considering this mitigation. A well with a new inner string can be expected to remain in service for as long as a new gas storage well.

VI. HISTORICAL GRAPHICS

As directed by the Commission in the Phase 2 Decision, this section illustrates the accomplishments in safety work and the progress in mitigating safety risks over the two immediately preceding RAMP cycles. A bar chart graphic is employed to depict historical progress. This graphic uses a key metric that aligns with Company safety goals to illustrate trends in historical progress and identify the remaining tasks necessary to continue mitigating risks.

Figure 2

Underground Storage Risk: Safety Progress 2016-2024



Safety work activities completed through SIMP from 2016-2024 include temperature and noise logs, casing wall thickness inspections, and pressure testing of well production casings.

As previously discussed, CalGEM regulations require mechanical integrity inspections on well casings at two years intervals, unless the inspection interval for a specific well is extended. Based on the results of inspections, well remediations may be performed, which can include well abandonments. SoCalGas completed its baseline inspections and initiated reassessments of existing storage wells in 2019 and 2020. In 2022, baseline assessments were conducted for newly drilled replacement wells, and reassessments continued for existing wells.

As discussed earlier, based on detailed analyses of previous well inspections and the potential risks and benefits of testing at two-year intervals, SoCalGas has submitted well-specific requests to CalGEM pursuant to 14 CCR 1726.6(a)(2) to extend the reassessment intervals beyond the mandated 24-month interval. In response, CalGEM has granted reassessment interval extensions for up to seven years The number of wells also initially declined due to well abandonments that were performed based on findings (for example, internal corrosion) identified from the baseline inspections that were performed earlier in the program.

The safety work that remains to be performed is addressed in the controls/mitigations detailed above in Section III. 2024-2031 Control & Mitigation Plan.

ATTACHMENTS

ATTACHMENT A

CONTROLS AND MITIGATIONS WITH REQUIRED COMPLIANCE DRIVERS

The table below indicates the compliance Drivers that underpin identified controls and mitigations.

ID	Control/Mitigation Name	Compliance Driver
C401	Storage Integrity Management Program (SIMP)	CPUC, Storage Integrity Management Program Balancing Account (SIMPBA), CalGEM (California Code of Regulations, Title 14, Division 2, Chapter 4, Subchapter 1, Article 4, Section 1726), PHMSA (49 CFR Part §192, Subpart A, 192.12, Underground Natural Gas Storage Facilities)
C402	Well Abandonment, Replacement, Demo Verification, and Monitoring Practices	CalGEM (CCR, Title 14, Division 2, Chapter 4, Subchapter 1, Article 4, Section 1726, PHMSA Regulations (49 CFR Part §192, Subpart A, 192.12, Underground Natural Gas Storage Facilities)
C408	Storage Field Maintenance – Underground Components	CalGEM (CCR, Title 14, Division 2, Chapter 4, Subchapter 1, Article 4, Section 1726, PHMSA Regulations (49 CFR Part §192, Subpart A, 192.12, Underground Natural Gas Storage Facilities)

ATTACHMENT B

UNDERGROUND GAS STORAGE SYSTEM - REFERENCE MATERIAL FOR QUANTITATIVE ANALYSES

The Phase 3 Decision at RDF Row 10 and Row 29 directs each utility to identify Potential Consequences of a Risk Event using available and appropriate data.[37] Appropriate data may include Company specific data or industry data supplemented by the judgment of subject matter experts. Provided below is a listing of the inputs utilized as part of this assessment and a description of the data.

Risk Data	Source Type	Source Information
Likelihood of failure and probability failure results in safety consequence	Internal Model Results	Source: Internal SIMP model Description: Integrity Management Department Internal model that uses internal and industry data
Storage Incident Cost data	External Data	Agency: PHMSA Link: Pipeline Incident Flagged Files | PHMSA Description: Due to insufficient internal data, financial consequences were modelled using national incident data as a function of release volume.
Meter Outages	Internal Data	Source: SME judgment and GIS data Description: SME expertise was used to determine scenarios that could result in a significant reliability impact and GIS data was used to determine the number of meters downstream that would be impacted.

[37] D.24-05-064, RDF Row 10 and Row 29.

ATTACHMENT C

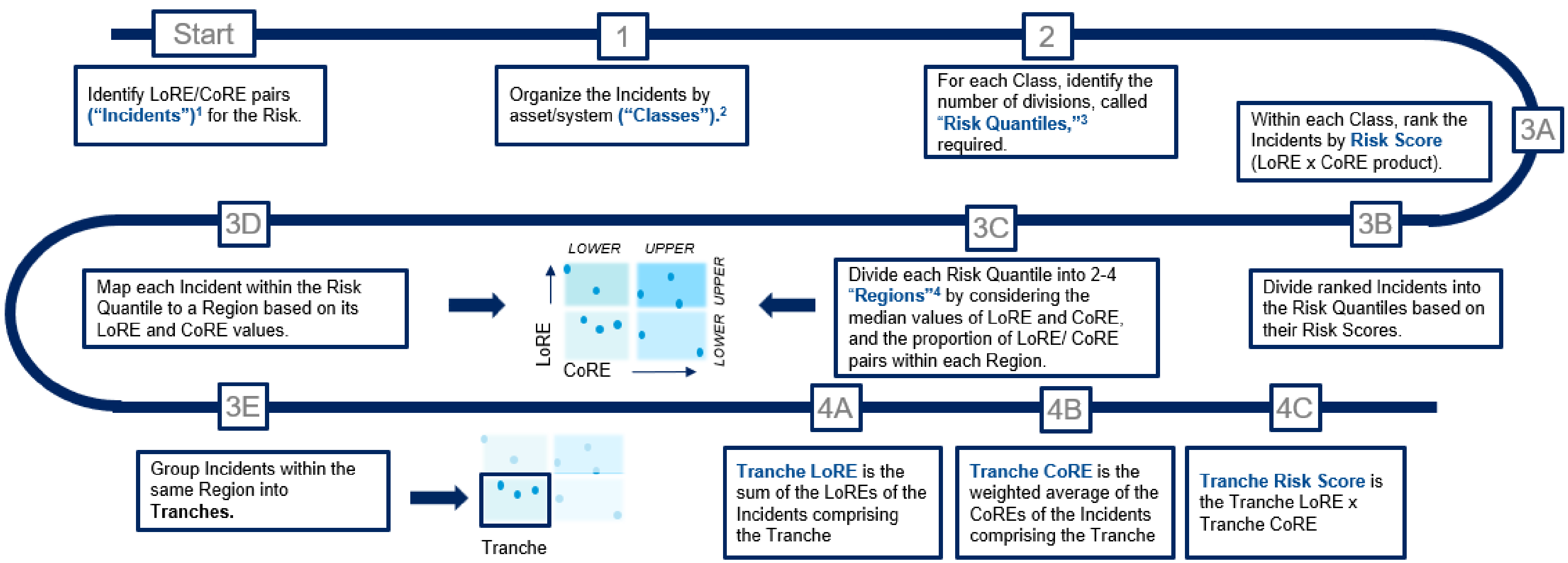
UNDERGROUND GAS STORAGE SYSTEM – SUMMARY OF ELEMENTS OF BOW TIE

SUMMARY OF ELEMENTS OF BOW TIE			
ID	**Control/Mitigation Name**	**Drivers Addressed**	**Consequences Addressed**
C401	Storage Integrity Management Program (SIMP)	DT.1, DT.2, DT.3, DT.4, DT.5, DT.6, DT.7, DT.8, DT.9, DT.10	PC.1, PC.2, PC.3, PC.4, PC.5, PC.6, PC.7
C402	Well Abandonment, Replacement, Demo Verification, and Monitoring Practices	DT.1, DT.2, DT.3, DT.4, DT.5, DT.6, DT.7, DT.8, DT.9, DT.10	PC.1, PC.2, PC.3, PC.4, PC.5, PC.6, PC.7
C408	Storage Field Maintenance – Underground Components	DT.1, DT.2, DT.3, DT.4, DT.5, DT.6, DT.7, DT.8, DT.9	PC.1, PC.2, PC.3, PC.4, PC.5, PC.6, PC.7

ATTACHMENT D

UNDERGROUND GAS STORAGE - APPLICATION OF TRANCHING METHODOLOGY

A sample walkthrough of the Homogeneous Tranching Methodology (HTM) as outlined in Volume 1, Chapter RAMP - 3: Risk Quantification Framework is provided.



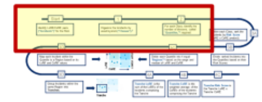
NOTES

[1]*For example, **Incidents (or "Risk Incidents")** for Gas Storage are generally comprised of release or damage*

[2]*For example, **Classes (or "Asset Classes")** for UGS the only class present is Underground Storage.*

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

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



Start

Identify LoRE/CoRE pairs (**"Incidents"**)[1] for the Risk.

1

Organize the Incidents by asset/system (**"Classes"**).[2]

2

For each Class, identify the number of divisions, called **"Risk Quantiles,"**[3] required.

Class	LORE / CORE PAIRS	TOTAL # PAIRS
UGS	Normal Operations in Aliso Canyon - 20 to 50 MMSCFD	50
	Well Interventions in Aliso Canyon - 100+ MMSCFD	
	Well Interventions in La Goleta - 10 to 20 MMSCFD	
	…and 47 more pairs	

$$\min\left(\frac{N}{8}-1, 9\right) < K \le \min\left(\frac{N}{8}, 10\right)$$

6

Step 3 for *UGS*

Within each Class, rank the Incidents by **Risk Score** (LoRE x CoRE product).

3A

3B

Divide ranked Incidents into the Risk Quantiles based on their Risk Scores.

UGS	Normal Operations in Aliso Canyon - 20 to 50 MMSCFD	50
	Well Interventions in Aliso Canyon - 100+ MMSCFD	
	Well Interventions in La Goleta - 10 to 20 MMSCFD	
	...and 47 more pairs	

$$\min\left(\frac{N}{8}-1,9\right) < K \leq \min\left(\frac{N}{8},10\right)$$

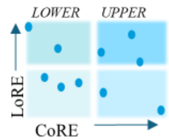
6

From Step 2 for *UGS*

Incident (LoRE/CoRE) Pair	Risk Score	Rank 3A	Quantile 3B
Normal Operations in Aliso Canyon - 50 to 100 MMSCFD	26,760,998	1	#1
Normal Operations in Aliso Canyon - 20 to 50 MMSCFD	20,016,118	2	
Normal Operations in Honor Rancho - 50 to 100 MMSCFD	4,078,158	3	
Well Interventions in Aliso Canyon - 100+ MMSCFD	1,004,449	4	
Normal Operations in Honor Rancho - 20 to 50 MMSCFD	965,067	5	
Well Interventions in Aliso Canyon - 20 to 50 MMSCFD	798,993	6	
Well Interventions in Honor Rancho - 100+ MMSCFD	715,126	7	
Well Interventions in Honor Rancho - 20 to 50 MMSCFD	397,461	8	
Normal Operations in La Goleta - 20 to 50 MMSCFD	243,814	9	#2
Well Interventions in Aliso Canyon - 10 to 20 MMSCFD	143,988	10	
Normal Operations in Aliso Canyon - 1 to 5 MMSCFD	140,302	11	
Well Interventions in La Goleta - 100+ MMSCFD	121,310	12	
Well Interventions in Aliso Canyon - 50 to 100 MMSCFD	98,949	13	
Well Interventions in La Goleta - 10 to 20 MMSCFD	89,045	14	
Well Interventions in Playa Del Rey - 10 to 20 MMSCFD	85,787	15	
Well Interventions in Playa Del Rey - 20 to 50 MMSCFD	70,346	16	
Well Interventions in La Goleta - 20 to 50 MMSCFD	62,996	17	
…	…	18-50	…

3D

Map each Incident within the Risk Quantile to a Region based on its LoRE and CoRE values.

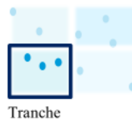


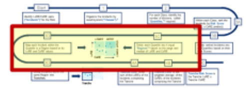
3C

Divide each Risk Quantile into 2-4 **"Regions"**[4] by considering the median values of LoRe and CoRE, and the proportion of LoRE/ CoRE pairs within each Region.

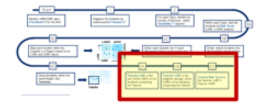
3E

Group Incidents within the same Region into **Tranches**.





		3A	3B	3C	3D
Incident (LoRE/CoRE) Pair	Risk Score	Rank	Quantile	Region	Tranche
Normal Operations in Aliso Canyon - 50 to 100 MMSCFD	26,760,998	1	#1	UL/LC	UGS-1-1
Normal Operations in Aliso Canyon - 20 to 50 MMSCFD	20,016,118	2		UL/LC	UGS-1-1
Normal Operations in Honor Rancho - 50 to 100 MMSCFD	4,078,158	3		UL/LC	UGS-1-1
Well Interventions in Aliso Canyon - 100+ MMSCFD	1,004,449	4		LL/UC	UGS-1-2
Normal Operations in Honor Rancho - 20 to 50 MMSCFD	965,067	5		UL/LC	UGS-1-1
Well Interventions in Aliso Canyon - 20 to 50 MMSCFD	798,993	6		LL/UC	UGS-1-2
Well Interventions in Honor Rancho - 100+ MMSCFD	715,126	7		LL/UC	UGS-1-2
Well Interventions in Honor Rancho - 20 to 50 MMSCFD	397,461	8		LL/UC	UGS-1-2
Normal Operations in La Goleta - 20 to 50 MMSCFD	243,814	9	#2	LL/UC	UGS-2-3
Well Interventions in Aliso Canyon - 10 to 20 MMSCFD	143,988	10		UL/LC	UGS-2-4
Normal Operations in Aliso Canyon - 1 to 5 MMSCFD	140,302	11		UL/LC	UGS-2-4
Well Interventions in La Goleta - 100+ MMSCFD	121,310	12		LL/UC	UGS-2-3
Well Interventions in Aliso Canyon - 50 to 100 MMSCFD	98,949	13		LL/UC	UGS-2-3
Well Interventions in La Goleta - 10 to 20 MMSCFD	89,045	14		UL/LC	UGS-2-4
Well Interventions in Playa Del Rey - 10 to 20 MMSCFD	85,787	15		UL/LC	UGS-2-4
Well Interventions in Playa Del Rey - 20 to 50 MMSCFD	70,346	16		LL/UC	UGS-2-3
Well Interventions in La Goleta - 20 to 50 MMSCFD	62,996	17		LL/UC	UGS-2-3



4A

Tranche LoRE is the sum of the LoREs of the Incidents comprising the Tranche

4B

Tranche CoRE is the weighted average of the CoREs of the Incidents comprising the Tranche

4C

Tranche Risk Score is the Tranche LoRE x Tranche CoRE

Incident (LoRE/CoRE) Pair	Tranche	Tranche Lore (4A)	Tranche Core (4B)	Tranche Risk Score (4C)
Normal Operations in Aliso Canyon - 50 to 100 MMSCFD	UGS-1-1	0.369	$140,349,682	$51,820,341
Normal Operations in Aliso Canyon - 20 to 50 MMSCFD	UGS-1-1			
Normal Operations in Honor Rancho - 50 to 100 MMSCFD	UGS-1-1			
Normal Operations in Honor Rancho - 20 to 50 MMSCFD	UGS-1-1			
Well Interventions in Aliso Canyon - 100+ MMSCFD	UGS-1-2	0.005	$588,390,706	$2,916,028
Well Interventions in Aliso Canyon - 20 to 50 MMSCFD	UGS-1-2			
Well Interventions in Honor Rancho - 100+ MMSCFD	UGS-1-2			
Well Interventions in Honor Rancho - 20 to 50 MMSCFD	UGS-1-2			
Normal Operations in La Goleta - 20 to 50 MMSCFD	UGS-2-3	0.002	$381,403,774	$597,415
Well Interventions in La Goleta - 100+ MMSCFD	UGS-2-3			
Well Interventions in Aliso Canyon - 50 to 100 MMSCFD	UGS-2-3			
Well Interventions in Playa Del Rey - 20 to 50 MMSCFD	UGS-2-3			
Well Interventions in La Goleta - 20 to 50 MMSCFD	UGS-2-3			
Well Interventions in Aliso Canyon - 10 to 20 MMSCFD	UGS-2-4	2.155	$213,039	$459,122
Normal Operations in Aliso Canyon - 1 to 5 MMSCFD	UGS-2-4			
Well Interventions in La Goleta - 10 to 20 MMSCFD	UGS-2-4			
Well Interventions in Playa Del Rey - 10 to 20 MMSCFD	UGS-2-4			