

PG&E 2024 Risk Assessment and Mitigation Phase Workshop #3

June 18th, 2024





Agenda

Topic	Presenter(s)	Length (min)	Time
Opening Remarks	Safety Policy Division	5	10:00-10:05
Safety and Introductions	Ken Arnold	5	10:05-10:10
PG&E Opening Remarks	Paul McGregor	5	10:10-10:15
Purpose of Today's Workshop & PG&E's RAMP Procedural Schedule	Ken Arnold	5	10:15-10:20
RAMP Risks, Report Organization, & Workpaper Overviews	Sandy Allan, Kim Mullins	20	10:20-10:40
ICE Calculator Implementation and SPD_002 Data Request Update	Benson Wong	15	10:40-10:55
BREAK		15	10:55-11:10
RAMP Risk Presentation: Wildfire with PSPS and EPSS	Andy Abranches, Benson Wong	85	11:10-12:35
BREAK (LUNCH)		45	12:35-1:20
RAMP Risk Presentation: Large Uncontrolled Water Release (Dam Safety)	Russ Cruzen, Jayne Young	40	1:20-2:00
RAMP Risk Presentation: Loss of Containment on Gas Transmission Pipeline	Chris Warner, Gordon Ye	40	2:00-2:40
BREAK		15	2:40-2:55
RAMP Risk Presentation: Cybersecurity Risk Event	Yusuf Ezzy, David Lo	40	2:55-3:35
Q&A		25	3:35-4:00
PG&E Closing Remarks	Paul McGregor	5	4:00-4:05
SPD Closing Remarks	Safety Policy Division	5	4:05-4:10

Safety and Security Orientation

Assign safety roles if in person

Psychological Safety

- Practice transparency and vulnerability
- Avoid blame; learn from mistakes
- Show care and appreciation
- Invite new ideas from all
- Disagree respectfully and with curiosity
- Prioritize mental health by encouraging self-care

Fire

- Exits, escape routes, evacuation
- Fire ext.

Earthquake

- Drop, cover, hold

Medical Emergency

- First aid/CPR
- 911/share location
- AED

Security

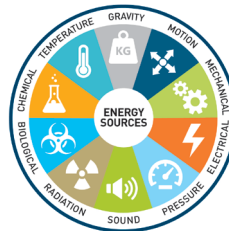
- Active shooter—get out, hide out, take out, call out
- Maintain situational awareness to mitigate hazards

Ergonomics

- Proper ergo
- 30/30: move for 30 secs every 30 min

Don't report to work if testing positive for COVID-19

Energy-Based Hazard Wheel



Park in a safe location

Presenter	Title	Area
Paul McGregor	Sr. Director – Enterprise and Operational Risk Management (EORM)	Overall RAMP
Sandy Allan	Principal – EORM Risk Policy and Regulatory Strategy	RAMP Report
Kim Mullins	Principal – EORM Risk Analytics	Risk Modeling
Andy Abranches	Sr. Director – Wildfire Risk Management	Wildfire Risk
Benson Wong	Sr. Manager – Electric Risk Management	Wildfire/Electric Risk Management
Russ Cruzen	Director – Power Generation	Energy Supply
Jayne Young	Asset Management Risk Principal	Energy Supply
Chris Warner	Sr. Director – Gas Engineering	Gas Transmission
Gordon Ye	Supervisor – Risk Engineering	Gas Transmission
Yusuf Ezzy	VP – Cybersecurity	Cybersecurity
David Lo	Director – Cybersecurity	Cybersecurity

Regulatory Requirements

Ken Arnold – Regulatory





Purpose of Today's Workshop

To provide an overview of PG&E's 2024 RAMP report, to discuss changes to its risk modeling approach, and to confirm the Commission's review process.

RAMP Report Overview	Risk Modeling Approach	Process and Key Considerations
<ul style="list-style-type: none">• Final RAMP Risks• Report Outline and Organization• Risk Presentations (by Functional Areas)• Control and Mitigation Programs	<ul style="list-style-type: none">• Model Updates• Changes in Risk Values• Cost-Benefit Ratios• Control and Mitigation Program Workpapers	<ul style="list-style-type: none">• Risk Assessment and Mitigation Strategy• Alternative Mitigations Considered• CPUC Review Process

Through the RAMP and GRC, PG&E intends to support a GRC forecast that is **risk-informed, prioritizes safety**, and includes **effective risk control and mitigation programs**.



PG&E's RAMP Procedural Schedule

The RAMP Post-Filing Workshop presents an opportunity for PG&E to provide additional transparency and detail into its risk programs and mitigation strategies.

2024 Risk Assessment and Mitigation Phase (RAMP)

1

Preliminary RAMP
Risk Workshop

**RDF (D.22-12-027 Appendix A)
Row No. 12:** "... the utility will host a publicly noticed workshop ... to gather input from SPD, other interested CPUC staff, and interested parties to inform the determination of the final list of risks ..."

February 7, 2024

2

Cost-Benefit Approach
Demonstration Workshop

D.22-12-027 OP 3: "Pacific Gas and Electric Company shall conduct a Cost-Benefit Approach Demonstration Workshop ... at least 30 days prior to its 2024 (RAMP) filing."

April 11, 2024

3

RAMP Filing

**D.20-01-002, Appendix A,
Adopted Revised GRC
Application Filing Schedule:**
"May 15, one year prior to the Utility's GRC filing, Utility files application to initiate its RAMP proceeding."

May 15, 2024

4

SPD Issues RAMP
Evaluation Report

**D.20-01-002 Appendix
A, Adopted Revised
GRC Application Filing
Schedule:**
"~Day 110 (since filing) - SED (SPD) files and serve(s) report on utility's RAMP submission".

Sep 3, 2024

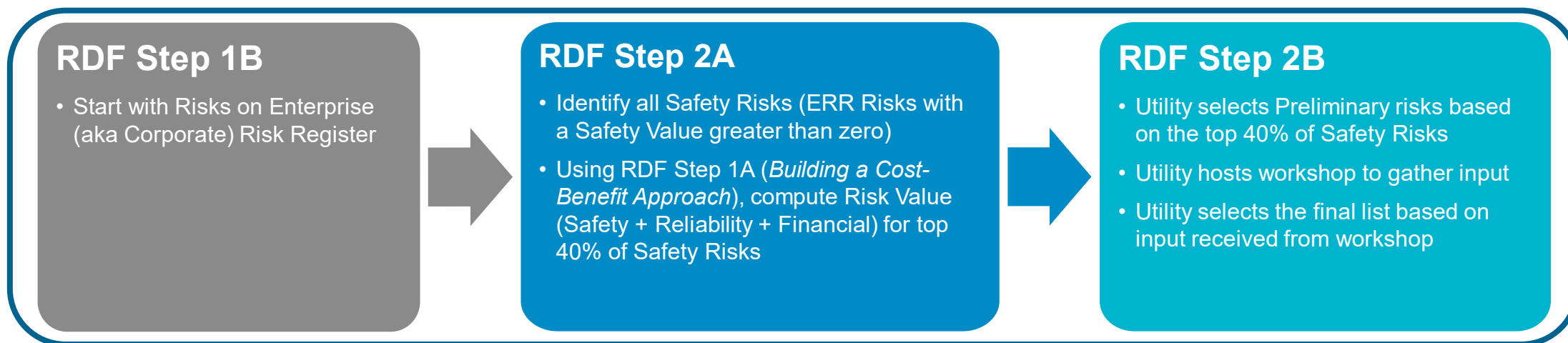
RAMP Risk Overview

Sandy Allan – Enterprise and Operational Risk Management



RAMP Risk Selection

PG&E identified 12 risks for consideration in the RAMP filing, based on safety scores and the regulatory requirements for selection.



PG&E followed the regulatory requirements for RAMP Risk Selection

RDF Row No. 9: *“...the utility will sort its ERR risks in descending order by the monetized Safety Risk Value. For the top 40% of ERR risks with a Safety Risk Score greater than zero, the utility will compute a monetized Risk Value using at least the Safety, Reliability and Financial Attributes...”*

Safety Regulatory Requirement

PG&E identified **11 risks** as the top 40% of ERR risks with a Safety Risk Value greater than zero dollars.

Risks below the 40% threshold

The top 40% of ERR risks includes ***Electric Transmission Systemwide Blackout***, which is not funded under the jurisdiction of the GRC proceeding. To ensure GRC-funded safety risks are adequately represented, PG&E also included ***Large Overpressure Event Downstream of Gas M&C Facility*** in its RAMP risk selection.

2024 RAMP Risks and Risk Values

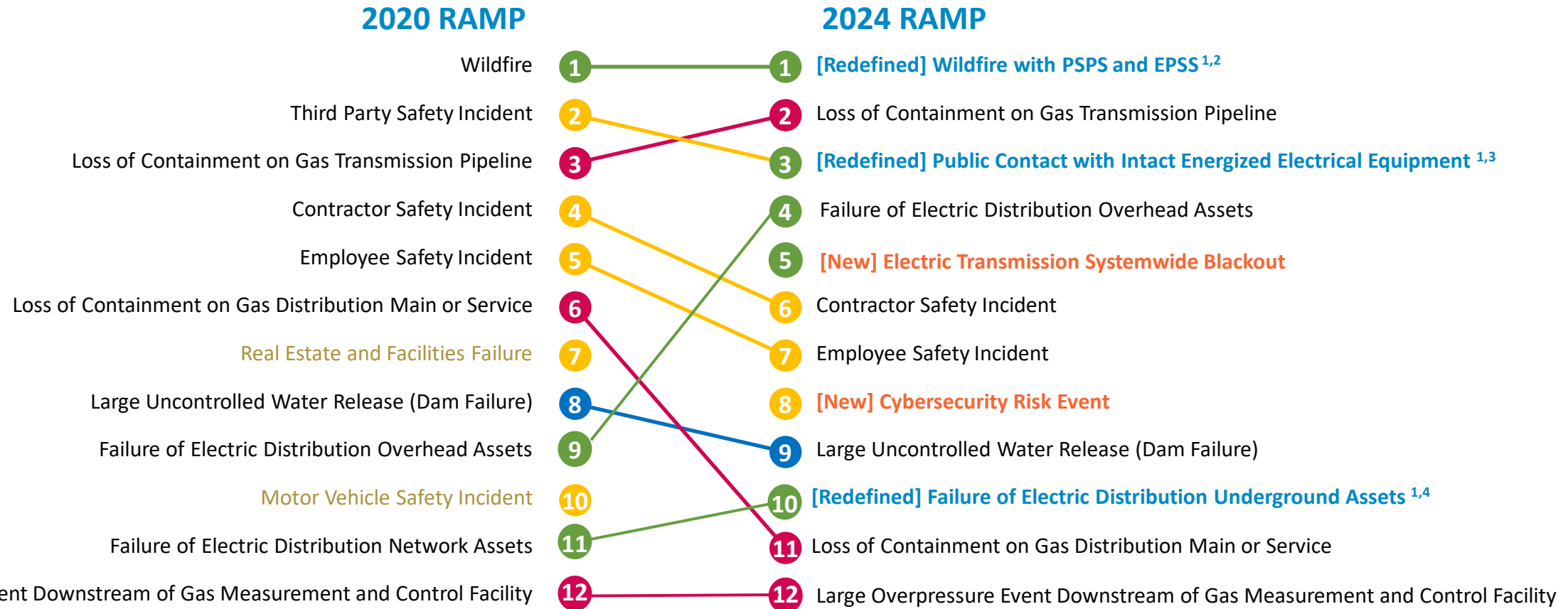
Safety Rank	Risk Event	TY Baseline Risk Values for 2027*						
		Direct Safety (\$M)	Indirect Safety (\$M)	Total Safety (\$M)	Electric Reliability (\$M)	Gas Reliability (\$M)	Financial (\$M)	Total Risk Value (\$M)
1	Wildfire with PSPS and EPSS	153	69	222	5,466	-	1,977	7,666
2	Loss of Containment on Gas Transmission Pipeline	139	-	139	-	22	26	186
3	Public Contact with Intact Energized Electrical Equipment	60	-	60	-	-	-	60
4	Failure of Electric Distribution Overhead Assets	8	46	54	3,175	-	124	3,354
5	Electric Transmission Systemwide Blackout	-	52	52	1,844	-	8	1,903
6	Contractor Safety Incident	39	-	39	-	-	-	39
7	Employee Safety Incident	30	-	30	-	-	9	39
8	Cybersecurity Risk Event	<0.1	25	25	915	25	42	1,007
9	Large Uncontrolled Water Release (Dam Failure)	21	-	21	-	-	237	258
10	Failure of Electric Distribution Underground Assets	15	4	19	686	-	23	728
11	Loss of Containment on Gas Distribution Main or Service	19	-	19	-	9	79	107
12	Large Overpressure Event Downstream of Gas M&C Facility	18	-	18	-	0.3	0.7	19

This table provides information required by RDF Step 2B, Row 12:

1. The monetized Safety Risk Value for each risk in the ERR
2. The monetized Risk Value for the top ERR risks identified through the process in Row 9 (top 40% of ERR risks with a Safety Risk Value greater than zero dollars)

*Source: *workpaper Exhibit (PG&E-2) RM-RMCBR-14*

2020 RAMP vs 2024 RAMP Risks and Rankings



Legend

- Electric Operations
- Gas Operations
- Energy Supply
- Shared Services

Notes to Results

1. Risk event definitions/scope have changed since the 2020 RAMP.
2. Wildfire risk score now also reflects consequences of Public Safety Power Shutoff (PSPS) and Enhanced Powerline Safety Settings (EPSS).
3. For Public Contact, the scope was narrowed to focus on members of the public and third-party contractors experiencing serious injuries or fatalities resulting from interactions with intact energized electric facilities, not involving asset failure.
4. Two risk models that were previously separate, Failure of Electric Distribution Network Assets and Failure of Electric Distribution Underground Assets, have been assembled into a single model.



RAMP Risk Chapters

Workshop Risks

① Wildfire with PSPS and EPSS

The Baseline Wildfire Risk is defined as a wildfire that may endanger the public, private property, sensitive lands or environment originating from PG&E assets or activities. In the near term, due to the use of PSPS and EPSS, we have also defined Post PSPS/EPSS Wildfire Risk as Wildfire Risk with PSPS and EPSS. This does account for the benefits and consequences of operational mitigations such as PSPS and EPSS.

② Large Uncontrolled Water Release

Failure of a high or significant hazard dam, where failure could cause loss of human life and/or could cause economic loss, environmental damage, and other concerns.

③ Loss of Containment (LOC) on Gas Transmission Pipeline

Failure of a gas transmission pipeline resulting in a LOC, with or without ignition, that could lead to significant impact on public safety, employee safety, contractor safety, property damage, financial loss, or the inability to deliver natural gas to customers. Failure of a gas transmission pipeline includes both pipeline leak and pipeline rupture.

④ Cybersecurity Risk Event

A coordinated malicious attack targeting PG&E's core business functions, resulting in disruption or damage of systems used for gas, electric and/or business operations.

Additional Risks Included in the 2024 RAMP Report

Electric Operations

Public Contact with Intact Energized Electrical Equipment

PCEEE is defined as the risk of reportable serious injury or fatality to a third-party contractor or member of the public from an interaction with intact PG&E electric assets that did not originate from asset failure.

Electric Transmission Systemwide Blackout

A system wide disturbance leading to a cascading event that causes a blackout of PG&E's electrical system, with the inability to restore the grid in a timely fashion.

Failure of Electrical Distribution Overhead Assets

Failure of Electric Distribution Overhead Assets or lack of remote operational functionality may result in public or employee safety issues, property damage, environmental damage, or inability to deliver energy.

Failure of Electric Distribution Underground Assets

The failure of distribution underground (including radial and network) assets or lack of remote operation functionality may result in public or employee safety issues, property damage, environmental damage, or inability to deliver energy.

Gas Operations

Loss of Containment (LOC) on Gas Distribution Main or Service

Failure of a gas distribution main or service resulting in a LOC, with or without ignition, that can lead to significant impact on public safety, employee safety, contractor safety, property damages, financial losses, or the inability to deliver natural gas (NG) to customers.

Large Overpressure Event Downstream of Gas Measurement and Control Facility

Failure of a gas M&C facility to perform its pressure control function resulting in a large OP event downstream that can lead to significant impact on public safety, employee safety, contractor safety, property damages, financial losses, and the inability to deliver natural gas to customers.

Shared Services

Employee Safety Incident

Any event resulting in: (1) a serious injury or fatality as defined by PG&E's SIF Standard which is aligned with the EEI SCL model or (2) a DART incident as defined by the OSHA.

Contractor Safety Incident

Any event resulting in a contractor serious injury or fatality as defined by PG&E's SIF Standard which is aligned with the EE International SCL Model.

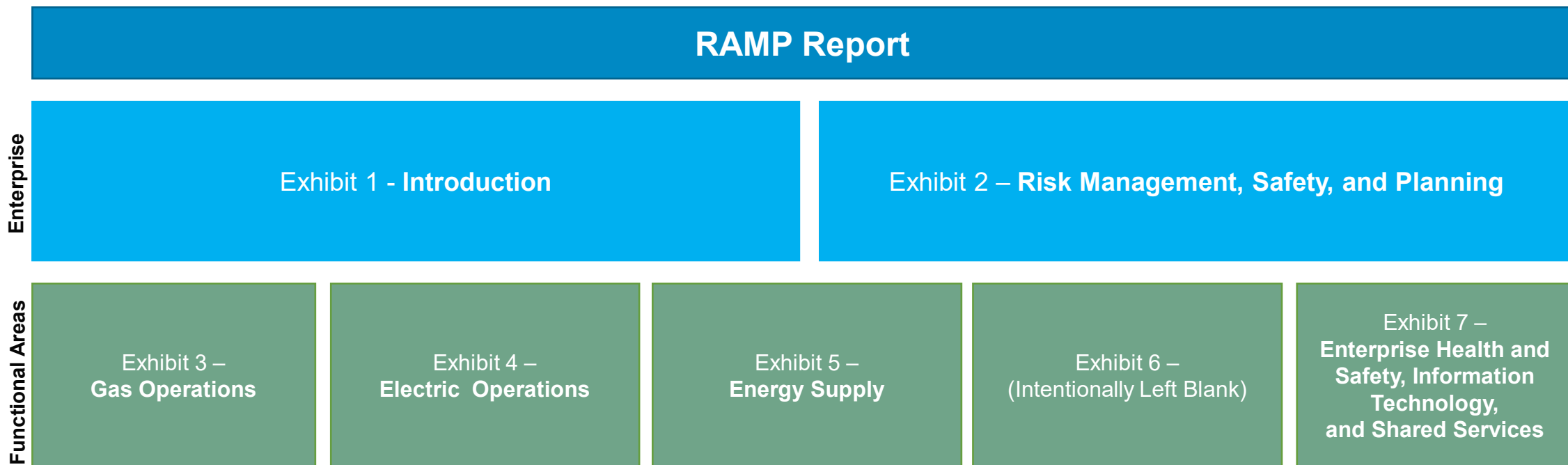
RAMP Report Organization

Sandy Allan – Enterprise and Operational Risk Management



RAMP Report Structure

PG&E aligned the RAMP 2024 filing with the organizational structure outlined in D.22-10-002, ensuring consistency across RSARs, RAMPs, and GRCs by standardizing chapters and headings.



PG&E’s 2024 RAMP report is organized into 7 Exhibits, with the first two exhibits providing an overview of the RAMP filing, applying the enterprise risk framework, and incorporating key lessons learned.

D.22-10-002

“The IOUs shall standardize chapters and headings in the RSAR, RAMPs and GRCs. Specifically, where RAMP risks pertain to only one GRC program, the filings should simply have the same name”



RAMP Report Overview

Exhibit 1 – Introduction

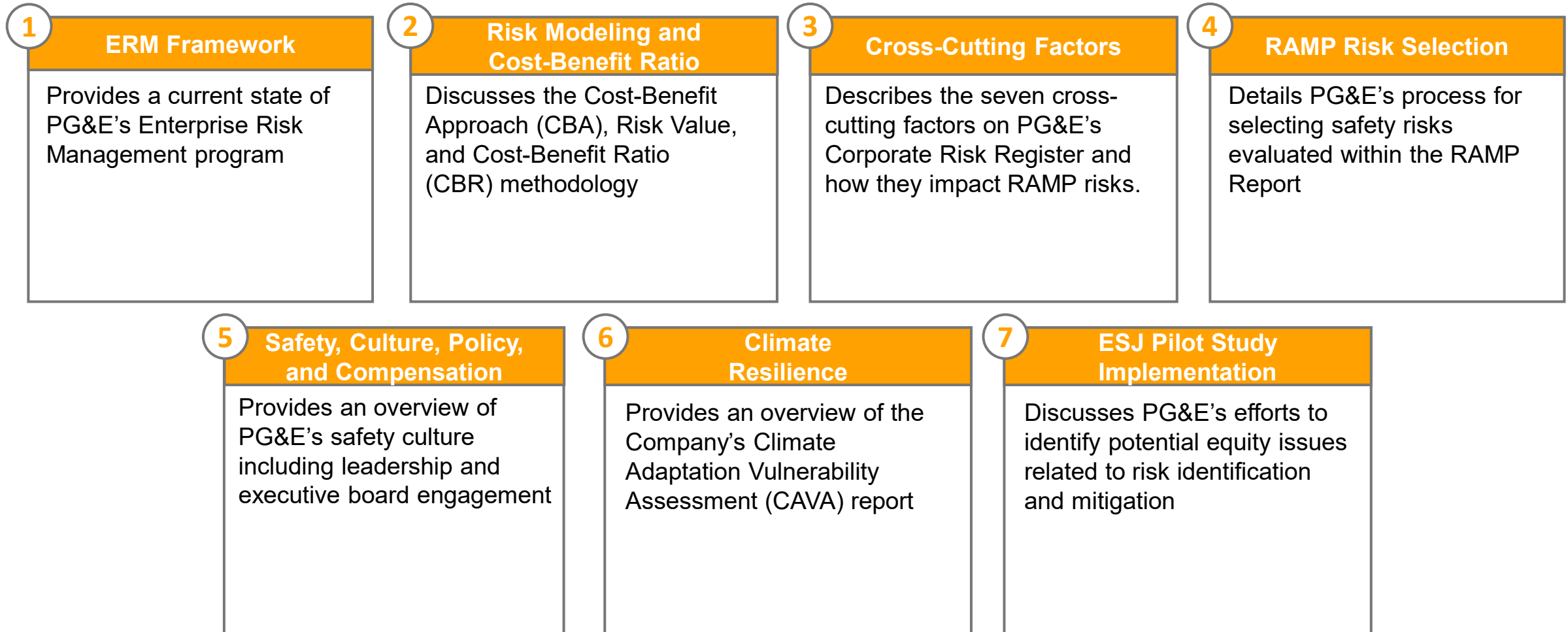
PG&E's 2024 RAMP Report constitutes the initial phase of the 2027 General Rate Case and represents progress on the joint efforts to enhance risk-informed decision-making.

Key Learnings	Guiding Principles	Developments from 2020 RAMP
<ul style="list-style-type: none">• Maintaining Flexibility• Applying a Balanced Approach to Risk Mitigation Planning• Understanding Limitations due to Modeling and Uncertainties• Prioritizing Safety	<ul style="list-style-type: none">• Transparency and Collaboration• Flexible and Nimble risk assessments and mitigation strategies• Balancing the use of quantitative models with utility management• Focus on eliminating incidents involving serious injuries or fatalities related to our assets and operations	<ul style="list-style-type: none">• Development and Implementation of Cost Benefit Approach (CBA)• Incorporation of Environmental and Social Justice Pilot Study Plan• Updated Modeling of PSPS Events as Risk Events• Refreshed view of RAMP Risks:<ul style="list-style-type: none">• Addition of Transmission Systemwide Blackout and Cybersecurity Risk Events• Removal of Real Estate and Facilities Failure risk and Motor Vehicle Safety Incident risk

RAMP Report – Risk Management Overview

Exhibit 2 – Risk Management, Safety, and Planning

Exhibit 2 provides an overview of PG&E’s approach to risk management, including its enterprise risk framework, risk modeling methodologies, and safety considerations.





RAMP Report – Risk Chapters Overview

Exhibit 3 – Gas Operations

Risks:

- Loss of Containment on Gas Transmission Pipeline
- Loss of Containment on Gas Distribution Main or Service
- Large Overpressure Event Downstream of Gas Measurement and Control (M&C) Facility

Exhibit 4 – Electric Operations

Risks:

- Wildfire with PSPS and EPSS
- Electric Transmission Systemwide Blackout
- Public Contact with Intact Energized Electrical Equipment
- Failure of Electric Distribution Overhead Assets
- Failure of Electric Distribution Underground Assets

Exhibit 5 – Energy Supply

Risks:

- Large Uncontrolled Water Release (Dam Failure)

Exhibit 7 – Enterprise Health and Safety, Information Technology, and Shared Services

Risks:

- Employee Safety Incident
- Contractor Safety Incident
- Cybersecurity Risk Event

Sections*

Risk
Assessment

2023-2026 Control
and Mitigation Plan

2027-2030 Proposed Control
and Mitigation Plan

Alternative
Mitigations Analysis

*While all exhibits contain these sections, there may be variance in sub-sections by exhibit

RAMP Workpaper Overview

Kim Mullins – Enterprise and Operational Risk Management





Workpapers for Exhibit and Chapters

Exhibit (PG&E-2)	Chapter/Section Name	Folder/Zip Name Convention
Exhibit (PG&E-2), Chapter 1	Risk Management Framework	RM – RSKMF
Exhibit (PG&E-2), Chapter 2	Risk Modeling and CBR	RM-RMCBR
Exhibit (PG&E-2), Chapter 3	Climate Change	RM-CCF > CCF-CLIMT
	IT Asset Failure	RM-CCF > CCF-ITAFL
	Physical Attack	RM-CCF > CCF-PHYSA
	Records and Information Management	RM-CCF > CCF-RECIM
	Seismic	RM-CCF > CCF-SSIMC
Exhibit (PG&E-2), Chapter 4	RAMP Risk Selection	RM – SELECT
Exhibit (PG&E-2), Chapter 5	Safety Culture, Policy, and Compensation	RM – SAFEC

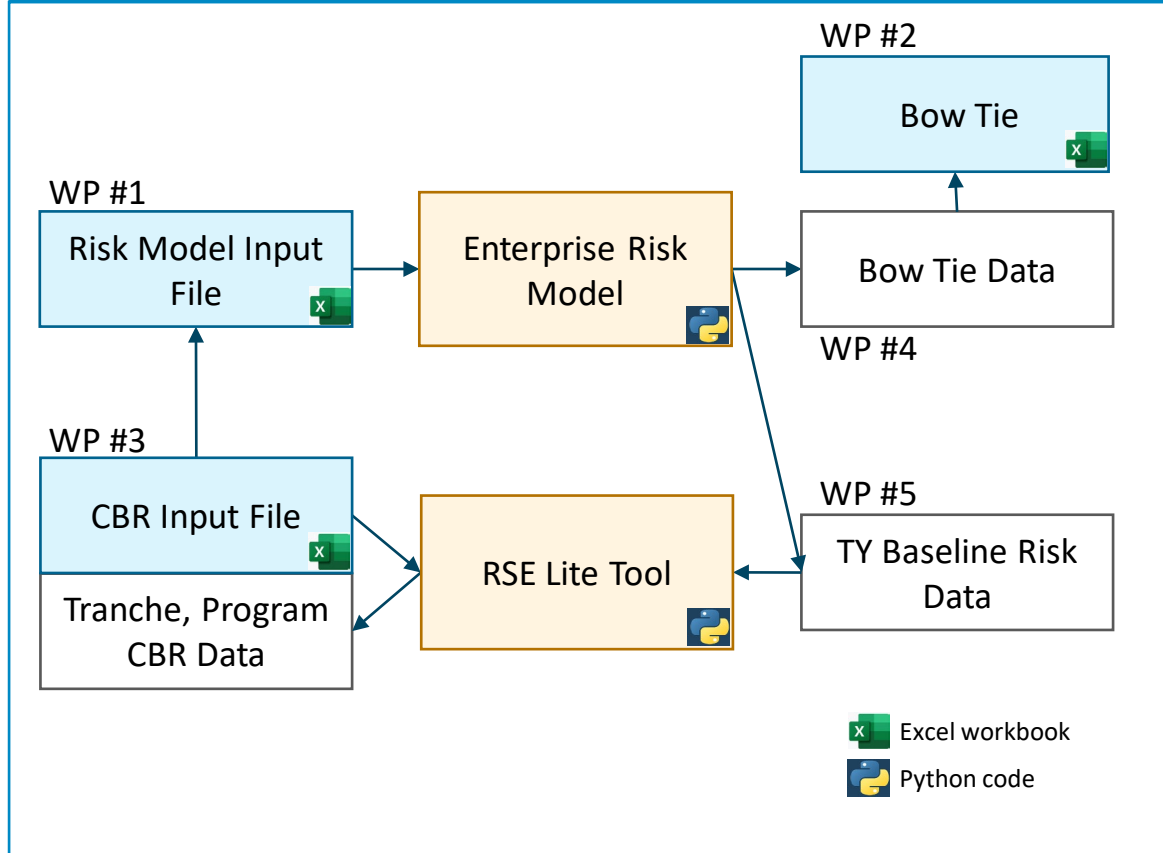
Exhibits with Risk Chapters	Chapter Name	Folder/Zip Name Convention
Exhibit (PG&E-3), Chapter 1	Loss of Containment (LOC) on Gas Transmission Pipeline	GO-LOCTM
Exhibit (PG&E-3), Chapter 2	LOC on Gas Distribution Main or Service	GO-LOCDM
Exhibit (PG&E-3), Chapter 3	Large Overpressure Event Downstream of Gas Measurement and Control (M&C) Facility	GO-LRGOP
Exhibit (PG&E-4), Chapter 1	Wildfire with PSPS and EPSS	EO-WLDFR > EO-WLDFR EO-WLDFR > EO-WPSPS EO-WLDFR > EO-WEPS
Exhibit (PG&E-4), Chapter 2	Electric Transmission Systemwide Blackout	EO-BLKOT
Exhibit (PG&E-4), Chapter 3	Public Contact with Intact Energized Electrical Equipment (PCEEE)	EO-PCEEE
Exhibit (PG&E-4), Chapter 4	Failure of Electric Distribution Overhead Assets	EO-DOVHD
Exhibit (PG&E-4), Chapter 5	Failure of Electric Distribution Underground Assets	EO-DUNGD
Exhibit (PG&E-5), Chapter 1	Large Uncontrolled Water Release (Dam Failure)	EO-LGUWR
Exhibit (PG&E-7), Chapter 1	Contractor Safety Incident	EHS-CNTSI
Exhibit (PG&E-7), Chapter 2	Cybersecurity Risk Event	IT-CYBER
Exhibit (PG&E-7), Chapter 3	Employee Safety Incident	EHS-EMPSI

Exhibit (PG&E-2) Ch2 Risk Modeling and CBR WPs

WP Ref No.	Document Description	WP Ref No.	Document Description
RM-RMCBR-0	Workpaper Package Guide, containing how to navigate workpapers and description of standard files and their relationships	RM-RMCBR-11	Contains source of 2.3% long-term inflation rate.
RM-RMCBR-1	Documentation and User Guide for ERM model and associated Risk Model Input File, used to compute risk values in the RAMP report	RM-RMCBR-12	Foundational activities costs are allocated across programs.
RM-RMCBR-2	Documentation and User Guide for RSE Lite Tool and associated CBR Input File, used to compute the CBR values of the mitigation and control program.	RM-RMCBR-13	PVRR Multiplier Calculation used in CBR Calculation
RM-RMCBR-3a, 3b	Replication of Baseline Risk Values for BLKOT and PCEEE risks	RM-RMCBR-14	2027 TY Baseline Risk Values for CRR risks by attributes
RM-RMCBR-3c, 3d, 3e	Replication of CBR for PCEEE-C001, PCEEE-C002, PCEEE-M001	RM-RMCBR-15	Mitigation and Control CBRs and Tranche-level CBRs
RM-RMCBR-4	Bow Tie File User Guide	RM-RMCBR-16	This file contains numerical example that are illustrated in Exhibit (PG&E-2) Chapter 2, section D.5.
RM-RMCBR-5	US CPI-U Index (used for historical inflation rates and monetized value escalation)	RM-RMCBR-17	PG&E's 2024 RAMP Prefiling Workshop #2 Slide deck, April 11, 2024
RM-RMCBR-6	Calculation of VSL used to derive monetized Safety Attribute values in PG&E's CBA	RM-RMCBR-18	Graphs (one for each risk) showing the 2027 TY Baseline Risk Values per Exposure VS Exposure. Tranches are sorted by risk value per exposure. Area shows the risk by tranche.
RM-RMCBR-7	California Consumer Price Index, 1955-2023	RM-RMCBR-19	Graphs showing the NPV risk reduction VS the NPV program cost 2027-2030.
RM-RMCBR-8	ICE calculator with PG&E's User Inputs. Used to derive monetized Electric Reliability attribute values in PG&E's CBA.	RM-RMCBR-20	Graphs showing the Tranche-level (or risk-level for CCF) CBRs VS the NPV Program Cost. Tranches (or risks for CCF) are sorted by CBR. Area shows the NPV risk reduction 2027-2030.
RM-RMCBR-9	PG&E input data used for number of customers by customer type, manufacturing customer % and outage distribution by time of day and year to be used in ICE Calculator.		
RM-RMCBR-10	Derivation of Gas Reliability Attribute Monetization Values, based on RDF, using implied value from PG&E's MAVF.		

Modeling, Technical Workpaper Overview

Relationship between Modeling Workpapers



Modeling Workpapers

The set of workpapers common to each of the 12 RAMP risk chapters.

- The data in the Risk Model Input File and the Enterprise Risk Model (ERM) calculations are described in (PG&E-2) WPs RM-RMCBR-1
- The data in the CBR Input File and the RSE Lite Tool calculations are described in (PG&E-2) WPs RM-RMCBR-2
- The data in the Bow Tie file is described in (PG&E-2) WPs RM-RMCBR-4.











Technical Workpapers

The set of files in workpapers 6+ (the Technical Workpapers) includes data, analysis, assumptions, etc. that support the Modeling Workpapers. The set of files will vary from risk to risk, though some technical workpapers may be shared by multiple risks.

Risk Chapter Workpaper Folder Structure

A majority of the Risk Event and Cross-Cutting Factor Event Workpaper Folders will follow the structure below.

Example for (PG&E-4) Ch3 EO-PCEEE:

-  EO-PCEEE-0_Risk Workpaper Index.xlsx
-  EO-PCEEE-1_Risk Model Input File.xlsm
-  EO-PCEEE-2_Bow tie.xlsm
-  EO-PCEEE-3a_CBR Input File (System Hardening).xlsm
-  EO-PCEEE-3b_CBR Input File (PCEEE Programs).xlsm
-  EO-PCEEE-4_Bow Tie Data File.xlsx
-  EO-PCEEE-5_TY Baseline Risk Data.xlsx
-  EO-PCEEE-6_SIF_Incidents_2018-2022.xlsx
-  EO-PCEEE-7_20. PCEEE Programs.xlsx
-  EO-PCEEE-F.xlsx

#0-5: Modeling workpapers















#6-N: Technical workpapers

#F: Financial workpaper

Risk Chapter Workpaper Folder Structure (cont'd)

Some Electric Operations risks have additional workpapers that serve as the input to the CBR Input File. These will have the Mitigation or Control IDs in the File ID.

Example for (PG&E-4) Ch1 EO-WSPSPS:

-  EO-WSPSPS-0_Risk Workpaper Index.xlsx
-  EO-WSPSPS-1_Risk Model Input File.xlsm
-  EO-WSPSPS-2_Bow tie.xlsm
-  EO-WSPSPS-3a_CBR Input File (System Hardening).xlsm
-  EO-WSPSPS-3b_CBR Input File (PSPS).xlsm
-  EO-WSPSPS-3c_CBR Input File (Battery).xlsm
-  EO-WSPSPS-4_Bow Tie Data File.xlsx
-  EO-WSPSPS-5_TY Baseline Risk Data.xlsx
-  EO-WSPSPS-6_Safety Impacts from Widespread Unplanned Out...
-  EO-WSPSPS-7_PSPS Battery Workpapers.xlsx
-  EO-WSPSPS-8_PSPS Lookback Analysis_2022 Guidance.xlsx
-  EO-WSPSPS-9_PSPS Event Financial Cost 2019-2021.xlsx
-  EO-WSPSPS-10_PSPS Lookback Tag Multiplier.xlsx
-  EO-WSPSPS-M002_Dx_Sectionalizers.xlsx

#0-5: Modeling workpapers

#6-N: Technical workpapers

#MXXX or #CXXX: Input to CBR Input File

Interruption Cost Estimate Calculator

Benson Wong – Enterprise and Operational Risk Management





PG&E's Electric Reliability Attribute Risk Valuation

PG&E used the Weighted Average Value of Electric Reliability from ICE for its 2024 RAMP.

- Large disparities in Values between C&I and Residential Customers could lead to significant, unintended consequences.
- PG&E will review the policy of using the Average pending the ICE 2.0 update.
- PG&E expresses the Monetized Electric Reliability Attribute as Cost per Customer Minutes Interrupted (\$/CMI), shown below in \$2023.

$$\frac{\text{Cost}}{\text{CMI}} = \frac{\text{Cost Per Event}}{\text{SAIDI}} = \frac{\text{Cost Per Event} \times \text{Total No. of Customers}}{\text{Sum of All Customer Interruption Durations}}$$

ICE Model Outputs				
	ICE User Input Default		PG&E Data	
Sector	Cost per CMI (2016\$)	Cost per CMI (2023\$)	Cost per CMI (2016\$)	Cost per CMI (2023\$)
Medium and Large C&I	\$70.37	\$89.34	\$61.35	\$77.89
Small C&I	\$5.36	\$6.81	\$7.87	\$9.99
Residential	\$0.04	\$0.06	\$0.04	\$0.06
All Customers	\$1.53	\$1.94	\$2.50	\$3.17

- To compute Electric Reliability Attribute Risk Values in its risk models, PG&E is using the \$3.17/CMI for all customer classes.
- The resulting Electric Reliability Risk Values are approximately 63% higher with PG&E's User Inputs, compared to \$1.94/CMI from the default User Input.

Note: PG&E adjusted ICE Calculator year 2016 results to \$2023 using BLS CPI data, available at <https://data.bls.gov/timeseries/CUUR0000SA0>.

SPD requested on May 20th analyses varying the weighted value of reliability from ICE Calculator 1.0 based on the customer mix by geographical location

- Blended Value of Reliability to be split based on High Fire Threat District (HFTD) Tier 3, HFTD Tier 2, non-HFTD EPSS Capable, and non-HFTD EPSS Not Capable.
- While 'Total Customers' based on Customer Sector are a large driver to the blended Cost/CMI, other inputs in the ICE Calculator would also be impacted, but not assessed here. PG&E responded to Question 1 and 2 based on 'Total Customers' updates only on June 11th.
 - PG&E refreshed its customer and customer mix data for this analysis but anchored to the customer count as presented in 2024 RAMP.
- Additionally, using the updates to the Blended Value of Reliability, SPD wants to re-compute CBA Risk Scores for the Electric Risks.
- The application of this Blended Value of Reliability would be based on risk event location vs customer location.
- This analysis would not be consistent with what is presented in RAMP and how reliability risk is being evaluated.
- This analysis will require the restructuring of the RAMP models and PG&E tentatively expects this to be completed by September.
- PG&E is engaged in bi-weekly meetings with SPD on the progress of this analysis.

Note:

- As part of this analysis, PG&E identified an error in the ICE Calculator Inputs, specifically the Outage by Time of Day.
- PG&E utilized UTC instead of Local Time to determine the percentage of Outage by Time of Day.
- PG&E has will be issuing an ERRATA log communication to document this and the result does not have a significant impact.

RAMP Risk Presentations



Wildfire with PSPS and EPSS 2024 RAMP Post-Filing Workshop

Electric Operations

Presenters: Andy Abranches, Benson Wong



Wildfire with PSPS and EPSS: Executive Summary

We will provide an overview of Wildfire with PSPS and EPSS for inclusion in the 2027 GRC.

Key Topics:

Overview

Definition of Wildfire with PSPS and EPSS, RAMP risk score, mitigation strategy

Risk Comparison

Measurement and comparison of Wildfire with PSPS and EPSS safety risk versus other risks in RAMP

Assessment

Model overview, Risk Bowtie, Drivers, Consequence

Mitigation Strategies

CBR and risk reduction overview of control and mitigation programs for Wildfire with PSPS and EPSS



Wildfire Including PSPS and EPSS: Definition

Risk Name

Wildfire with PSPS and EPSS

Risk Definition

The Baseline Wildfire Risk is defined as a wildfire that may endanger the public, private property, sensitive lands or environment originating from PG&E assets or activities. In the near term, due to the use of PSPS and EPSS, we have also defined Post PSPS/EPSS Wildfire Risk as Wildfire Risk with PSPS and EPSS. This does account for the benefits and consequences of operational mitigations such as PSPS and EPSS.

Scope

In Scope

- 2015 to 2022 PG&E recorded ignition record (CPUC reportable and non-reportable).
- Other PG&E failure events (e.g., equipment failure without ignition, outage, etc.)

Out of scope

- Fire ignitions and associated impacts not related to PG&E electric system assets.

Tranche development

Location and Facility Type, PG&E Wildfire Distribution Risk Model and Transmission Asset Classifications

Tranches

- Location – Union of HFTD¹ + HFRA² (HFTD/HFRA) and non-HFTD/HFRA
- Facility Types – Transmission, Substation, Distribution Primary (Overhead and Underground), Secondaries and Services
- Distribution - Deciles of Risk based on WDRMv3
- Transmission Voltage Class

Date range

2015 through 2022

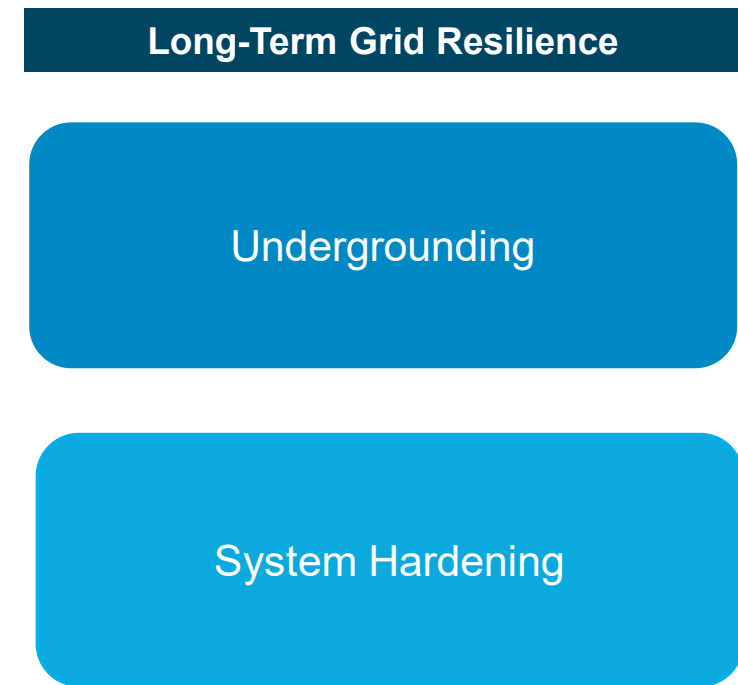
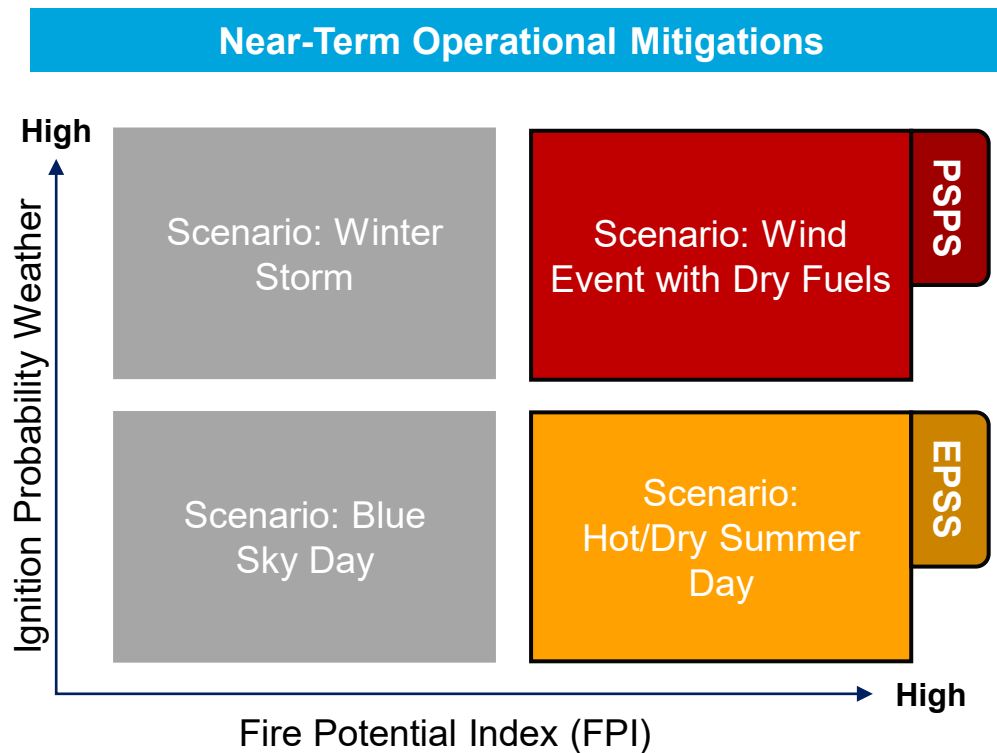
1. HFTD: High Fire Threat District
2. HFRA: High Fire Risk Area

Wildfire Including PSPS and EPSS: RAMP Risk Scores

Safety Rank	PG&E Enterprise Risk Register (ERR) Risk	RAMP Risk	TY Baseline (2027)	
			Safety Risk Value (\$M)	Total Risk Value (\$M)
1	Wildfire with PSPS and EPSS	✓	222	7,666
2	Loss of Containment (LOC) on Gas Transmission Pipeline	✓	139	186
3	Public Contact with Intact Energized Electrical Equipment	✓	60	60
4	Failure of Electric Distribution Overhead Assets	✓	54	3,354
5	Electric Transmission Systemwide Blackout	✓	52	1,903
6	Contractor Safety Incident	✓	39	39
7	Employee Safety Incident	✓	30	39
8	Cybersecurity Risk Event	✓	25	1,007
9	Large Uncontrolled Water Release (Dam Failure)	✓	21	258
10	Failure of Electric Distribution Underground Assets	✓	19	728
11	Loss of Containment on Gas Distribution Main or Service	✓	19	107
12	Large Overpressure Event Downstream of Gas M&C Facility	✓	18	19

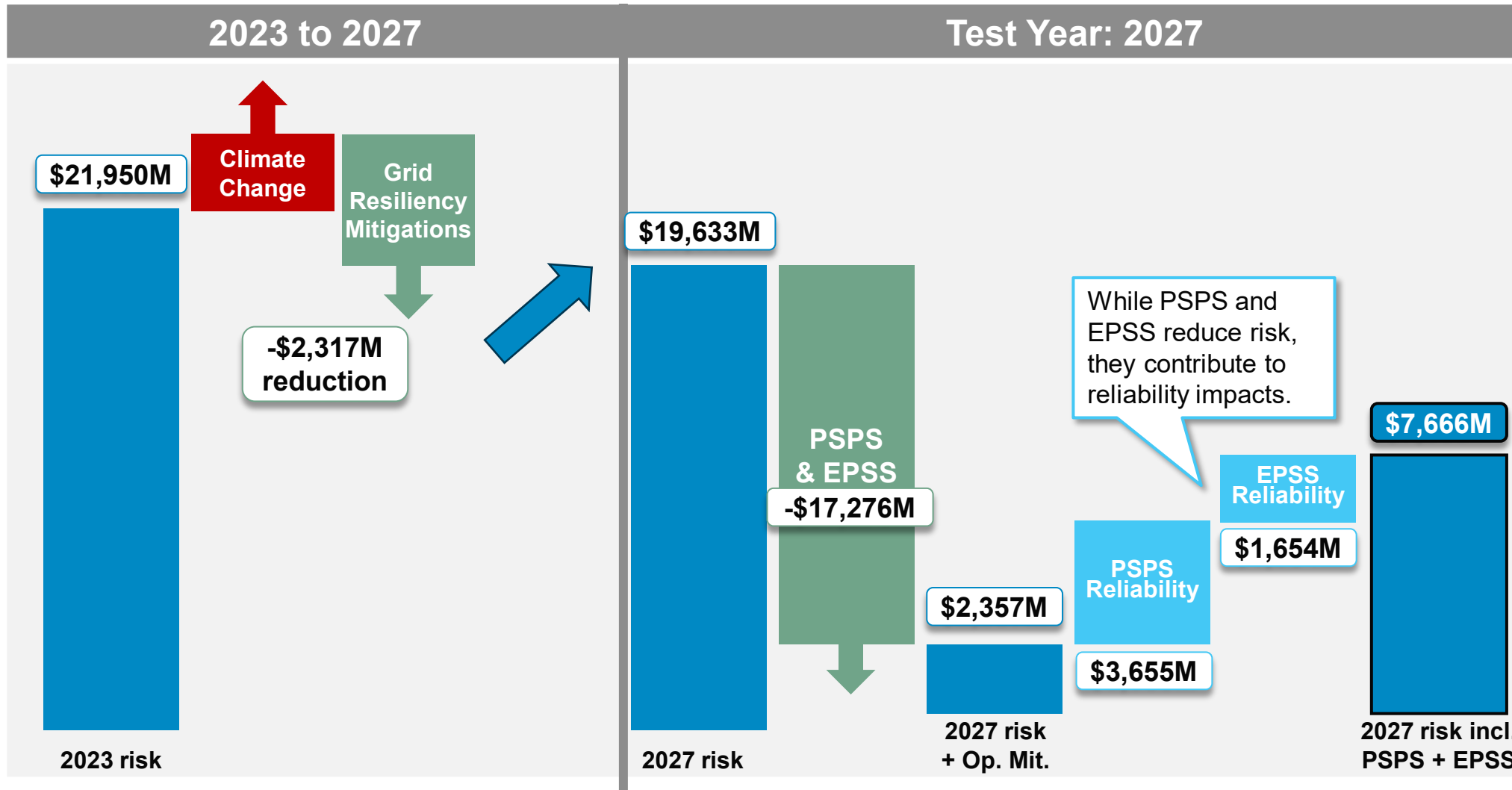
Wildfire Mitigation Strategy

While we continue to develop and implement long-term, permanent risk mitigation strategies like undergrounding and system hardening work, we have built and continue to improve upon near-term measures like **Public Safety Power Shutoff** and **Enhanced Powerline Safety Settings**. These operational mitigations quickly address dangerous weather events and potential ignitions.



As we continue to build on long-term grid resilience efforts,
the need for operational mitigations will decrease over time.

Wildfire Risk with PSPS and EPSS: 2023 vs. 2027




2027-2030:
Continuing to
prioritize grid
resiliency
mitigations.

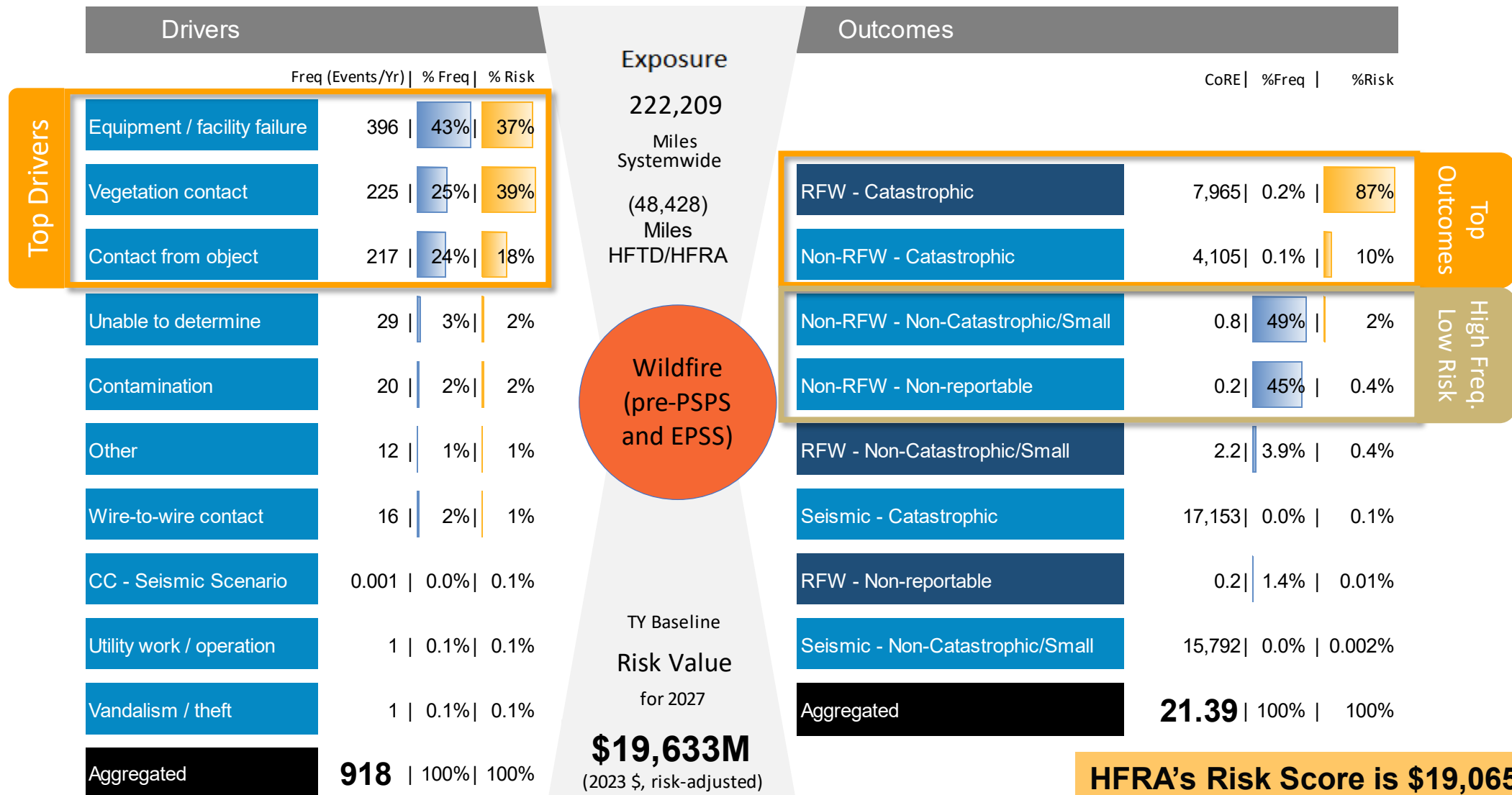
Distribution Primary Tranches

We are focusing our resiliency mitigation work in the highest risk areas. Despite increased climate change risks, these efforts will reduce risk in our top deciles by 2027 compared to 2023.

Grid Resiliency Mitigations

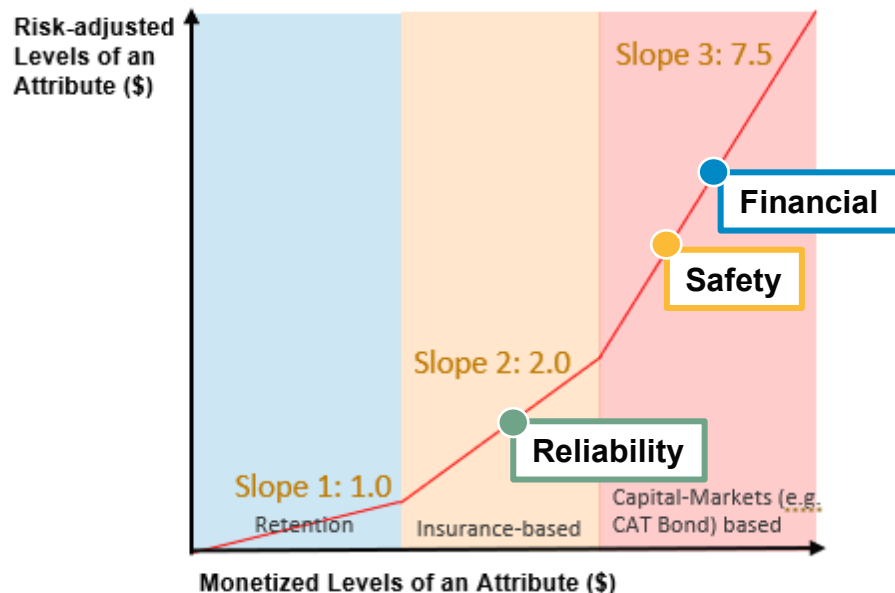
Row Labels	Miles	2023 Baseline				2027 TY Baseline		
		Risk	% Risk	Risk/Mile		Risk	% Risk	Risk/Mile
HFRA - Distribution - Primary - Tranche 1	434	1,739	7.9%	4.0		636	3.2%	1.5
HFRA - Distribution - Primary - Tranche 2	596	1,718	7.8%	2.9		627	3.2%	1.1
HFRA - Distribution - Primary - Tranche 3	718	1,743	7.9%	2.4		1,385	7.1%	1.9
HFRA - Distribution - Primary - Tranche 4	869	1,729	7.9%	2.0		1,754	8.9%	2.0
HFRA - Distribution - Primary - Tranche 5	1,088	1,790	8.2%	1.6		1,840	9.4%	1.7
HFRA - Distribution - Primary - Tranche 6	1,340	1,740	7.9%	1.3		1,721	8.8%	1.3
HFRA - Distribution - Primary - Tranche 7	1,765	1,740	7.9%	1.0		1,768	9.0%	1.0
HFRA - Distribution - Primary - Tranche 8	2,535	1,755	8.0%	0.7		1,788	9.1%	0.7
HFRA - Distribution - Primary - Tranche 9	3,930	1,699	7.7%	0.4		1,776	9.0%	0.5
HFRA - Distribution - Primary - Tranche 10	12,660	1,517	6.9%	0.1		1,558	7.9%	0.1

Systemwide Wildfire Risk



Wildfire Risk Score Calculation

Risk Scaling Function



Financial	\$0 - \$10m	\$10m - \$1b	\$1b+	
Safety	0 - 1 EF \$0 - \$15.2m	1 - 10 EF \$15.2m - \$152m	10+ EF \$152m+	\$15.23m/EF
Electric Reliability	0 - 100m CMI \$0 - \$317m	100 - 1,000m CMI \$317m - \$3.17b	1,000m+ CMI \$3.17b+	\$3.17/CMI
Gas Reliability	0-7.5k cust \$0 - \$11.5m	7.5k - 75k cust \$11.5m - \$115m	75k+ cust \$115m+	\$1,570 / customer

Slope 1 set to reflect preference to "in-house" the risk, slopes 2 and 3 set based on observed multipliers in insurance and Cat-Bond pricing.

Total Risk Score (risk-adjusted) = **\$19,633M**

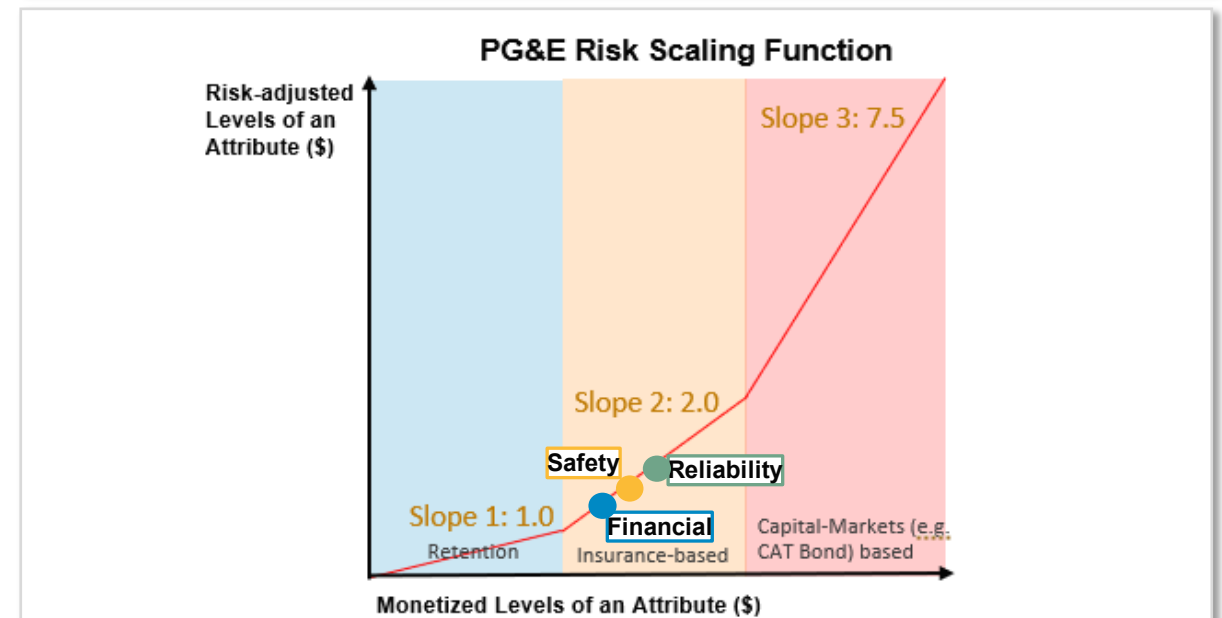
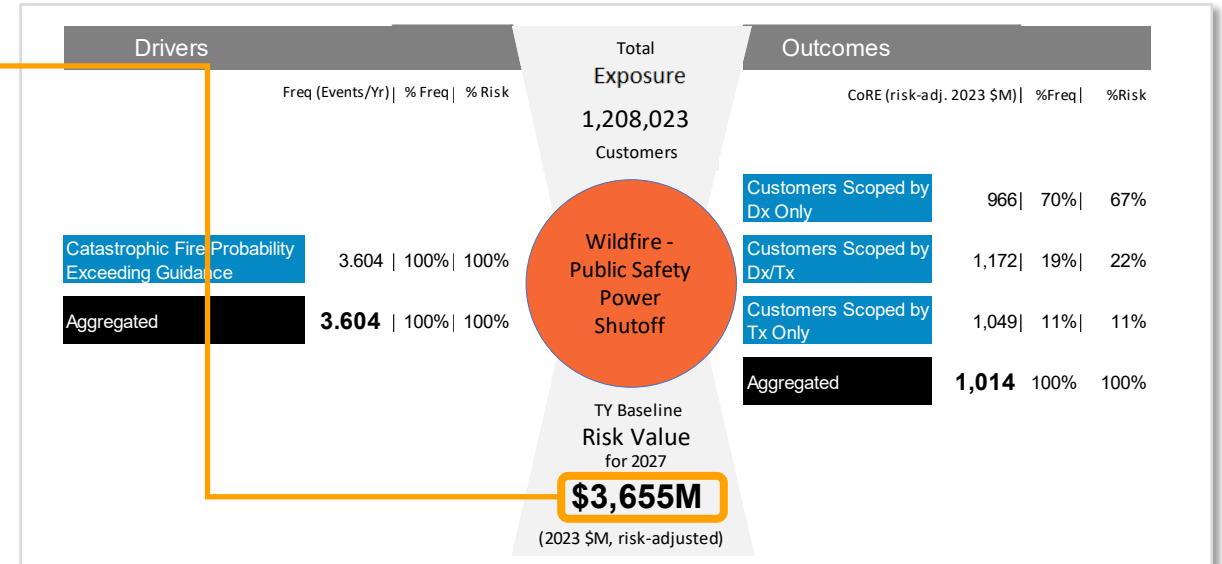
<div><div>a</div><div>×</div><div>b</div><div>×</div><div>c</div><div>=</div><div>Risk Score (\$M)</div></div>					
	Natural Units	Risk Monetization	Risk Attitude		
Attribute	Financial	\$3.069 billion	\$1	5.45	\$16,741
	Safety	22.78 Equivalent Fatalities (EF)	\$15.23/EF	5.34	\$1,851
	Reliability	221.8M Customer Minutes Interrupted (CMI)	\$3.17/CMI	1.48	\$1,041

Attribute	Natural Units Derived from
Financial	Historical damages associated with large fires (e.g., suppression cost per acre, cost of buildings destroyed)
Safety	Historical safety impacts based on CALFIRE dataset
Reliability	Historical CMI impact from fires

Total Risk Score (risk-adjusted) = **\$3,655M**

		<div>a</div> Natural Units	×	<div>b</div> Risk Monetization	×	<div>c</div> Risk Attitude	= Risk Score (\$M)
Attribute	Financial	\$45 million		\$1		1.28	\$58
	Safety	2.1 Equivalent Fatalities (EF)		\$15.23M/ EF		1.37	\$44
	Reliability	690M Customer Minutes Interrupted (CMI)		\$3.17/ CMI		1.62	\$3,553

Attribute	Natural Units Derived from
Financial	Cost estimates based on linear regression of historical PSPS execution costs
Safety	Indirect safety risk impacts based on reliability minutes in the PSPS lookback
Reliability	PSPS historical lookback of current PSPS criteria applied against historical weather conditions



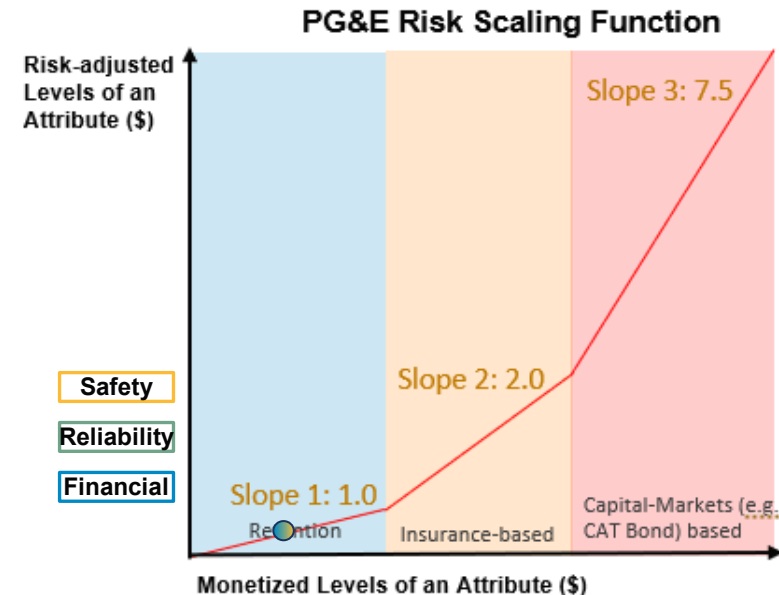
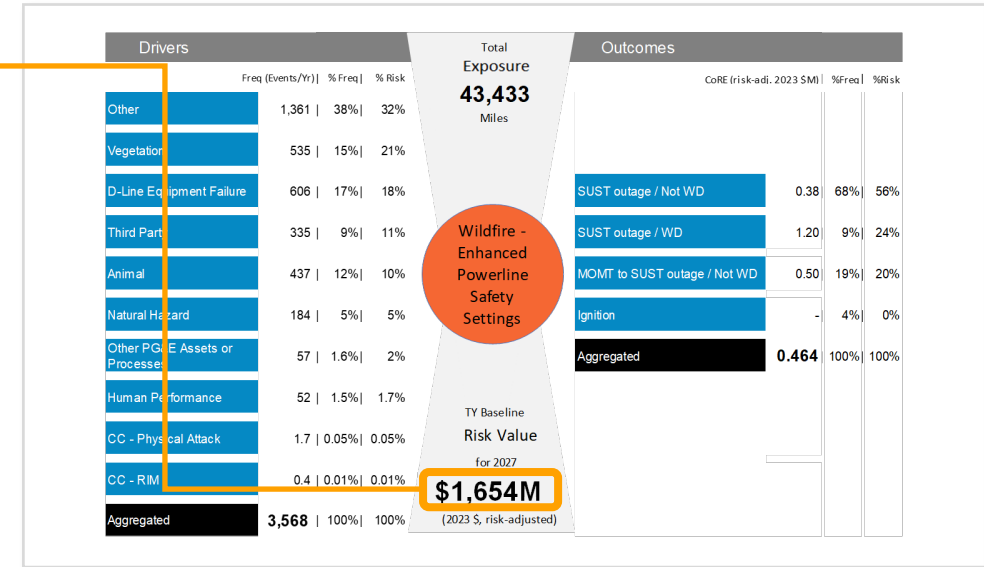
Note: The points shown are the ratio of the Expected Risk-Adjusted Value to the Expected Risk-Neutral Value. They are superimposed on the Risk Scaling Function to convey, overall the effects of Risk-Scaling

EPSS Reliability

Total Risk Score (risk-adjusted) = **\$1,654M**

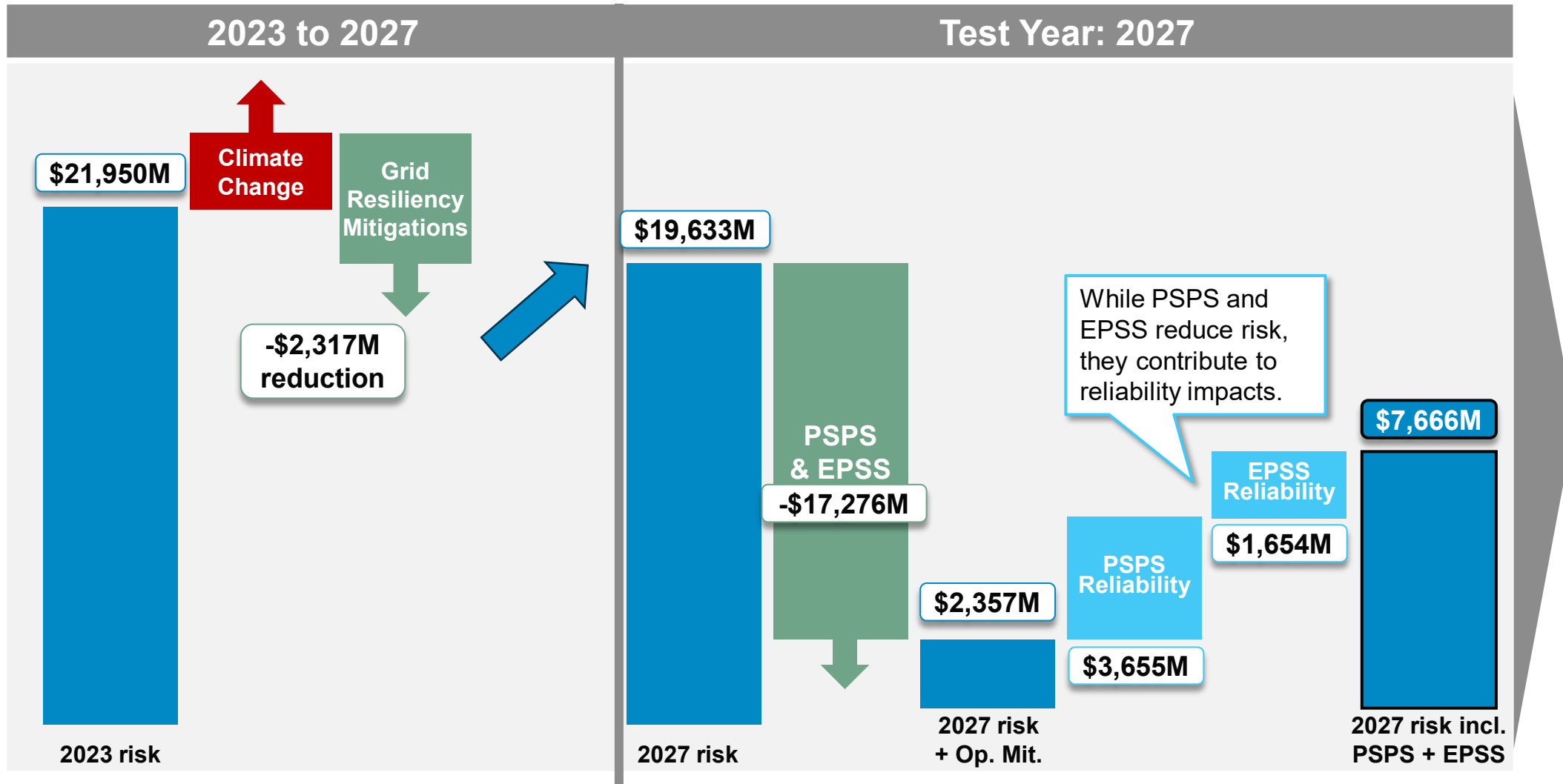
		<div>a</div> Natural Units	×	<div>b</div> Risk Monetization	×	<div>c</div> Risk Attitude	= Risk Score (\$M)
Attribute	Financial	\$2.94 million		\$1		1.0	\$2.94
	Safety	1.21 Equivalent Fatalities (EF)		\$15.23M/EF		1.0	\$18.5
	Reliability	515M Customer Minutes Interrupted (CMI)		\$3.17/CMI		1.0	\$1,633

Attribute	Natural Units Derived from
Financial	Incremental cost expected based on EPSS lookback of additional momentary turned sustained costs
Safety	Indirect safety risk impacts from incremental reliability impacts from EPSS lookback
Reliability	EPSS historical lookback against historical outages and incremental increase of CMI



Note: The points shown are the ratio of the Expected Risk-Adjusted Value to the Expected Risk-Neutral Value. They are superimposed on the Risk Scaling Function to convey, overall the effects of Risk-Scaling

Wildfire Risk with PSPS and EPSS: 2023 vs. 2027



Environmental and Social Justice (ESJ) Pilot Study Plan

Customers in Disadvantaged and Vulnerable Communities (DVCs) comprise a proportionally larger subset of customers in higher risk areas. As a result, DVCs receive a disproportionately large share of the benefit from wildfire safety work.

Line No.	Distribution Tranche Group*	% DVC Customers	Baseline WF Risk	DVC Risk	Non-DVC Risk	% DVC Risk
1	HFRA – Distribution – Tranche 1	23%	786	226	560	29%
2	HFRA – Distribution – Tranche 2	18%	808	210	599	26%
3	HFRA – Distribution – Tranche 3	35%	1,530	638	892	42%
4	HFRA – Distribution – Tranche 4	32%	1,896	740	1,155	39%
5	HFRA – Distribution – Tranche 5	28%	1,959	709	1,250	36%
6	HFRA – Distribution – Tranche 6	31%	1,843	641	1,202	35%
7	HFRA – Distribution – Tranche 7	20%	1,899	529	1,370	28%
8	HFRA – Distribution – Tranche 8	22%	1,930	593	1,337	31%
9	HFRA – Distribution – Tranche 9	15%	1,946	414	1,532	21%
10	HFRA – Distribution – Tranche 10	13%	1,709	338	1,371	20%
11	Non-HFRA – Distribution – Tranche 1	87%	12	3	9	23%
12	Non-HFRA – Distribution – Tranche 2	3%	20	2	18	10%
13	Non-HFRA – Distribution – Tranche 3	64%	24	7	17	29%
14	Non-HFRA – Distribution – Tranche 4	27%	25	7	17	30%
15	Non-HFRA – Distribution – Tranche 5	17%	17	6	11	35%
16	Non-HFRA – Distribution – Tranche 6	56%	34	12	22	36%
17	Non-HFRA – Distribution – Tranche 7	39%	33	9	24	27%
18	Non-HFRA – Distribution – Tranche 8	21%	31	10	22	31%
19	Non-HFRA – Distribution – Tranche 9	16%	56	12	44	21%
20	Non-HFRA – Distribution – Tranche 10	31%	260	106	154	41%
21	Grand Total	29%	16,818	5,213	11,604	31%

Note: HFRA in this table refers to HFTD/HFRA.

Overview:

- PG&E selected WLDFR as an Environmental and Social Justice Pilot Study Plan (PSP) pilot risk for Action Items #1 and #6
- PG&E developed a methodology for determining the benefits to Disadvantaged and Vulnerable Communities (DVCs, as defined in D.22-12-027)
- PG&E expects \$2 billion or 31 percent to be spent on System Hardening [UG] mitigation to reduce risk in DVCs, relative to \$6.5 billion forecasted mitigation budget
- For example, in Tranche 1, the DVC customers, which make up 23% of the total customer population, get 29% of the risk reduction value from SH

Control and Mitigation Programs Performance Overview

PG&E provides Cost-Benefit Ratios (CBRs) across 33 Control and Mitigation programs to demonstrate the 2027-2030 benefits contributed to reducing Wildfire risk. Twenty-two programs have a CBR over 1, while others are maintained for compliance, adherence to the Wildfire Mitigation Plan (WMP) and modeling limitations.

33

Overall Programs

21

Mitigation Programs

12

Control Programs

<0.1 – 117.1

CBR Range

Highest CBR Programs				
Rank	Controls		Mitigations	
	Program	CBR	Program	CBR
1	Animal Abatement (Proactive) [2AC,KAD]	117.1	EPSS	51.9
2	Emergency Distribution Replacements [17B]	111.4	PSPS	42.8
3	Animal Abatement (Reactive) [2AB,KAC]	18.0	System Hardening [Remote Grid]	20.9

Highest Risk Reduction Programs				
Rank	Controls		Mitigations	
	Program	Risk Reduction	Program	Risk Reduction
1	Emergency Distribution Replacements [17B]	\$46,108M	System Hardening [Underground]	\$51,323M
2	VM Distribution – Routine Patrols	\$6,531M	EPSS	\$24,975M
3	Animal Abatement (Proactive) [2AC,KAD]	\$3,465M	System Hardening [Overhead]	\$7,987M

Control and Mitigation Programs Overview by Type

33

Overall Programs

21

Mitigation Programs

12

Control Programs

<0.1 – 117.1

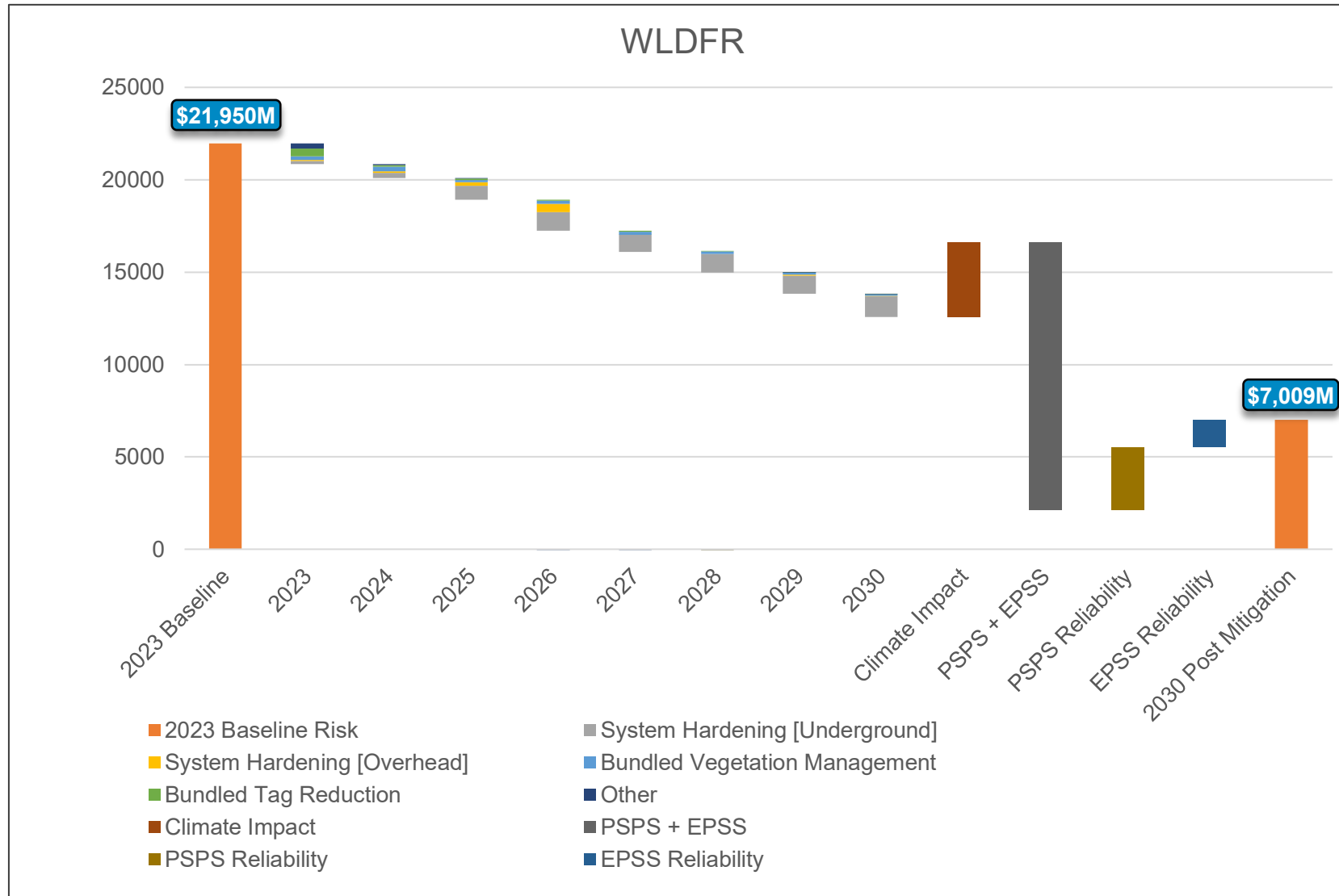
CBR Range

Control Programs		
Program Type	# of Programs	CBR Range
Animal Abatement	2	18 – 117.1
Vegetation Inspection/Control	2	0.8 – 3.2
Distribution Maintenance and Repair	5	0.2 – 111.4
Distribution Pole	3	<0.1 – 1

Mitigation Programs		
Program Type	# of Programs*	CBR Range
Distribution Grid Hardening	3	7.9 – 20.9
Operational - (SIPT, EPSS, PSPS)	3	5.7 – 51.9
Distribution Backlog	4	<0.1 – 6.6
Vegetation	7	<0.1 – 5.4
PSPS - Mitigation	5	2.3 – 13.7
EPSS - Mitigation	4	4.1 – 13.7

*26 mitigation program count reflects overlap of 5 mitigation programs across different program types (System Hardening [UG], VM Distribution – Operational Improvements, Permanent Battery, Portable Battery, RSI Battery).

Wildfire with PSPS and EPSS: Risk Reduction Waterfall



Overview:

Largest risk mitigations included:

- System Hardening [Overhead]
- System Hardening [Underground]
- Bundled Tag Reduction
- Bundled Vegetation Management

Other consists of all remaining Wildfire mitigations for 2023 – 2030

Climate Impact compares the baseline mitigation from 2030 and 2023

PSPS + EPSS includes the proposed 2030 baseline mitigation and climate impact

Alternatives Analysis

PG&E also considered four alternative mitigations that could be deployed in the future, including the cost estimates, risk reduction values, and CBRs for each of the Alternative Plans.

Alternative Plan 1: System Hardening [UG]	Alternative Plan 2: Grid Monitoring
<p>Program ID(s): WLDFR-A001, WPSPS-A001, DOVHD-A001, PCEEE-A003 Risk Reduction: \$60,725.9M CBR: 9.7</p> <ul style="list-style-type: none"> • Considers Primary cables considered for Undergrounding, with Secondary and Service lines mitigated through Overhead System Hardening ONLY • Alternate workplan would underground fewer miles per year after 2027 <ul style="list-style-type: none"> • 2027: 500 miles, 2028: 550 miles, 2029: 600 miles, 2030: 650 miles • Lowers cost, allowing additional budget for other electric programs including addressing the backlog of identified pole tags 	<p>Program ID(s): WLDFR-A002, DOVHD-A002 Risk Reduction: \$600.2M CBR: 6.9</p> <ul style="list-style-type: none"> • Builds on SME assessment model by implementing technologies that provide new quantitative and performance metrics • Implements several line and pole mounted technologies to address high priority threats on the distribution system that lack real time condition monitoring
Alternative Plan 3: Line Slap	Alternative Plan 4: Wildfire Resilience Partnerships – Fuels Treatment
<p>Program ID(s): WLDFR-A003 Risk Reduction: \$1.7M CBR: <0.1</p> <ul style="list-style-type: none"> • Reconfigures conductor attachments in like of risk presented by line slap • In unusual circumstances, such as wind events, occur that may cause conductors to slap together, called “conductor slap” • High energy arcing may occur and could result in hot metal particles falling to the ground and igniting fuel 	<p>Program ID(s): WLDFR-A004 Risk Reduction: \$5.0M CBR: 21.7</p> <ul style="list-style-type: none"> • Catalyzes community and forest work aligned with local risk drivers through partnerships • Through partnerships, PG&E may facilitate fuel management within utility rights of way along likely wildfire pathways, create expanded fuel breaks beyond designated rights of way, improve community and forest wildfire defenses, facilitate or co-fund roadside clearing under rights of way along key ingress/egress routes and collaborate on wood management

Large Uncontrolled Water Release 2024 RAMP Post-Filing Workshop

Energy Supply

Presenters: Russ Cruzen, Jayne Young



Large Uncontrolled Water Release: Executive Summary

We will provide an overview of Large Uncontrolled Water Release for inclusion in the 2027 GRC.

Key Topics:

Overview

Definition of LGUWR, RAMP risk score, mitigation strategy

Risk Comparison

Measurement and comparison of LGUWR safety risk versus other risks in RAMP

Assessment

Model overview, Risk Bowtie, Drivers, Consequence

Mitigation Strategies

CBR and risk reduction overview of control and mitigation programs for LGUWR



Large Uncontrolled Water Release: Definition

Risk Name

Large Uncontrolled Water Release (Dam Failure)

Risk Definition

Failure of a high or significant hazard dam, where failure could cause loss of human life and/or could cause economic loss, environmental damage, and other concerns.

Scope

In Scope

- The 60 dams designated as high or significant hazard, per the FERC hazard classification system.

Out of scope

- Non-FERC jurisdictional dams, low hazard dams, water conveyance facilities, powerhouses, and other hydroelectric assets. Although low hazard dams are not included in LGUWR, PG&E inspects and maintains these dams.

Tranche development

PG&E assigned one tranche for each of the 60 dams in PG&E's Corporate Risk Register (CRR) that are classified as high or significant hazard by the Federal Energy Regulatory Commission (FERC). Allocating one tranche per dam allows PG&E to better capture dam specific risk and risk reduction when pursuing mitigation projects for each unique dam.

Tranches

- One tranche for each of the 60 dams.

Date range

2019

Large Uncontrolled Water Release: RAMP Risk Scores

Safety Rank	PG&E Enterprise Risk Register (ERR) Risk	RAMP Risk	TY Baseline (2027)	
			Safety Risk Value (\$M)	Total Risk Value (\$M)
1	Wildfire with PSPS and EPSS	✓	222	7,666
2	Loss of Containment (LOC) on Gas Transmission Pipeline	✓	139	186
3	Public Contact with Intact Energized Electrical Equipment	✓	60	60
4	Failure of Electric Distribution Overhead Assets	✓	54	3,354
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6	Contractor Safety Incident	✓	39	39
7	Employee Safety Incident	✓	30	39
8	Cybersecurity Risk Event	✓	25	1,007
9	Large Uncontrolled Water Release (Dam Failure)	✓	21	258
10	Failure of Electric Distribution Underground Assets	✓	19	728
11	Loss of Containment on Gas Distribution Main or Service	✓	19	107
12	Large Overpressure Event Downstream of Gas M&C Facility	✓	18	19

Large Uncontrolled Water Release: Strategy

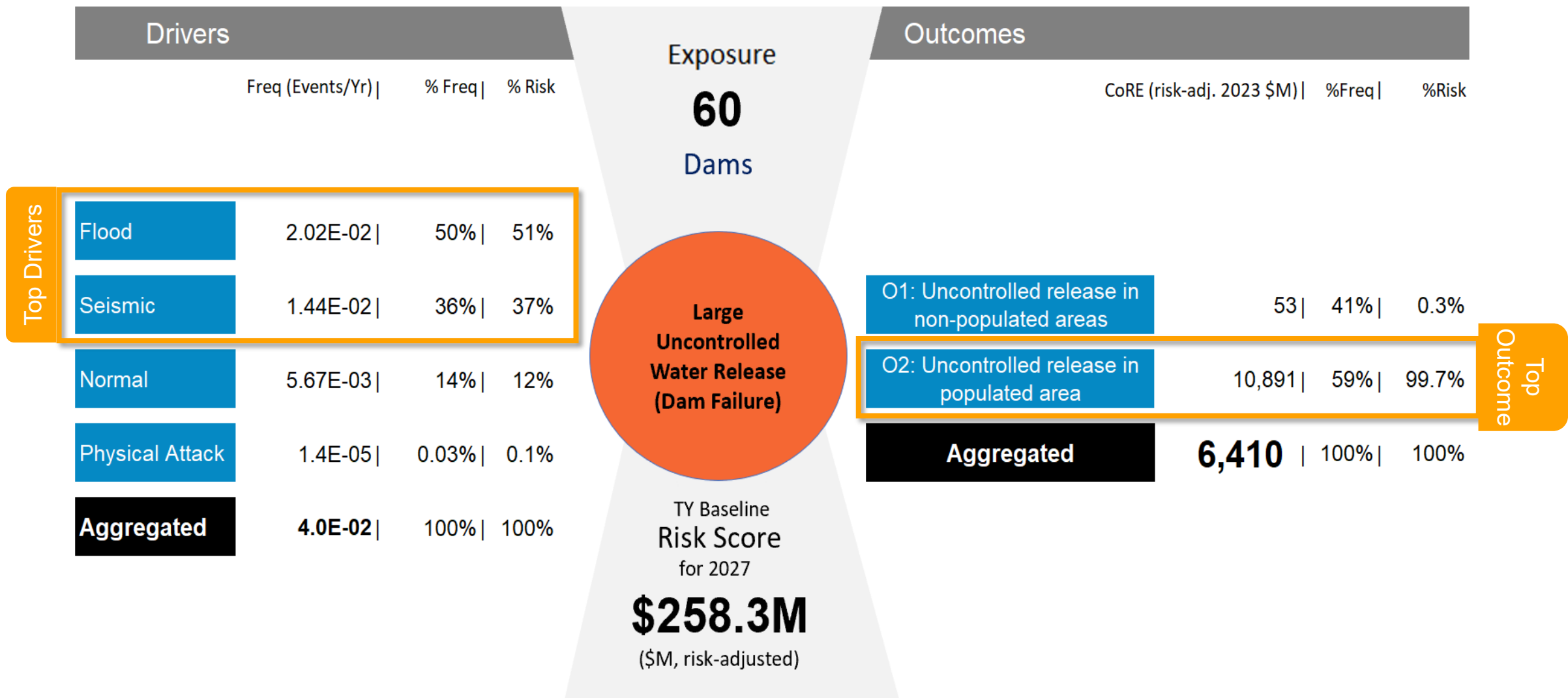
Our mitigation strategy includes five primary programs: Internal Erosion Mitigations, Spillway Remediations, Seismic Retrofits, LLO Refurbishments, and Physical Security that aim to mitigate the four main drivers of risk: **flood, seismic activity, failure under normal operation conditions, and physical attack.**

Mitigations and Strategy

Internal Erosion Mitigations	Spillway Remediations	Seismic Retrofits	LLO Refurbishments	Physical Security
<ul style="list-style-type: none"> Minimize the potential for internal erosion failure modes Projects include installing downstream seepage berm with filter and drains, and installing or maintaining a seepage barrier on the upstream side of the dam 	<ul style="list-style-type: none"> Ensures dams can safely pass design flood events Projects include improvements to or rehabilitation of spillway control structures, spillway chutes, gates, log booms, and operators 	<ul style="list-style-type: none"> Ensures dams and components will not fail under the seismic design loads Projects include strengthening structural capability of the dams and components such as spillway gates, intake structures, and LLOs 	<ul style="list-style-type: none"> Ensures the reservoir can be drained during an emergency or for dam maintenance LLO program includes the entire series of components that would be used to lower the reservoir – including the LLO, power tunnels, and canals 	<ul style="list-style-type: none"> Reduces the likelihood of malicious threats from third party individuals or groups on dam safety Projects include constructing physical barriers and installing surveillance monitoring systems

Our mitigation strategy will gradually reduce LGUWR risk and allow us to **better capture dam specific risk and risk reduction when pursuing mitigation projects for each unique dam**

Large Uncontrolled Water Release: Risk Bow Tie



Large Uncontrolled Water Release: Tranches

Out of the 165 total dams within the system, 60 dams are classified as high or significant hazard structures per FERC's hazard classification, have complete flood hazard and life safety consequence analyses, and are included in the LGUWR risk exposure

The top five dams constitute nearly half of the total adjusted risk for LGUWR. In 2027 and beyond, mitigation work will continue for highest risk dams

Dam Resiliency Mitigations

Tranche	Percent Exposure	Safety Adj-Risk Score (\$M/year)	Financial Adj-Risk Score (\$M/year)	2023 Baseline	
				Total Adj-Risk Score (\$M/year)	Percent of Total Risk
Pit 3	1.67%	2.4	47.0	49.4	17%
Pit 5 Open Conduit	1.67%	1.4	24.1	25.5	9%
Fordyce	1.67%	0.8	21.7	22.5	8%
Spaulding No. 1	1.67%	7.4	13.3	20.7	7%
Belden Forebay	1.67%	0.04	21.65	21.7	8%
Lake Almanor	1.67%	0.26	24.6	24.8	9%
Rock Creek (Feather)	1.67%	0.4	13.8	14.2	5%
Salt Springs	1.67%	0.6	14.8	15.4	5%
Pit 4	1.67%	0.01	12.34	12.4	4%
Iron Canyon	1.67%	0.05	10.8	10.8	4%
All remaining dams	83.30%	32.9	324.3	71.41	25%
Total	100%			288.8	100%

2027 Baseline	
Total Adj-Risk Score (\$M/year)	Percent of Total Risk
39.2	15%
27.5	11%
22.3	9%
20.6	8%
17.9	7%
17.4	7%
14.5	6%
14.4	6%
13.3	5%
10.9	4%
60.3	23%
258.3	100%

Large Uncontrolled Water Release: Drivers

The Large Uncontrolled Water Release Risk (LGUWR) has four key risk drivers: (1) flood, (2) seismic, (3) failure under normal operating conditions (formerly internal erosion), and (4) physical attack.

D1 – Flood	D2 – Seismic	D3 - Failure Under Normal Operating Conditions	D4 – Physical Attack
<ul style="list-style-type: none"> • Flooding elevates dam failure risk • Flood-related factors account for ~51% of the risk drivers • The aggregated flood factor may prompt an incident every 50 years, or 1 in 85 years if only O2 was considered 	<ul style="list-style-type: none"> • PG&E dams near fault lines at risk of earthquake damage • Seismic factors make up around 37% of LGUWR risk drivers • Combined seismic risks: incident every 69 years, or 1 in 95 years for outcome O2 	<ul style="list-style-type: none"> • PMFs cover potential uncontrolled releases during regular operations such as component failures or erosion • Normal operation failures make up 12% of LGUWR risk drivers • Combined factors suggest an incident every 176 years, or 1 in 737 years focusing on outcome O2 	<ul style="list-style-type: none"> • Threats from third party individuals such as break ins, vandalism, and attack that could result in a dam failure • No recorded dam failures from physical attacks in the US since 2012 • Assumed dam failure probability post-physical attack is 3.8%

Large Uncontrolled Water Release: Consequences

The aggregated O1 outcome constitutes 41% of total frequency, but only 0.3% of risk. The O2 outcome constitutes 59% of frequency and 99.7% of total risk

Financial consequences included in the LGUWR risk are direct economic damage to the public, cost of replacement for PG&E's dams and powerhouses, and foregone revenue from loss of generation

Safety consequences for the LGUWR risk are potential fatalities and injuries when incremental uncontrolled release from dam's impact population centers or recreational areas

	CoRE	%Freq	%Risk	Freq	Natural Units Per Event		Monetized Levels (\$M) of a Consequence Per Event		CoRE (risk-adjusted, \$M)		Natural Units per Year		Expected Loss per Year (\$M)		Attribute Risk Score (risk-adjusted, \$M)	
					Safety EF/event	Financial \$M/event	Safety \$M	Financial \$M	Safety	Financial	Safety EF/yr	Financial \$M/yr	Safety \$M/yr	Financial \$M/yr	Safety \$M/yr	Financial \$M/yr
O1: Uncontrolled release in non-populated areas	53	41%	0.3%	1.70E-02	-	30.9	-	30.9	-	53.2	-	0.5	-	0.5	-	0.9
O2: Uncontrolled release in populated areas	10,891	59%	99.7%	2.36E-02	11.4	1,673.0	143.0	1,673.0	880.0	10,010.5	0.3	39.5	3.4	39.5	20.8	236.6
Aggregated	6,410	100%	100%	4.03E-02	6.7	994.2	83.9	994.2	516.2	5893.9	0.3	40.1	3.4	40.1	20.8	237.5

Environmental and Social Justice (ESJ) Pilot Study Plan

Dam	ESJ Areas within Inundation Zone	Tribal Lands Areas within Inundation Zone	2027-2030 Program Risk Reduction Net Present Value (NPV)	2027-2030 Capital Cost NPV	2027-2030 Expense Cost NPV	2027-2030 Total Cost NPV
Bear, Lower	Yes	No	\$0.68	\$6.76	\$0.39	\$7.15
Bear, Lower . 2	Yes	No	\$0.45	\$6.76	\$0.39	\$7.15
Bear, Upper	Yes	No	\$0.79	\$6.76	\$0.39	\$7.15
Bucks Lake	Yes	No	\$11.33	\$11.49	\$0.31	\$11.80
Crane Valley	No	Yes	\$7.42	\$8.44	\$0.39	\$8.82
Fordyce	Yes	No	\$73.58	\$17.72	\$0.39	\$18.11
Lake Almanor	Yes	No	\$15.98	\$29.37	\$0.31	\$29.69
Pit 1 Forebay	No	Yes	\$0.17	\$7.61	\$0.39	\$8.00
Pit 3	No	Yes	\$15.86	\$17.08	\$0.39	\$17.47
Pit 4	No	Yes	\$12.45	\$8.41	\$0.39	\$8.79
Pit 5 Open Conduit	No	Yes	\$5.98	\$8.77	\$0.39	\$9.15
Pit 6	No	Yes	\$86.49	\$40.17	\$0.77	\$40.94
Pit 7	No	Yes	\$59.93	\$32.62	\$0.39	\$33.01
Relief	Yes	No	\$16.49	\$31.12	\$0.39	\$31.51
Salt Springs	Yes	No	\$10.85	\$6.81	\$0.39	\$7.20
Scott	No	Yes	\$0.31	\$5.37	\$0.39	\$5.76
Spaulding No. 1	Yes	No	\$78.98	\$19.83	\$0.31	\$20.14
Spaulding No. 2	Yes	No	\$53.19	\$7.85	\$0.39	\$8.24
Spaulding No. 3	Yes	No	\$2.20	\$7.92	\$0.39	\$8.30

Overview:

- For RAMP 2024, ESJ for LGUWR is included as a pilot study with the goal being to identify which communities could be impacted by potential dam breach. Results of this study were not used when planning controls and mitigation measures
- The total cost for mitigations and controls, along with the estimated risk reductions were calculated by including all mitigation and control projects for dams that were identified to impact DVC
- PG&E identified 19 dams that have the potential to impact DVCs
- PG&E expects to spend \$36.8 million in expense and \$1,065 million in capital on risk reduction for LGUWR, of those totals \$7.5 million in expense and \$288.4 million in capital will be spent on dams that affect DVC

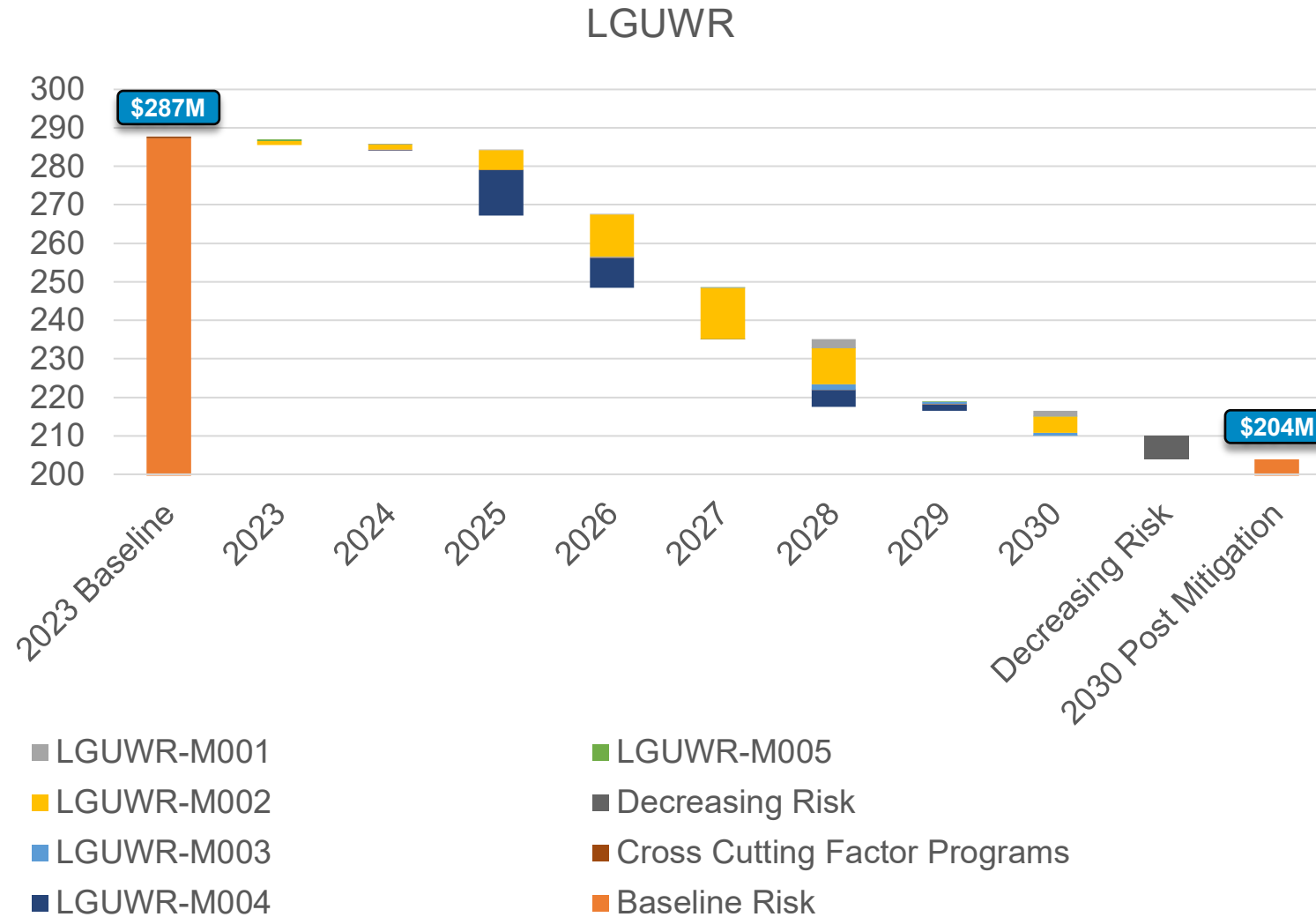
Large Uncontrolled Water Release: Risk Reduction Waterfall

Overview:

Largest risk mitigation included:

- LGUWR-M002: Spillway Remediations
- LGUWR-M004: LLO Refurbishments

Cross Cutting Factor Programs include mitigations related to records and physical attack



Large Uncontrolled Water Release: Mitigations and Controls

We calculated Cost-Benefit Ratios (CBRs) for our 6 Control and Mitigation programs to demonstrate cost efficiency. Two programs have a CBR over 1, while others represent significant risk reductions to support management of the Large Uncontrolled Water Release despite having CBRs below 1

6

Overall Programs

5

Mitigation Programs

1

Control Program

<0.1 – 1.3

CBR Range

Highest CBR Programs				
Rank	Controls		Mitigations	
	Program	CBR	Program	CBR
1	Maintenance	1.3	LLO	1.2
2			Spillway	0.9
3			Seismic retrofit	0.5

Highest Risk Reduction Programs				
Rank	Controls		Mitigations	
	Program	Risk Reduction	Program	Risk Reduction
1	Maintenance	\$26.2M	Spillway	\$651M
2			LLO	\$123M
3			Internal Erosion	\$58M



Large Uncontrolled Water Release: Alternatives Analysis

Each mitigation category (M001 through M005) consists of many unique and site-specific projects. As part of the RAMP process, PG&E considered two alternative mitigations that could be deployed in the future, including the cost estimates, risk reduction values, and CBRs for each of the Alternative Plans. The alternatives provided here are part of the Internal Erosion Mitigation Category and are two of many unique projects considered.

Alternative Plan 1: Relief Dam – Local Patching

Mitigation Number(s): LGUWR-A001

Risk Reduction: \$0.2M

CBR: <0.1

Local Patching involves significant continuous long term repair and maintenance costs as other portions of aging liner deteriorate. This alternative was not selected because the localized patching efforts only target limited areas of significant deterioration and leaves the majority of the aging gunite liner in place.

Alternative Plan 2: Relief Dam – Full Shotcrete Overlay

Mitigation Number(s): LGUWR A002

Risk Reduction: \$14.8M

CBR: 0.17

This alternative evaluated applying a reinforced shotcrete liner. It was not selected because of factors such as high cost, limited construction schedule, material vulnerable to cracking caused by dam deformations and freeze thaw, and the need to reapply sealant between shotcrete panels.

Mitigation ID	Mitigation Name	Mitigation Project ^(b)	Thousands of Nominal Dollars				Millions of Dollars (NPV) ^(a)		CBR [B]/[A]
			2027	2028	2029	2030	Program Cost [A]	Risk Reduction [B]	
LGUWR-M001	Internal Erosion	Relief Dam - Resurface Upstream Liner				\$87,900	\$73.4	\$14.8	0.2
LGUWR-A001 ^(c)	Internal Erosion	Relief Dam - Local Patching				\$82,709	\$51.5	\$0.2	<0.1

Mitigation ID	Mitigation Name	Mitigation Project ^(b)	Thousands of Nominal Dollars				Millions of Dollars (NPV) ^(a)		CBR [B]/[A]
			2027	2028	2029	2030	Program Cost [A]	Risk Reduction [B]	
LGUWR-M001	Internal Erosion	Relief Dam - Resurface Upstream Liner				\$87,900	\$73.4	\$14.8	0.2
LGUWR-A002	Internal Erosion	Relief Dam – Full Shotcrete Overlay				\$102,830	\$85.9	\$14.8	0.17

(a) NPV uses a base year of 2023

(b) Costs for LGUWR-M001 – Relief Dam – Resurface Upstream Liner reflect updated costs since the preliminary costs were submitted for the RAMP forecasts. Final costs estimates may still change and will be provided in the 2027 GRC

Note: For additional details see Exhibit (PG&E-5), WP GEN-LGUWR-F.

Power Generation developed cost estimates shown in this table per the estimating method described in detail in A.21-06-021, the 2023 GRC, Exhibit (PG&E-5), Chapter 4, Section D Estimating Method, p. 4-63 to p.4-65

Loss of Containment on Gas Transmission Pipeline 2024 RAMP Post-Filing Workshop

Gas Operations

Presenters: Chris Warner, Gordon Ye





Loss of Containment on Gas Transmission Pipeline: Executive Summary

This section provides an overview of the risks related to Loss of Containment on Gas Transmission Pipeline for inclusion in the 2027 GRC.

Key Topics:

Overview	Define the risks present relating to LOCTM and strategy to managing those risks
Risk Comparison	Review and measure the safety risk of LOCTM, relative to other risks in RAMP
Risk Assessment	Assess and quantify different components of the risk, including key drivers, consequence impacts, and modeling
Mitigation Strategies	Develop strategies to meet and mitigate against identified risks

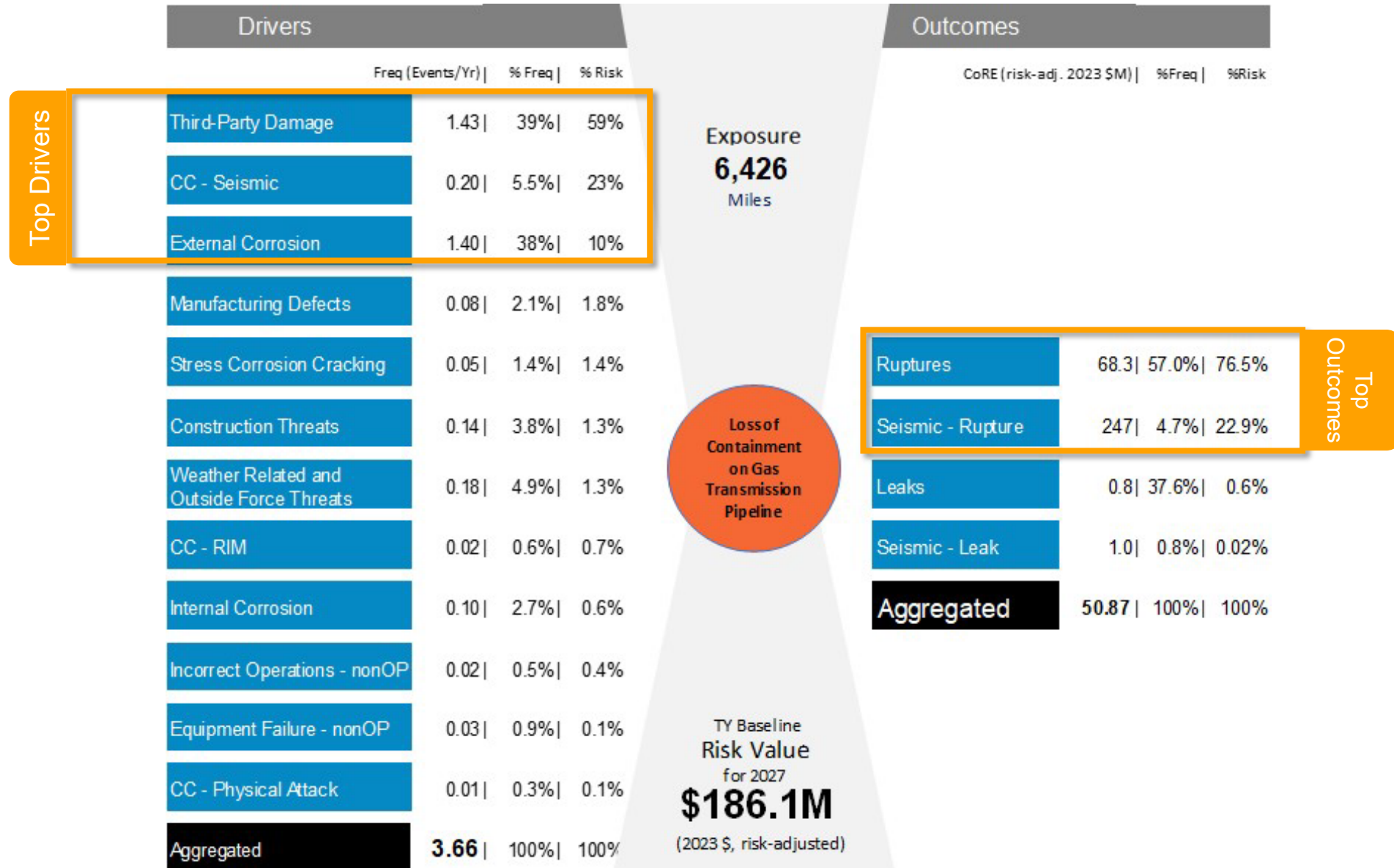
Loss of Containment on Gas Transmission Pipeline: Definition

Risk Name	Loss of Containment on Gas Transmission Pipeline
Risk Definition	<p>Failure of a gas transmission pipeline resulting in a loss of containment, with or without ignition, that could lead to significant impact on public safety, employee safety, contractor safety, property damage, financial loss, or the inability to deliver natural gas to customers. Failure of a gas transmission pipeline includes both significant pipeline leak and pipeline rupture.</p>
Scope	<p>In Scope</p> <ul style="list-style-type: none"> Failure of a transmission pipeline that leads to a significant loss of containment (leak or rupture). Significant is defined as a LOC that results in an injury requiring in patient hospitalization, a fatality, or total costs valued at \$50,000 or more, measured in 1984 dollars Pipeline and Hazardous Materials Safety Administration (PHMSA) 49 Code of Federal Regulations (CFR) Part 191.3 lists the leak reporting criteria, which is used in the RAMP LOCTM model. <p>Out of scope</p> <ul style="list-style-type: none"> A loss of containment driven by Large Over-pressurization (OP) Events (included in the “Large OP Event” risk model)
Tranche development	<p>The gas transmission tranches were increased from 4 to 24 since the 2023 GRC filing to include a more granular categorization of assets. This development allows for more targeted review by tranche to assess risk across a wider range of likelihood of failure (LOF) and consequence of failure (COF) categories. The 24 tranches are defined by likelihood of failure (LOF) and consequence of failure (COF) categories. These LOF and COF categories are drawn from threat-specific likelihood and consequence area data used in the Transmission Integrity Management (TIMP) operational risk model.</p>
Tranches	<p>Six LOF and four COF categories lead to 24 tranches. The LOF categories are built from TIMP Threat Identification models. The COF categories are built from TIMP Consequence Areas, Dept. of Transportation Class locations, and TIMP Leak/Rupture Boundary analysis</p>
Date range	<p>Pipeline and Hazardous Materials Safety Administration (PHMSA) data: 1984-2023</p> <p>Gas Quarterly Incident data: 2010- 2022</p> <p>Working Assessment Plan (WAP) data from TIMP operational risk model based on the 2022 risk run result</p>

Loss of Containment on Gas Transmission Pipeline: Risk Values

Safety Rank	PG&E Enterprise Risk Register (ERR) Risk	RAMP Risk	TY Baseline (2027)	
			Safety Risk Value (\$M)	Total Risk Value (\$M)
1	Wildfire with PSPS and EPSS	✓	222	7,666
2	Loss of Containment (LOC) on Gas Transmission Pipeline	✓	139	186
3	Public Contact with Intact Energized Electrical Equipment	✓	60	60
4	Failure of Electric Distribution Overhead Assets	✓	54	3,354
5	Electric Transmission Systemwide Blackout	✓	52	1,903
6	Contractor Safety Incident	✓	39	39
7	Employee Safety Incident	✓	30	39
8	Cybersecurity Risk Event	✓	25	1,007
9	Large Uncontrolled Water Release (Dam Failure)	✓	21	258
10	Failure of Electric Distribution Underground Assets	✓	19	728
11	Loss of Containment on Gas Distribution Main or Service	✓	19	107
12	Large Overpressure Event Downstream of Gas M&C Facility	✓	18	19

Loss of Containment on Gas Transmission Pipeline: Risk Bow Tie



Loss of Containment on Gas Transmission: Drivers

The Loss of Containment on Gas Transmission Risk has 9 key risk drivers, including third party damage and equipment failure.

D1 – Third Party Damage <ul style="list-style-type: none"> Pipeline damage inflicted by first, second, or third parties through digging activities Accounts for 1.43 (39%) of the 3.7 expected annual number of LOC events 	D2 – External Corrosion <ul style="list-style-type: none"> Deterioration of the outside of steel pipe EC can reduce pipe wall thickness, increasing susceptibility to other threats EC accounts for 1.4 (38%) of the 3.7 expected annual number of LOC events 	D3 - WROFs <ul style="list-style-type: none"> Water crossings, unstable soil, erosion, heavy rains, and floods WROFs accounts for 0.18 (4.9%) of the 3.7 expected number of LOC events
D4 – Construction Threats <ul style="list-style-type: none"> Connection between two segments of pipe. Construction Threats accounts for 0.14 (3.8%) of the 3.7 expected annual number of LOC events. 	D5 – Internal Corrosion <ul style="list-style-type: none"> Corrosion of the internal wall of steel transmission pipelines IC accounts for 0.10 (2.7%) of the 3.7 expected annual number of LOC events. 	D6 – Manufacturing Defects <ul style="list-style-type: none"> Longitudinal seam defects, as well as SSWC Manufacturing defects accounts for 0.08 (2.1%) of the 3.7 expected annual number of LOC events
D7 – Stress Corrosion Cracking <ul style="list-style-type: none"> Refers to cracking from the combined influence of tensile stress and a corrosive environment SCC accounts for 0.05 (1.4%) of the 3.7 average expected number of LOC events 	D8 – Incorrect Operations <ul style="list-style-type: none"> Any PG&E personnel action or omission affecting pipeline safety or reliability Incorrect operations accounts for 0.02 (0.5%) of the 3.7 expected annual number of LOC events. 	D9 – Equipment Failure <ul style="list-style-type: none"> Failure of pipeline facilities Equipment failure accounts for 0.03 (0.9%) of the 3.7 expected annual number of LOC events

Loss of Containment on Gas Transmission: Consequences

LOCTM risk is measured by whether a significant loss of containment event occurred leading to either a leak or rupture. Consequences are evaluated in terms of safety, reliability, and financial impact

Ruptures and Seismic Ruptures have the highest CoRE, frequency, risk levels, and adjusted risk value. **Leaks and Seismic Leaks** are relatively common and contribute far less to overall risk value than ruptures and seismic ruptures

Outcomes					Natural Units Per Event			Monetized Levels of a Consequence Per Event (2023 \$M/event)			CoRE (risk-adjusted 2023 \$M)			Natural Units Per Year			Expected Loss per Year (2023 \$M/yr)			Risk Value (risk-adjusted 2023 \$M)		
	CoRE	% Freq	% Risk	Freq	Safety EF/Event	Gas Reliability #cust/event	Financial \$M/event	Safety	Gas Reliability	Financial	Safety	Gas Reliability	Financial	Safety EF/Event	Gas Reliability #cust/event	Financial \$M/event	Safety	Gas Reliability	Financial	Safety	Gas Reliability	Financial
Ruptures	68.3	57%	77%	2.08	0.71	3,820	3.0	10.8	6.0	3.0	48.9	8.9	10.6	1.47	7,963	6.15	22.45	12.50	6.15	101.85	18.51	22.09
Seismic - Rupture	247.0	5%	23%	0.17	2.53	5,995	8.3	38.5	9.4	8.3	211.9	16.2	19.0	0.44	1,033	1.44	6.63	1.62	1.44	36.52	2.78	3.27
Leaks	0.8	38%	1%	1.37	0.01	102	0.5	0.1	0.2	0.5	0.1	0.2	0.5	0.01	141	0.69	0.13	0.22	0.69	0.13	0.24	0.69
Seismic - Leak	1	1%	0%	0.03	0.01	137	0.7	0.1	0.2	0.7	0.1	0.2	0.7	0.00	4	0.02	0.00	0.01	0.02	0.00	0.01	0.02
Aggregated	50.9	100%	100%	3.66	0.52	2,498	2.3	8.0	3.9	2.3	37.9	5.9	7.1	1.92	9,141	8.30	29.22	14.35	8.30	138.51	21.54	26.07

Loss of Containment on Gas Transmission: Tranches

We are focusing our LOCTM mitigation work in the highest risk areas – particularly Geohazard/All Other Pipe and HCA which present the highest risk in terms of safety, financial, and aggregated risk

PG&E identified 24 tranches that each represent a group of transmission assets determined to have a similar risk profile associated with Likelihood of Failure (LOF) and Consequence of Failure (COF) LOCTM events

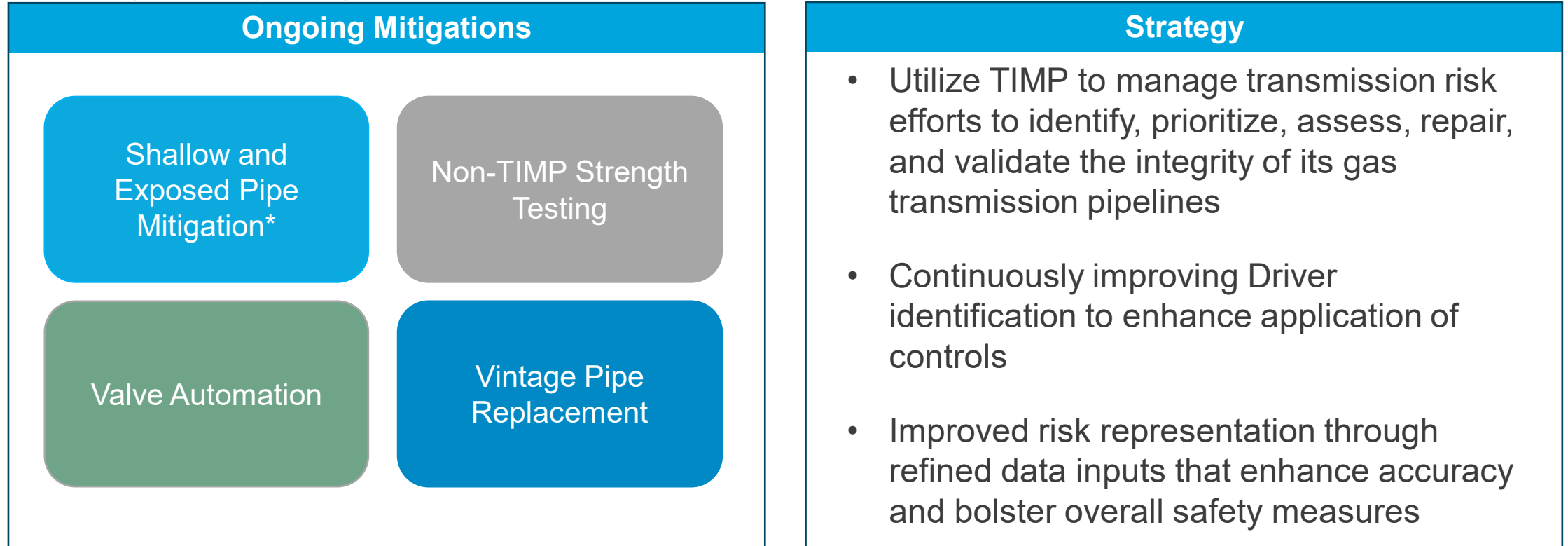
Ongoing Mitigations

Tranche	Percent Exposure	Safety Risk Value (\$M)	Reliability Risk Value (\$M)	Financial Risk Value (\$M)	2023 Baseline	
					Aggregated Risk Value (\$M)	Risk (%)
Geohazard Pipe and HCA	5.7%	70.4	2.7	8.0	81.2	43%
All Other Pipe and HCA	9.4%	24.0	0.4	6.2	30.6	16%
Shallow/Exposed Pipe and HCA	2.5%	17.3	0.4	4.3	22.0	12%
Potential Manufacturing Defect Pipe and HCA	3.0%	8.6	0.2	2.7	11.5	6%
Potential IC Pipe and HCA	3.1%	8.0	0.5	1.9	10.3	5%
Geohazard Pipe and (IOC = 0 or leak mode on Non-HCA/MCA)	13.3%	1.5	6.8	1.3	9.6	5%
Potential SCC/SSWC Pipe and (IOC = 0 or leak mode on Non-HCA/MCA)	5.2%	0.1	3.4	0.1	3.6	2%
Potential SCC/SSWC Pipe and HCA	0.8%	2.4	0.2	0.7	3.3	2%
Potential Manufacturing Defect Pipe and (IOC = 0 or leak mode on Non-HCA/MCA)	14.0%	0.5	2.0	0.5	3.0	2%
All other Tranches	42.8%	7.60	5.13	1.05	13.78	7%
Total	100%	140.42	21.75	26.77	188.93	100%



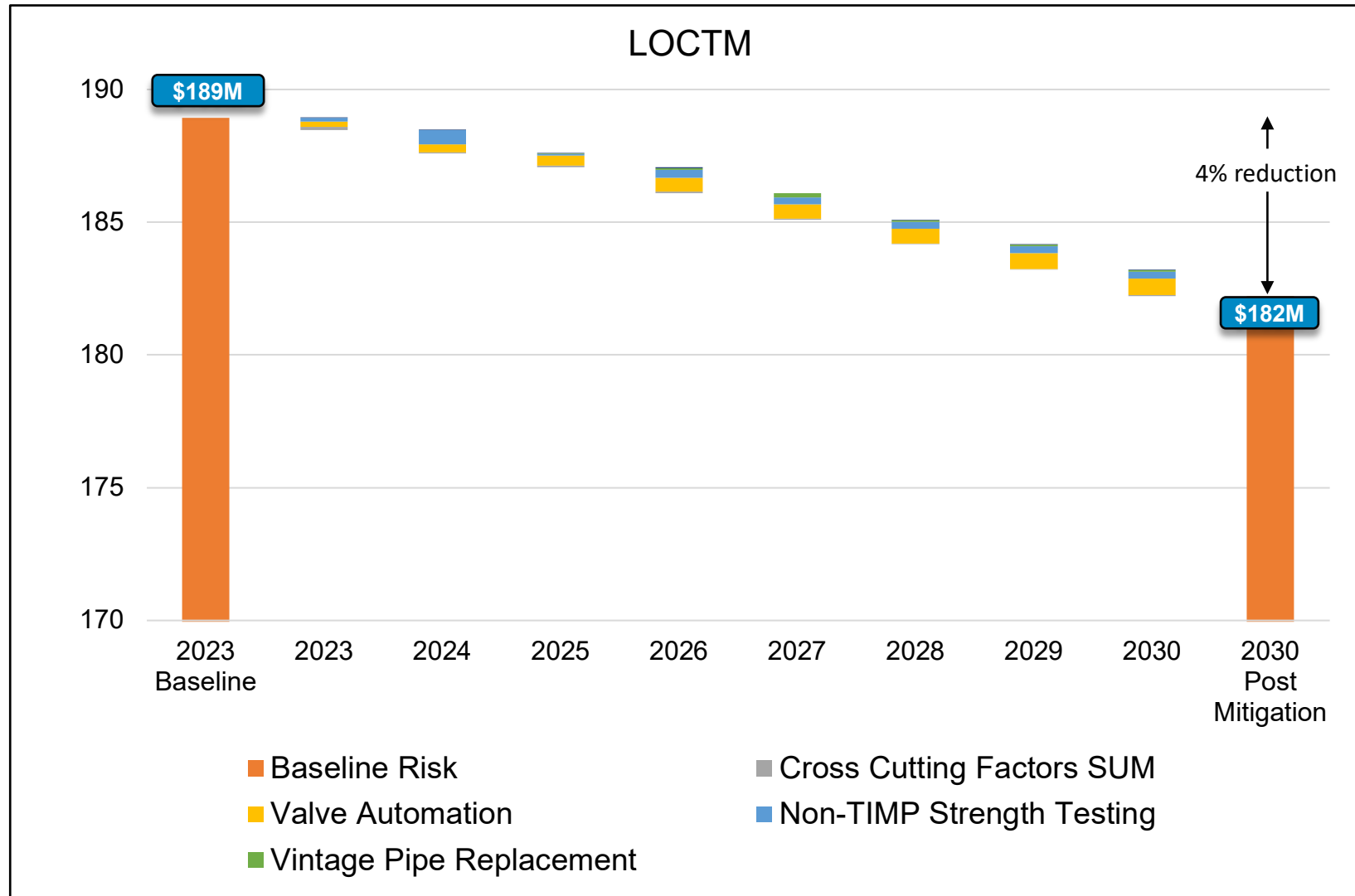
2027 Baseline	
Aggregated Risk Value (\$M)	Risk (%)
80.23	43%
30.12	16%
21.53	12%
11.05	6%
10.21	5%
9.56	5%
3.55	2%
3.24	2%
2.98	2%
13.65	7%
186.13	100%

PG&E's strategy to manage and reduce the risk of loss of containment on gas transmission pipelines (LOCTM) is based on a wide range of control and mitigation programs, including integrity management controls, addressing geohazard threats, and preventing third party damage



PG&E's ongoing mitigations will continue through the 2027 GRC and are **designed to reduce the incidence and consequence of LOCTM events.**

Loss of Containment on Gas Transmission Pipeline: Risk Reduction Waterfall



Overview:

Largest risk mitigations included:

- Valve Automation
- Vintage Pipe Replacement
- Non-TIMP Strength Testing

Cross Cutting Factors included:

- M1: Prevent
- M2: Detect
- Implementation and records management – Structured Data Repositories
- Implementation and records management – Unstructured Data Repositories

Loss of Containment on Gas Transmission: Mitigations and Controls

We calculated Cost-Benefit Ratios (CBRs) for our 36 Control and Mitigation programs to demonstrate cost efficiency. Six programs have a CBR over 10, while others represent significant risk reductions to support management of the Loss of Containment on Gas Transmission

36

Overall Programs

4

Mitigation Programs

32

Control Programs

<0.1 – 111.5

CBR Range

Highest CBR Programs				
Rank	Controls		Mitigations	
	Program	CBR	Program	CBR
1	Locate and Mark - Transmission	111.5	Vintage Pipe Replacement	0.8
2	Pipeline Marker Maintenance	52.3	Valve Automation	0.5
3	Cathodic Protection	47.6	Shallow and Exposed Pipe Mitigation	<0.1

Highest Risk Reduction Programs				
Rank	Controls		Mitigations	
	Program	Risk Reduction	Program	Risk Reduction
1	In-Line Inspection	\$5,865M	Valve Automation	\$31.5M
2	Cathodic Protection	\$1,769M	Non-TIMP Strength Testing	\$12.3M
3	Valve Safety and Reliability	\$824	Vintage Pipe Replacement	\$6.1M

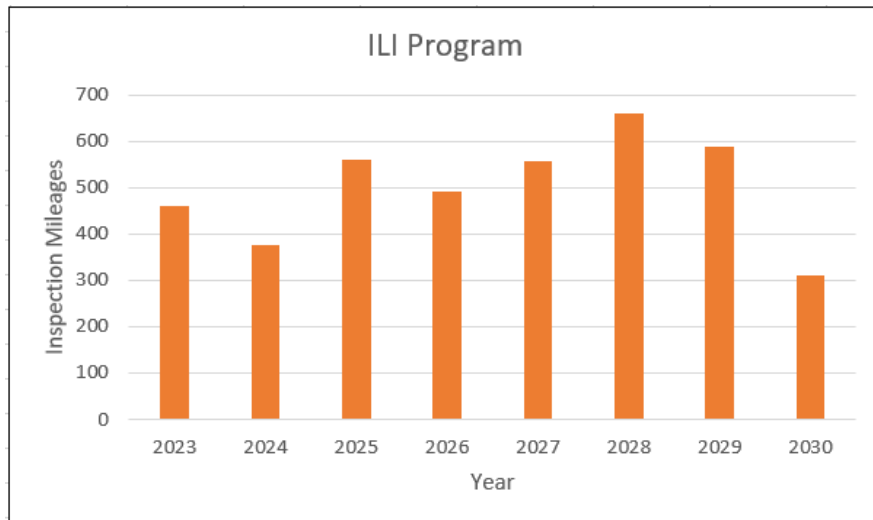


In-Line Inspection (ILI) Program (LOCTM-C005)

Program Summary

- This control addresses traditional ILI cleaning and inspection, and Non-Traditional ILI runs on gas transmission pipelines. This also includes ILI direct examination digs and repairs made as a result of the ILI inspection such as sleeve installation and pipe replacements.
- ILI Upgrade projects (98C) were moved to this control from mitigation LOCTM-M005 for 2024 RAMP. ILI upgrades provide a mitigation for the first run where a thorough integrity assessment is enabled. However, it is the on-going ability to confirm the pipelines' integrity that provides the Control to ensure risk is not increasing that provides the on-going benefit of ILI upgrades.
- Purpose of combining those MATs is to bring in alignment with the other inspection programs (Direct Assessment, hydrotest) and provide a holistic view instead of a breakdown view of the work done through these bundled MATs (98C, HPB, HPI, HPR, 75P).

ILI Program



Program Cost, Risk & CBR Values

Program ID	Expense MATs	Capital MATs	Program Cost (\$M)	Risk Reduction (\$M)	CBR
LOCTM-C005	HPB, HPI, HPR	75P, 98C	\$1132	\$5864.9	5.2

Loss of Containment on Gas Transmission: ESJ

Program	Risk Reduction				Spend			
	(\$M, risk adj.)		(%)		(\$M, NPV)		(%)	
	DVC	Non-DVC	DVC	Non-DVC	DVC	Non-DVC	DVC	Non-DVC
Geo-Hazard Threat Identification and Mitigation	0.02	0.1	25%	75%	8.1	18.2	31%	69%
LNG/CNG to Support Strength Testing	1.2	3.2	27%	73%	7.2	19.5	27%	73%
Earthquake Fault Crossings	0.3	1	20%	80%	14.5	36.1	29%	71%
In-Line Inspection	1,687.30	4,177.60	29%	71%	323.3	808.5	29%	71%
Gas Gathering Divestiture	0.6	1.3	32%	68%	5.5	15.5	26%	74%
Shallow and Exposed Pipe (Including Water and Levee Crossings) - Control	0.004	0.008	32%	68%	0.9	2.4	28%	72%
Pipeline Safety and Reliability	0.2	0.6	24%	76%	8.3	34.5	19%	81%
Locate and Mark - Transmission	68.9	178.8	28%	72%	0.6	1.6	27%	73%
Locate and Mark - Transmission Standby	131.5	341	28%	72%	4.3	11.7	27%	73%
Public Awareness	42.8	110.9	28%	72%	1.4	3.8	27%	73%
Required Pipeline Patrol Program	37.8	98.2	28%	72%	5.6	15.3	27%	73%
PM Gas Pipeline Valves Program	0.2	0.4	28%	72%	1.1	3.1	27%	73%
CM Gas Pipeline Valves Program	24	65	27%	73%	0.5	1.4	27%	73%
Pipeline Marker Maintenance	25.8	66.8	28%	72%	0.5	1.3	27%	73%
Vegetation Management	0.1	0.3	26%	74%	1.2	3.2	27%	73%
Vegetation Manage Project	11.2	32.6	26%	74%	3.8	10.2	27%	73%
Encroachments	3	8.1	27%	73%	1.5	4.1	27%	73%
Cathodic Protection	509.3	1,259.80	29%	71%	9.9	26.9	27%	73%
Transmission Leak Management	43.1	110.5	28%	72%	5.5	15	27%	73%
Direct Assessment	1.4	3.4	30%	70%	70	160.7	30%	70%
Valve Safety and Reliability	214.8	608.9	26%	74%	25.8	70.1	27%	73%
TIMP Strength Testing	0.4	0.9	29%	71%	13.6	34.3	28%	72%
Pipe Investigations and Field Engineering	21.8	55.1	28%	72%	2.8	7.6	27%	73%
Class Location Change	0.1	0.1	34%	66%	25.3	51.5	33%	67%
Gas Holder Maintenance	0.01	0.02	26%	74%	0.1	0.2	27%	73%
Internal Corrosion Program	0.3	0.6	29%	71%	3.7	10.1	27%	73%
Electrical Interference Program	29	71.5	29%	71%	8.1	22	27%	73%
Atmospheric Corrosion Program	4.6	11.4	29%	71%	3.4	9.1	27%	73%
Transmission Corrosion Control Program	4.9	12	29%	71%	20.3	55	27%	73%
Vintage Pipe Replacement	1.6	4.6	25%	75%	2	5.9	25%	75%
Shallow and Exposed Pipe (Including Water and Levee Crossings) - Mitigation	0.2	0.5	30%	70%	7.6	19.2	28%	72%
Non-TIMP Strength Testing	3.5	8.8	28%	72%	80	231.2	26%	74%
Valve Automation	8.3	23.3	26%	74%	19.9	49.2	29%	71%
Total	2,877.8	7,257.3	28%	72%	686.3	1,758.2	28%	72%

Overview:

- PG&E selected LOCTM as an Environmental and Social Justice Pilot Study Plan (PSP) pilot risk for Action Items #1 and #6
- PG&E developed a methodology for determining the impact to Disadvantaged and Vulnerable Communities (DVCs, as defined in D.22-12-027) and used this methodology to calculate the consequences, mitigation benefits, and the total costs of mitigations associated with DVCs. Pipelines in DVCs make up 27% of the total exposure.
- In-Line Inspection, the program with the largest risk reduction potential, is also the highest spend due to its effectiveness with a variety of threats.
- Using the tranche percentage approach, PG&E expects \$686.3 million to be spent on mitigations reducing risk in DVCs by \$2,878M.



Loss of Containment on Gas Transmission: Alternatives Analysis

As part of the RAMP process, PG&E considered two alternative mitigations that could be deployed in the future, including the cost estimates, risk reduction values, and CBRs for each of the Alternative Plans.

Alternative Plan 1: Mitigate Transmission Pipeline Impacted by Climate Change

Mitigation Number(s): LOCTM-A001

Risk Reduction: \$1.5M

Total Cost: \$130.9M

CBR: <0.1

This alternative aims to mitigate climate change impacts like flooding and heavy precipitation, which could lead to coastal flooding, delta levee breaches, landslides, and erosion hazards. Mitigation strategies include relocating pipelines or reinforcing them through anchoring or concrete coating. PG&E identified 36 miles of pipelines for intervention over 27 years, prioritizing areas at higher risk based on FEMA 100-year and 500-year storm events.

Mitigation No.	Mitigation Name	Thousands of Nominal Dollars				Millions of Dollars (NPV) ^(a)		CBR [B]/[A]
		2027	2028	2029	2030	Program Cost [A]	Risk Reduction [B]	
LOCTM-A001	Mitigate Transmission Pipeline Impacted by Climate Change	\$31,301	\$32,240	\$33,207	\$34,203	\$123.6	\$1.5	<0.1
Total		\$31,301	\$32,240	\$33,207	\$34,203			

Alternative Plan 2: Mitigate Transmission Pipeline With Strong A-NN SCC and SSWC threats

Mitigation Number(s): LOCTM-A002

Risk Reduction: \$18.6M

Total Cost: \$84.5M

CBR: 0.2

This mitigation aims to replace pipelines vulnerable to Strong Axial Near-Neutral Stress Corrosion Cracking (A-NN SCC) and SSWC threats, in order to reduce the risk of damage to transmission pipeline assets. These threats are increasingly detected in the industry, with PG&E observing more anomalies than before. The total mitigation involves replacing 86 miles of pipelines, including 34 miles with strong SSWC and 52 miles with strong A-NN SCC.

Mitigation No.	Mitigation Name	Thousands of Nominal Dollars				Millions of Dollars (NPV) ^(a)		CBR [B]/[A]
		2027	2028	2029	2030	Program Cost [A]	Risk Reduction [B]	
LOCTM-A002	Replacement of pipelines with Strong A-NN SCC and SSWC threats	\$20,189	\$20,795	\$21,419	\$22,061	\$79.7	\$18.6	0.2
Total		\$20,189	\$20,795	\$21,419	\$22,061			

(a) NPV uses a base year of 2023.

Notes: For additional details see Exhibit (PG&E-3), WP GO-LOCTM-F.

The cost estimates in this table are generally based on PG&E's 2024 budget plan carried forward through 2030. See Exhibit (PG&E-1), Chapter 1, Section D.3.

Cybersecurity Risk Event 2024 RAMP Post-Filing Workshop

Information Technology

Presenters: Yusuf Ezzy, David Lo



Cybersecurity Risk Event: Executive Summary

This section will provide an overview of the Cybersecurity Risk Event for inclusion in the 2027 GRC.

Key Topics:

Overview

Define the risks present and strategy to managing those risks

Risk Comparison

Review and measure the safety risk of CYBER, relative to other risks in RAMP

Risk Assessment

Assess and quantify different components of the risk, including key drivers, consequence impacts, and modeling

Mitigation Strategies

Develop strategies to meet and mitigate against identified risks



Cybersecurity Risk Event: Definition

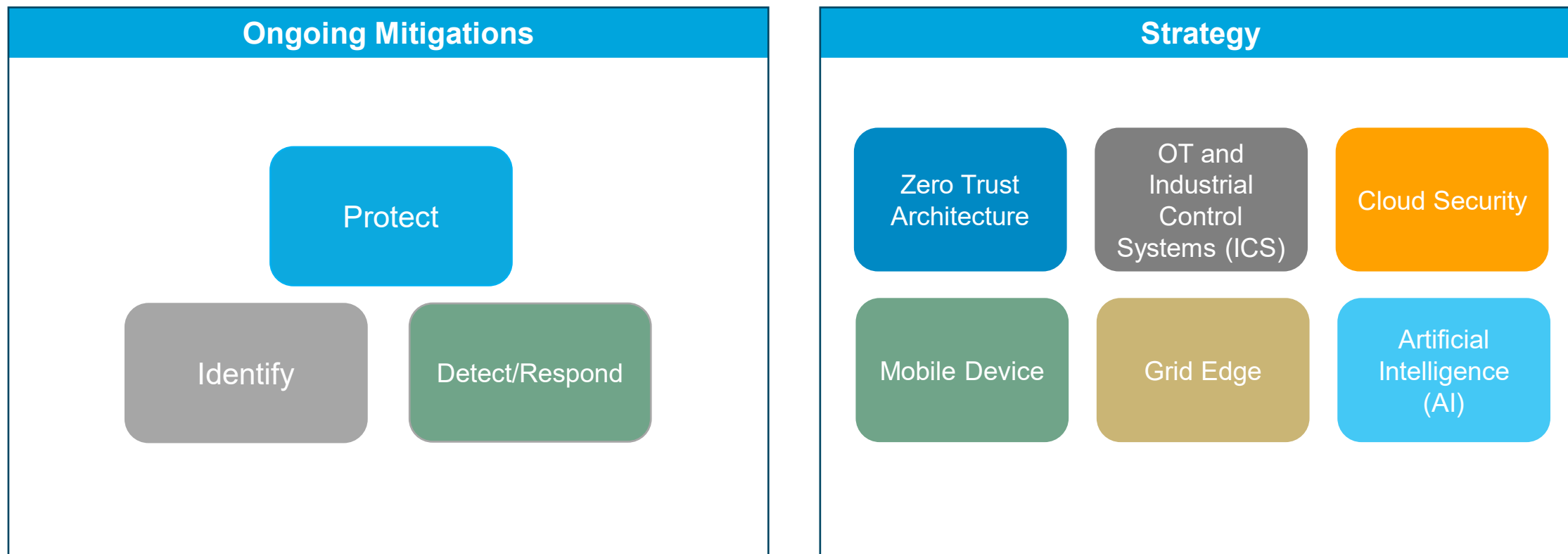
Risk Name	Cybersecurity Risk Event
Risk Definition	A coordinated malicious attack targeting PG&E's core business functions, resulting in disruption or damage of systems used for gas, electric and/or business operations.
Scope	<p>In Scope</p> <ul style="list-style-type: none">PG&E IT and OT systems and infrastructure assets supporting PG&E's mission and business model <p>Out of Scope</p> <ul style="list-style-type: none">Internal systems and infrastructure managed by the Nuclear functional area for Diablo Canyon Nuclear Power Plant (DCPP). IT managed systems and devices supporting DCPN are within scope
Tranche development	PG&E Cybersecurity reviewed possible vectors for a threat actor to exploit via one of the drivers and cause a cybersecurity incident.
Tranches	<ul style="list-style-type: none">UDN – Utility Data NetworkODN – Operational Data NetworkPeople – Employees and Contractors (Workforce)Third Parties – Vendors, SaaS providersSoftware/Applications
Date range	2018 through December 2023

Cybersecurity Risk Event: RAMP Risk Scores

Safety Rank	PG&E Enterprise Risk Register (ERR) Risk	RAMP Risk	TY Baseline (2027)	
			Safety Risk Value (\$M)	Total Risk Value (\$M)
1	Wildfire with PSPS and EPSS	✓	222	7,666
2	Loss of Containment (LOC) on Gas Transmission Pipeline	✓	139	186
3	Public Contact with Intact Energized Electrical Equipment	✓	60	60
4	Failure of Electric Distribution Overhead Assets	✓	54	3,354
5	Electric Transmission Systemwide Blackout	✓	52	1,903
6	Contractor Safety Incident	✓	39	39
7	Employee Safety Incident	✓	30	39
8	Cybersecurity Risk Event	✓	25	1,007
9	Large Uncontrolled Water Release (Dam Failure)	✓	21	258
10	Failure of Electric Distribution Underground Assets	✓	19	728
11	Loss of Containment on Gas Distribution Main or Service	✓	19	107
12	Large Overpressure Event Downstream of Gas M&C Facility	✓	18	19

Cybersecurity Risk Event: Strategy

PG&E is committed to managing cybersecurity risks by analyzing emerging threats and investing in comprehensive mitigations. The ever-evolving cybersecurity threat landscape has required PG&E Cybersecurity to constantly re-evaluate risk and evolve accordingly. Our strategy bolsters existing initiatives to address evolving risks, emerging threats, and regulatory changes.



As we continue to build on long-term Cyber security resilience efforts, PG&E will significantly increase the **safety and security of its Cyber Security program both for the company and customers.**



Tranches represent the broad classification of the threat actor targets which represents our attack surface. PG&E identified five tranches which are represented in the risk model Bow Tie

PG&E's exposure to Cybersecurity Risk is measured in 'units of exposure' or Exposure Points. These represent the various targets of an attack coming from one of the Bow Tie drivers.

Total number of PG&E Exposure Points is currently calculated at 270,900 but continues to grow and evolve as new technologies are introduced to PG&E

Exposure Points are categorized as Network Segments; IT and OT systems and devices; PG&E employees, contractors and third parties currently doing business with PG&E; software

Tranche	Tranche Description
Utility Data Network (UDN)	PG&E's primary network which carries the most traffic and data and has the most users of PG&E's business systems. It is the network where PG&E conducts most of its daily business. As such, it could serve as an entry point for threat actors and UDN systems and devices are quantified to be represented as the node counts in the Bow Tie.
The Operational Data Network (ODN)	This network carries the traffic and data supporting the operational functions of PG&E. The ODN contains data, systems, and OT technologies that are core to the generation and distribution of energy to our customers. OT systems are the primary target of nation state threat actors as an impact to the ODN could potentially cause the most disruption to PG&E and its customers. ODN systems and devices are quantified to be represented as the node counts in the Bow Tie.
Third Parties	Represent anyone or any entity that provides goods, services and or has access to PG&E network or data. These are vendors and business partners that for business reasons need access to our data and our network and are quantified as the third-party count in the Bow Tie.
People	Represent both internal employees and contractors at PG&E. They are quantified as people in the Bow Tie.
Software/Applications	The computer programs (COTS and custom developed) that employees and contractors use every day. Software is particularly susceptible to programming flaws, vulnerabilities and one of the vectors threat actors use to cause a cybersecurity event.

Cybersecurity Risk Event: Drivers

The Cybersecurity Risk Event has six key risk drivers: (1) social engineering, (2) malware/ransomware, (3) software/application defects, (4) vulnerable devices and infrastructure, (5) supply chain, and (6) insider attack

D1 – Social Engineering <ul style="list-style-type: none"> • Manipulating, influencing, or deceiving a victim to gain control over a computer system, or to steal personal and financial information 	D2 – Malware/Ransomware <ul style="list-style-type: none"> • Malicious software developed by cybercriminals to steal data and damage or destroy computers and computer systems 	D3 - Software/ Application Defects <ul style="list-style-type: none"> • Inadvertent or purposely built in vulnerabilities that threat actors can use to gain access to systems and networks
D4 – Vulnerable devices and infrastructure <ul style="list-style-type: none"> • A vulnerability (unpatched systems, unsupported OS, etc.) that a threat actor can exploit to gain access to systems and networks 	D5 – Supply Chain <ul style="list-style-type: none"> • Occurs when someone infiltrates your system through an outside partner or provider with access to your systems and data 	D6 – Insider Attack <ul style="list-style-type: none"> • A malicious or inadvertent action that results in penetration of systems or networks, or an exfiltration of data



Cybersecurity Risk Event: Consequences

Consequences represent the range of possible outcomes/impacts due to a successful cyber attack. These impacts are measured on a scale of Level 1 to Level 5 based on CoRE and Frequency. We highlight below the consequence of an event at each level on a monetized basis and CoRE basis

Level 5 consequence outcomes contribute all of the potential non-financial consequence associated to cyber attack. Level 1 incidents are most common (99.8% frequency), and carry low risk

					Natural Units Per Event					Monetized Levels (2023 \$M) of a Consequence Per Event					CoRE (risk-adj 2023 \$M/event)				
	CoRE	%Freq	%Risk	Freq	Safety	Indirect Safety	Electric Reliability	Gas Reliability	Financial	Safety	Indirect Safety	Electric Reliability	Gas Reliability	Financial	Safety	Indirect Safety	Electric Reliability	Gas Reliability	Financial
					EF/event	EF/event	MCMI/event	#cust/event	\$M/event	\$M/event	\$M/event	\$M/event	\$M/event	\$M/event	\$M/event	\$M/event	\$M/event	\$M/event	\$M/event
Level 5	77,436	0.003%	98.6%	0.01	0.05	23	3,735	183,654	802	0.8	344	11,840	288	801.7	1.4	1,934	71,387	1,964	2,149
Level 4	387.5	0.005%	1.0%	0.03	-	-	-	-	197	-	-	-	-	197.1	-	-	-	-	387.5
Level 1	0.005	99.8%	0.2%	477.03	-	-	-	-	0.005	-	-	-	-	0.0	-	-	-	-	0.0
Level 3	11	0.035%	0.2%	0.17	-	-	-	-	8.977	-	-	-	-	9.0	-	-	-	-	10.9
Level 2	0.05	0.134%	0.003%	0.64	-	-	-	-	0.05	-	-	-	-	0.1	-	-	-	-	0.1
Aggregated	2.11	100%	100%	477.88	0.000001	0.001	0.100	4.9	0.040	0.00	0.01	0.32	0.01	0.0	0.00004	0.05	1.92	0.05	0.1

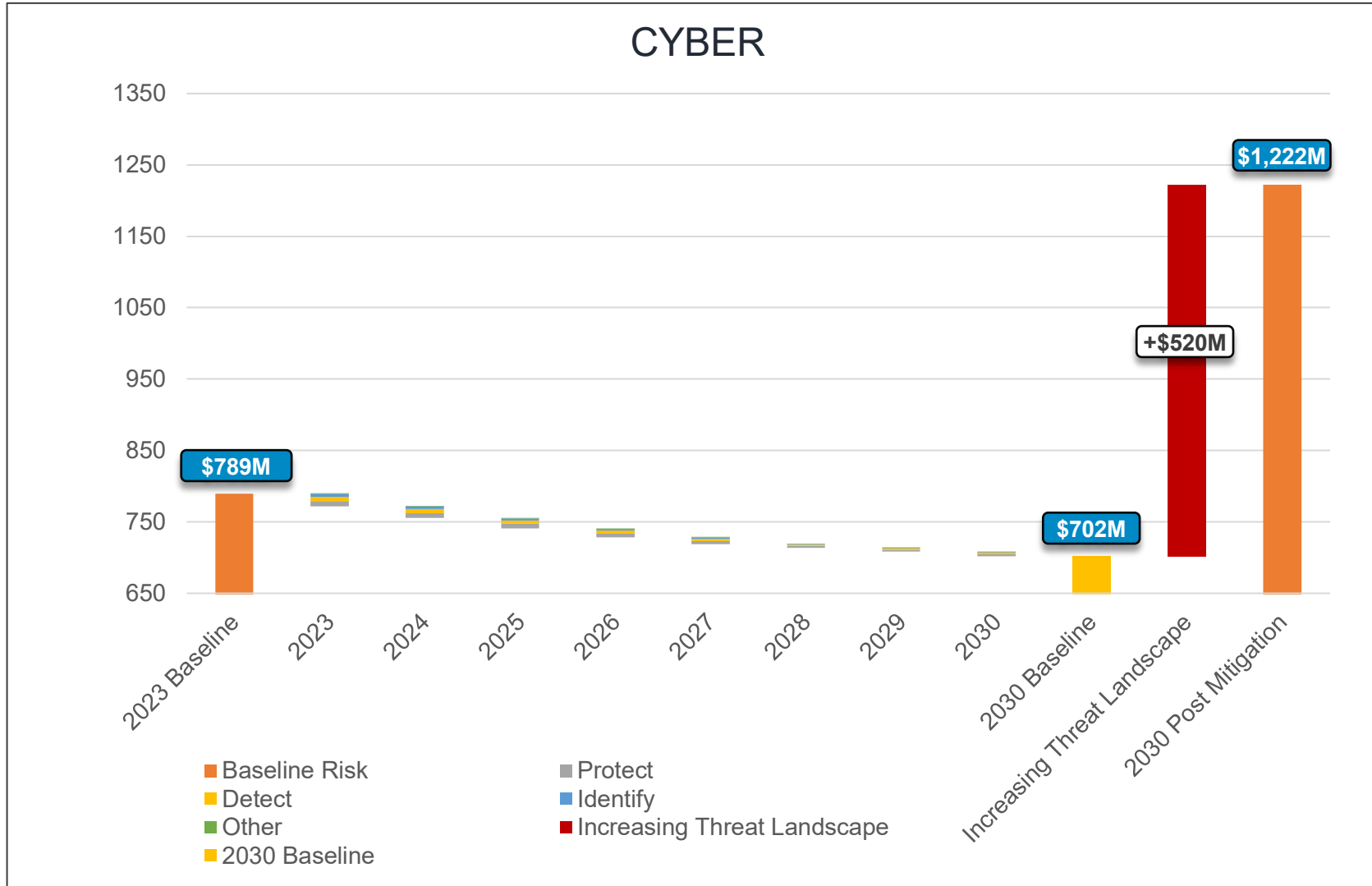
Cybersecurity Risk Event: Consequences (cont.)

The table below demonstrates the consequence of an event at each level in terms of expected loss and attribute risk score.

The increasing financial risk from level 1-4 are generally associated to the remediation of systems and potential lost productivity associated to a cyber risk event.

	Natural Units per Year					Expected Loss per Year (2023 \$M)					Attribute Risk Score (risk-adj 2023 \$M)				
	Safety	Indirect Safety	Electric Reliability	Gas Reliability	Financial	Safety	Indirect Safety	Electric Reliability	Gas Reliability	Financial	Safety	Indirect Safety	Electric Reliability	Gas Reliability	Financial
	EF/yr	EF/yr	MCMI/yr	#cust/yr	\$M/yr	\$M/yr	\$M/yr	\$M/yr	\$M/yr	\$M/yr	\$M/yr	\$M/yr	\$M/yr	\$M/yr	\$M/yr
Level 5	0.00	0.3	47.9	2,354.6	10	0.01	4.4	151.8	3.7	10	0.02	24.8	915.2	25.2	28
Level 4	-	-	-	-	5.1	-	-	-	-	5	-	-	-	-	10
Level 1	-	-	-	-	2.42	-	-	-	-	2.4	-	-	-	-	2.4
Level 3	-	-	-	-	1.50	-	-	-	-	1.5	-	-	-	-	1.8
Level 2	-	-	-	-	0.03	-	-	-	-	0.03	-	-	-	-	0.03
Aggregated	0.0006	0.29	47.89	2,354.6	19	0.01	4.41	151.80	3.7	19.28	0.02	24.79	915.24	25.19	41.76

Cybersecurity Risk Event: Risk Reduction Waterfall



Overview:

Largest risk mitigations included:

- Identity
- Protect
- Detect/Respond

Other consists of all remaining Cybersecurity Risk Event mitigations with total risk scores below 5 for 2023 – 2030

Increasing Threat Landscape is the estimated rate at which the external threat landscape could grow over time which would increase the likelihood of a cybersecurity risk event

Cybersecurity Risk Event: Mitigations and Controls

We calculated Cost-Benefit Ratios (CBRs) for our 7 Control and Mitigation programs to demonstrate cost efficiency. Four programs have a CBR over 50, while others represent significant risk reductions to support management of Cybersecurity Risk Events.

7 Overall Controls
& Mitigations

4 Control
Programs

3 Mitigation
Programs

0.8 – 175.4 CBR Range

Highest CBR Programs				
Rank	Controls		Mitigations	
	Program	CBR	Program	CBR
1	Governance/ Compliance	175.4	Identify	2.4
2	Cybersecurity Services	157.1	Detect/Respond	1.8
3	Cybersecurity Risk/Strategy	113.6	Protect	0.8
4	Security Intelligence Operations Center	50.2		

Highest Risk Reduction Programs				
Rank	Controls		Mitigations	
	Program	Risk Reduction	Program	Risk Reduction
1	Cybersecurity Services	\$7,443M	Protect	\$113.1M
2	Governance/ Compliance	\$1,657M	Detect/Respond	\$75.1M
3	Cybersecurity Risk/Strategy	\$1,657M	Identify	\$56.5M
4	Security Intelligence Operations Center	\$1,089M		



Cybersecurity Risk Event: Alternatives Analysis

As part of the RAMP process, PG&E considered two alternative mitigation that could be deployed in the future to reduce the risk of cybersecurity incidents.

Alternative Plan 1: CYBER-A001 – Identify (Alternative)									Alternative Plan 2: CYBER-A002 – Detect (Alternative)								
Mitigation Number(s): CYBER-A001 Risk Reduction: N/A CBR: N/A									Mitigation Number(s): CYBER-A002 Risk Reduction: N/A CBR: N/A								
This strategy would shift some of the focus on the current threat landscape to a more proactive focus on the evolving threats. Given the PG&E current state of documented blocked attacks (over a million each month) the decision was to continue to primarily focus on the current threat landscape and mitigation with the CSF classification of Protects and use existing levels of resources in CYBER-M001 to continue to analyze and plan for the evolving threats									Consideration was given to increasing the ability to detect and respond to an adverse cybersecurity event. The strategy would be to increase PG&E’s ability to detect an ‘indicator of compromise’ on the front end, and concurrently increase the ability to respond once a cyber event is detected, however this would require diverting resources from one of the other controls mitigation groups to another. Given the budget constraints a zero-sum game/situation. While both mitigations are highly efficient and mature, the reality of the fluid nature of the current threat landscape coupled with the evolving threats required PG&E to give consideration altering programs emphasis and mitigations.								
Mitigation ID	Mitigation Name	Thousands of Nominal Dollars				Millions of Dollars (NPV) ^(a)			Mitigation ID	Mitigation Name	Thousands of Nominal Dollars				Millions of Dollars (NPV) ^(a)		
		2027	2028	2029	2030	Program Cost [A]	Risk Reduction [B]	CBR [B]/[A]			2027	2028	2029	2030	Program Cost [A]	Risk Reduction [B]	CBR [B]/[A]
CYBER-A001	Identify (Alternative)	\$6,521	\$6,994	\$7,344	\$7,711	\$30.9	N/A	N/A	CYBER-A002	Detect (Alternative)	\$33,073	\$37,652	\$39,718	\$41,564	\$164.3	N/A	N/A
	Total:	\$6,521	\$6,994	\$7,344	\$7,711	\$30.9				Total:	\$33,073	\$37,652	\$39,718	\$41,564	\$164.3		

(a) NPV uses a base year of 2023.

For additional details see Exhibit (PG&E-7), WP IT CYBER-F.

The cost estimates in this table are generally based on PG&E’s 2024 budget plan carried forward through 2030. See Exhibit (PG&E-1), Chapter 1, Section D.3.