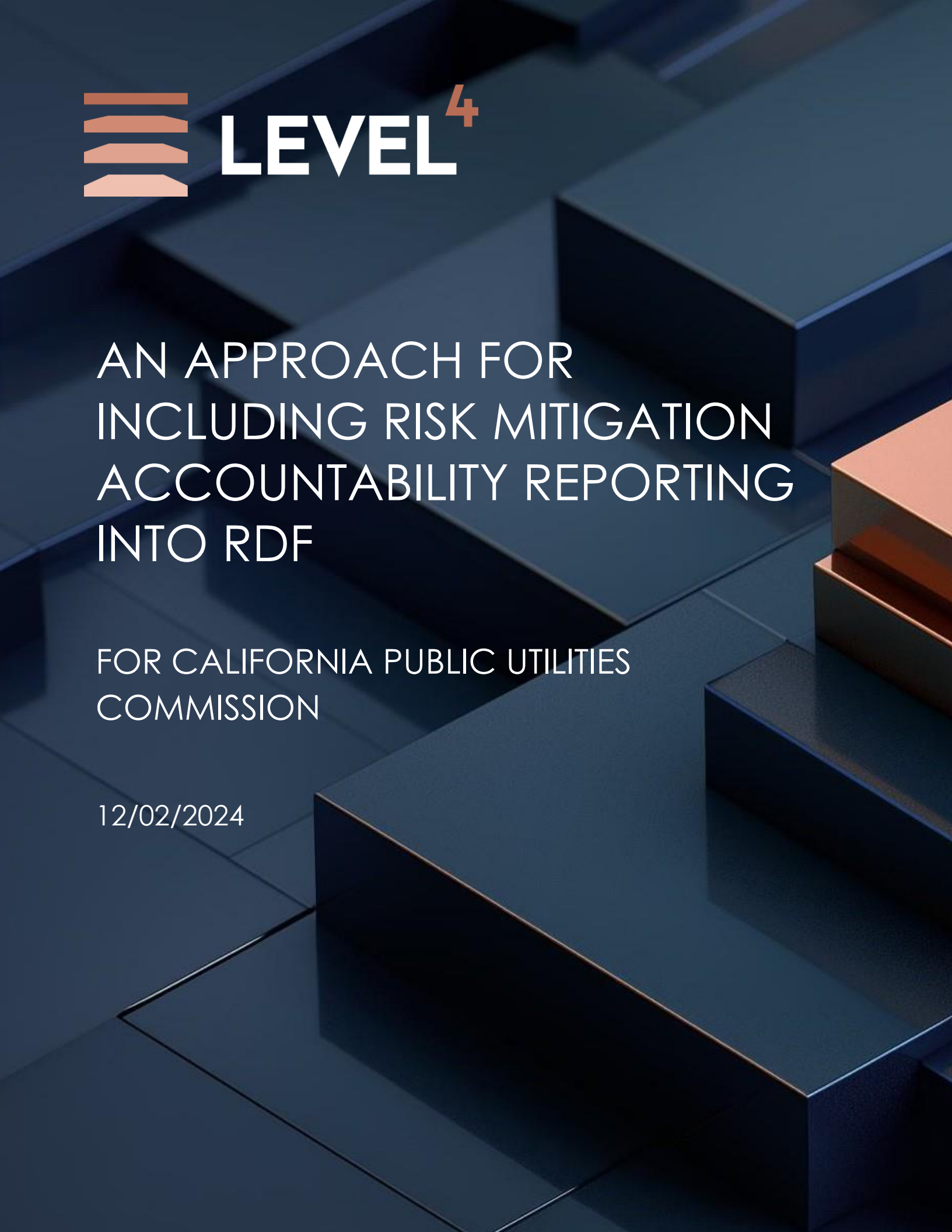

LEVEL 4

AN APPROACH FOR INCLUDING RISK MITIGATION ACCOUNTABILITY REPORTING INTO RDF

FOR CALIFORNIA PUBLIC UTILITIES COMMISSION

12/02/2024

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1 Project Overview

1.1 Project Description

The Safety Policy Department (SPD) of the California Public Utilities Commission (CPUC) has engaged Level 4 as an expert contractor to provide complex and technical expertise on risk mitigation accountability reporting (RMAR).

1.2 Purpose

This contract addresses the requirements of California Senate Bill (SB) 884 to develop, administer, and enforce new standards for an expedited electric utility distribution infrastructure program. Critical efforts of this contract include refining the Risk-Based Decision-Making Framework (RDF) to allow for an improved decision-support process.

Timely and relevant reporting is essential for improved decision-making. RMAR must help evaluators assess whether utilities are reducing utility risk to tolerable levels, as well as how quickly and cost-effectively they are doing so.

1.3 Approach

Level 4 will discuss approaches for RMAR. Level 4 will:

- Review the academic literature and discuss various approaches for accountability reporting in risk, finance, and other fields.
- Create a reporting framework that can be applied to undergrounding projects for SB 884, wildfire risk management in general, and the broader utility risk management beyond wildfire risk.
- Develop recommendations for how to modify the RDF for RMAR, and how to transition to the modified RDF.

As much as possible, the reporting examples and visualizations will be based on wildfire risk and other risks faced by California Public Utilities Commission (CPUC)--regulated utilities, such as (but not limited to) cyber risk and hydro-power risk.

2 Executive Summary

2.1 Overview

RMAR is a process that should enable regulators, intervenors, and other parties to determine how effectively the utilities are executing their mitigation plans. A strong RMAR is grounded in the following principles:

1. *Consolidation*. RMAR can be thought of as a "consolidated statement of risk" that presents a 360-degree perspective on risk for the utility as a whole and for major sub-categories such as attribute, risk event, and risk tranche, borrowing on established principles of business case development and financial reporting.
2. *Context*. RMAR answers "compared to what"—a starting point, a baseline, a plan, a forecast, a risk tolerance level, or other standards.
3. *Accuracy and relevance*. RMAR must never mislead, meaning it must present risk information in an accurate and relevant manner.
4. *Transparency*. RMAR ensures clarity, consistency, and comparability.
    a. Clarity: Data is clearly defined and labeled to avoid misinterpretation.
    b. Consistency: Consistent methodologies and definitions ensure "apples-to-apples" comparability over time.
    c. Comparability: Provides meaningful comparisons between forecasts and results, results over time, and across utilities.
5. *Comprehensiveness*. RMAR presents multi-dimensional views of risk reduction for all risks and must be capable of handling ten dimensions or more.
6. *Time exposure*. RMAR captures the timing, pacing, and sequencing of risk reduction. It combines aspects of business cases (forward-looking) and financial reporting (backward-looking.)
7. *Governance and Infrastructure*. RMAR requires utilities to have the infrastructure to ensure data integrity, hierarchy control, version control, and model control over multiple periods.

The content and structure of RMAR are consistent with financial and risk reporting in other industries. The International Financial Reporting Standards (IFRS) focus on consistency, comparability, transparency, and accuracy,[1] and the Bank of International Settlements (BIS) lists 14 principles for risk reporting, including accuracy and integrity, clarity, completeness, and comprehensiveness.[2]

Ultimately, the goal of RMAR is to provide a better understanding of all the risks faced by utilities and to create a structured way to hold utilities accountable for the forecasted risk reduction benefit and cost they present to the Commission in a Risk Assessment and Mitigation Phase (RAMP) or general rate case (GRC) to justify investments in mitigations.

[1] https://www.wallstreetmojo.com/ifrs/

[2] https://www.bis.org/publ/bcbs239.pdf

2.2 Key findings and summary recommendations

Level 4 has reviewed the various RDF-related reports and has found that, while each report provides a wealth of risk mitigation benefits and cost information, each one is designed for a specific purpose, and none provides a holistic view of risk, risk reduction, costs, and benefits. Key questions such as "How much risk remains, and is it within tolerance?", "compared to what?", and "why" are often not addressed.

A well-designed RMAR as a "consolidated statement of risk" should address these deficiencies. Level 4 makes the following summary recommendations, as outlined in Figure 2-1:

Recommendation	Description
R1. Integrate the Risk Mitigation Accountability Report (RMAR) into the Risk-based Decision-making Framework (RDF)	Utilities should be required to file updates to the RMAR on a regular basis.
R2. Required RMAR structure	To ensure a consistent and comprehensive report, the guidelines for RMAR should include requirements for key structural components.
R3. Change-control procedures	RMAR may span many years, and there must be flexibility to make changes that may affect past or future periods or both.
R4. RMAR must result in accountability	Accountability for RMAR accuracy needs to be supported by escalated enforcement actions.
R5. Discuss and certify underlying model accuracy	RMAR should include a narrative section that discusses model and data quality and sensitivity analysis that certifies that internal quality control requirements have been met.
R6. Streamline overlapping elements between RMAR, RAMP, GRC, RSAR, and other reports.	Parts of RMAR may overlap with other reporting processes, which presents the opportunity to identify and reduce duplication.

Figure 2-1. Recommendations summary.

Recommendations are presented in more detail in Chapter 11.

3 Background and Current State

3.1 RMAR in the RDF

The CPUC decision D.14-12-025 in December 2014 recommends that the utilities should be required to prepare two new annual reports, the RMAR and the Risk Spending Accountability Report (RSAR).[3] According to the decision,

- RMAR "would compare the utility's GRC projections of the benefits and costs of the risk mitigation programs adopted in the GRC to the actual benefits and costs and would explain any discrepancies between the projected risk mitigation and the actual risk mitigation."
- RMAR "would consist of a program-by-program comparison of the utility's GRC projections of risk mitigation programs—quantified as much as possible using the models examined in the Safety Model Assessment Proceeding(S-MAP) and used to prepare the RAMP assessments—with measured results of actual risk mitigation programs, including a comparison of projected and actual Risk Mitigation Cost Ratios."

CPUC decision D.16-08-018 includes further discussion on RMAR, including a suggestion to develop a common set of performance metrics.[4] CPUC D.19-04-020 further discusses RMAR and recognizes some of the obstacles for producing an RMAR. In particular, the decision observes the timing issues created by the staggered RAMP schedule for the large IOUs.[5] The decision's Table 3, reproduced below, lays out the timing considerations:

Table 3: Timeline to RMARs Comparing RSE Scores Based on SA Methodology

RAMP and GRC filings include RSE scores					RAMP and GRC filings compare RSE scores				
Test Year	Letter Requesting OII	RAMP Filing	GRC Filing	RMAR Report	Test Year	Issue Letter Requesting OII	RAMP Filing	GRC Filing	RMAR Report
Sempra TY 2022	*Sept 1, 2019*	*Nov 30, 2019*	*Sept 1, 2020*	*July and Sept 31, 2021*	*Sempra TY 2025*	*Sept 1, 2022*	*Nov 30, 2022*	*Sept 1, 2023*	*July 31 and Sept 31, 2024*
PG&E TY 2023	*Sept 1, 2020*	*Nov 30, 2020*	*Sept 1, 2021*	*March 31, 2022*	*PG&E TY 2026*	*Sept 1, 2023*	*Nov 30, 2023*	*Sept 1, 2024*	*March 31, 2025*
SCE TY 2024	*Sept 1, 2021*	*Nov 30, 2021*	*Sept 1, 2022*	*May 31, 2023*	*SCE TY 2027*	*Sept 1, 2024*	*Nov 30, 2024*	*Sept 1, 2025*	*May 31, 2026*

Figure 3-1. RMAR timeline based on other S-MAP requirements.

[3] CPUC D14.12.025, Section 3.5, page 43.

[4] CPUC D16.08.018, page 159.

[5] CPUC D19.04.020, page 31.

The Commission concluded by finding it "premature to approve specific RMAR requirements…at this time. Instead, it is reasonable to defer consideration of a specific RMAR methodology…until closer to the time when this can be accomplished given the schedule outlined in Table 3."[6] (Figure 3-1 above). In the interim, IOUs are directed "to include in their annual Safety Performance Metrics Reports some of the information originally envisioned as belonging in the RMARs", and in addition, the Commission "intends to revisit the program-by-program comparison of changes to cost-benefit ratios (CBRs) in a future S-MAP proceeding".[7]

As made clear from the history of RMAR since 2014, the implementation of a complex, multi-dimensional report that is both backward-looking and forward-looking has proven elusive.

3.2 Current state of RMAR

Review of how mitigation reports are included in current RAMPs and Wildfire Mitigation Plans (WMPs), and how mitigation effectiveness is evaluated and compared to the original commitments and funding requests.

The utilities have participated in working groups for developing and implementing RMAR. In A21-05-011, SDG&E provided an Interim RMAR, from which Figure 3-2 and Figure 3-3 are excerpted below.[8] The Interim RMAR is a high-level summary that compares actual operating and maintenance (O&M) expenses and capital expenditures for 2021 versus the "imputed authorized" expenses for that year, and calculates variances:

SDG&E O&M Details (2021 Direct $000)					
RAMP Chapter	RAMP Risk Description	2021 Actuals	2021 Imputed Authorized	Variance	Variance
SDG&E-01	Wildfires Caused by SDG&E Equipment (Including Third Party Pole Attachments)	67,809	41,999	25,810	61%
SDG&E-02	Catastrophic Damage Involving Third-Party Dig-Ins	7,112	4,760	2,351	49%
SDG&E-03	Employee, Contractor, and Public Safety	66,675	53,452	13,223	25%
SDG&E-04	Distributed Energy Resources – Safety and Operational Concerns	48	84	(36)	-43%
SDG&E-06	Fail to Blackstart	16	46	(30)	-65%
SDG&E-07	Cyber Security	12,799	8,643	4,156	48%
SDG&E-08	Aviation Incident	456	463	(7)	-1%
SDG&E-09	Workplace Violence	4,389	5,369	(980)	-18%

[6] Ibid., page 32.

[7] Ibid., page 32.

[8] CPUC A21.05.011, page 33-35.

SDG&E-10	Catastrophic Damage Involving High-Pressure Gas Pipeline Failure	10,299	5,834	4,466	77%
SDG&E-11	Unmanned Aircraft System Incident	177	183	(6)	-3%
SDG&E-12	Electric Infrastructure Integrity	8,464	22,422	(13,958)	-62%
SDG&E-13	Records Management	6,338	9,664	(3,327)	-34%
SDG&E-14	Climate Change Adaptation	-	454	(454)	-100%
SDG&E-16	Catastrophic Damage Involving Medium-Pressure Gas Pipeline Failure	12,073	16,829	(4,756)	-28%
SDG&E-17	Workforce Planning	3,372	2,471	901	36%
New	Emergent RAMP[51]	82,330	-	82,330	100%

Figure 3-2. SDG&E Interim RMAR for O&M mitigations in 2021.

SDG&E Capital Details (2021 Direct $000)					
RAMP Chapter	RAMP Risk Description	2021 Actuals	2021 Imputed Authorized	Variance	Variance
SDG&E-01	Wildfires Caused by SDG&E Equipment (Including Third Party Pole Attachments)	189,368	92,414	96,954	105%
SDG&E-02	Catastrophic Damage Involving Third-Party Dig-Ins	3	318	(315)	-99%
SDG&E-03	Employee, Contractor, and Public Safety	15,101	13,245	1,856	14%
SDG&E-04	Distributed Energy Resources – Safety and Operational Concerns	8	241	(233)	-97%
SDG&E-05	Major Disturbance to Electrical Service (e.g., Blackout)	0	1,726	(1,726)	-100%
SDG&E-06	Fail to Blackstart	34	2,051	(2,017)	-98%
SDG&E-07	Cyber Security	10,976	3,229	7,747	240%
SDG&E-08	Aviation Incident	0	1,980	(1,980)	-100%
SDG&E-09	Workplace Violence	5,061	4,185	876	21%
SDG&E-10	Catastrophic Damage Involving High-Pressure Gas Pipeline Failure	3,251	10,608	(7,358)	-69%
SDG&E-12	Electric Infrastructure Integrity	116,670	108,545	8,125	7%
SDG&E-13	Records Management	15,122	12,693	2,430	19%
SDG&E-16	Catastrophic Damage Involving Medium-Pressure Gas Pipeline Failure	123,334	45,431	77,903	171%
New	Emergent RAMP	218,856	32,282	186,574	578%
Total SDG&E RAMP		697,783	328,946	368,837	112%

Figure 3-3. SDG&E Interim RMAR for capital mitigations in 2021.

While a step in the right direction, the interim RMAR provides only one period of data and only for expenses. At this stage, it is more a spending reconciliation than a risk report which would focus on risk reduction as well as expenses.

In April 2024, SCE and SDG&E filed RSARs[9], which incorporate more dimensionality, such as granular spending categories and multi-year comparisons. The RSARs provide comparisons of actual and imputed authorized operating and capital expenditures for the five years spanning 2019 to 2023, for RAMP mitigation activities such as cybersecurity, substation reliability, records management, gas infrastructure resilience, etc.

In February 2024, PG&E filed its annual System Hardening Accountability Report (SHAR), which includes tables comparing forecasted future risk reduction versus a target level of risk reduction, as well as the actual risk reduction results versus the forecast and the target.[10] Figure 3-4 below is a four-year forecast of risk reduction versus a target risk reduction for the four years. Figure 3-5 below shows the actual risk reduction for the first year versus the target level risk reduction. Actual risk reduction versus the forecast can be determined by comparing the two figures.

Risk Model	2023	2024	2025	2026	Total 2023 - 2026
Total V2 Forecasted Annual Risk Reduction	2.4%	2.1%	1.1%	0.4%	6.1%
Total V3 Forecasted Annual Risk Reduction	0.1%	0.7%	6.5%	7.2%	14.5%
Sum of Total V2 + Total V3 Forecasted Annual Risk Reduction	2.5%	2.8%	7.6%	7.7%	20.6%
Sum of Total V2 + Total V3 Forecasted Cumulative Risk Reduction	2.5%	5.3%	12.9%	20.6%	20.6%
Cumulative Risk Reduction Target (D.23-11-069, OP 23)	2%	5%	10%	18%	18%

Figure 3-4. PG&E SHAR projected risk reduction percentage: Summary by year.

Risk Model	2023	2024	2025	2026	Total 2023 - 2026
Total V2 Forecasted Annual Mileage	394.7	266.8	171.0	53.5	886.0
Total V3 Forecasted Annual Mileage	28.3	56.0	508.6	575.1	1167.9
Sum of Total V2 + Total V3 Forecasted Annual Mileage	422.9	322.8	679.6	628.5	2053.9
Annual System Hardening Mileage Target	420	280	520	788	2008
Sum of Total V2 + Total V3 Forecasted Cumulative Mileage	422.9	745.7	1425.3	2053.9	2053.9
Cumulative System Hardening Mileage Target	420	700	1220	2008	2008

Figure 3-5. PG&E 2023 SHAR, projected system hardening miles: Summary by year.

[9] Risk Spending Accountability Report of SDG&E (U902M) and SCE (U904G) for 2023, April 30, 2024.

[10] Advice 7150-E-A, Attachment D - Baseline_Risk PGE SHAR 2023-Public

The RSAR and SHAR are encouraging signs of progress towards a full-fledged RMAR. The SHAR presents a multi-dimensional view of risk reduction, combining a time horizon, a forecast, a target, and actual results. And yet, an evaluator would have a very difficult time reviewing risk outcomes, actual mitigation benefits and costs versus plan, and post-mitigated risk, for various time periods in a single report. Section 12.2 the appendix describes in detail the obstacles faced by an evaluator trying to assemble such a report. Multi-dimensional views are a key feature of RMAR, and the following chapters will go into detail about what a full-fledged RMAR looks like.

4 Risk Reporting as a Consolidated Statement of Risk

4.1 The idea of a consolidated statement of risk

Consolidated financial reports provide evaluators with a holistic view of an organization and its major subgroups. The reports consist of tables that dissect different aspects of financial performance yet can always be "consolidated" to the whole.

In a similar vein, a consolidated statement of risk would provide evaluators with standardized tables that examine risk and risk reduction from a variety of perspectives, while answering the overarching questions:

1. Has utility risk been reduced to a tolerable level, and if not, when will it be reduced to that level?

2. How is the utility achieving other objectives such as cost-effectiveness, safety and reliability improvements, and affordability?

Standardized tables ensure that risk information is presented in an internally consistent way and that the results can be compared across utilities.

The primary purpose of a consolidated statement of risk is to present aggregated risk at the enterprise level and major subgroups ("macro reports"), but many of the principles apply for disaggregated reporting, for example at the project or scoped work level ("micro reports"). Figure 4-1 below are some of the key differences between micro and macro risk reports.

	Macro	Micro
Organization Level	Hierarchy Level, or major subgroup (Risk Event, Attribute, Tranche)	Risk Reporting Unit
Assessment	Decision-making, economic analysis	Compliance and Control
Focus	Portfolio Analysis Stochastic Optimization	Risk Reporting Unit analysis Revenue and cost accounting

Figure 4-1. Differences between macro and micro risk reporting.

It would be infeasible to attempt both types of reporting in a single report. RMAR lends itself more to macro reporting, while RSAR could fit the bill for micro reporting.

Another distinction is external, or publicly available reporting, versus reports for internal agency review only. This distinction can be accomplished by giving each table in the consolidated statement of risk a public or private designation.

In the following sections, we will provide sample tables from a fictitious consolidated statement of risk. These tables contain made-up, though internally consistent, data and are for illustrative purposes only. We will also use the terms consolidated statement of risk and RMAR interchangeably.

4.2 Context: "Compared to what"

The most important principle of a consolidated statement of risk is the context principle, in which every presentation of data is geared towards answering the question "compared to what", along with a secondary question, "why".[11]

Every table in the consolidated statement of risk is comparative in nature. Comparisons may include actual results to goals, actual results to modeled results, modeled results to risk tolerance, results of one period to another period, how a mitigation plan changes from an old model version to a new one, and many more.

The following table (Figure 4-2) from a hypothetical RMAR presents average risk reduction in the context of pre-mitigated risk and post-mitigated risk in year 3. Relevant comparisons include actual risk reduction versus plan and post-mitigated risk versus risk tolerance.

			Act B(W) Plan	
Risk reduction overview, average risk	**Actuals Y3**	**Planned Y3**	**$**	**%**
Pre-mitigated risk	$1,700	$1,700		
Risk reduction	**$168**	**$215**	**($47)**	**-22%**
Post-mitigated risk	$1,532	$1,485	($47)	-3%
Risk tolerance	$500	$500		
% Risk tolerance gap reduced	14%	18%		-4%

Figure 4-2. Example of RMAR table comparing actuals to planned risk reduction.

4.3 Accuracy and Relevance

The next key principle is that RMAR must never mislead. Faulty data, errors, and omissions often lead to inaccurate and misleading reports. Accuracy by itself may not be sufficient: including irrelevant information in tables and visuals can lead to obfuscation and confusion. An example of accurate but irrelevant reporting would be producing the likelihood of cyber-attacks using data since the 1990s before cyberattacks became ubiquitous[12]. Even if accurately calculated and presented, it could steer evaluators to underestimate current and future cyber risks.

Accuracy in RMAR is not the same as accuracy in risk modeling, despite sharing some common elements. Both require accurately capturing, storing, and retrieving data. Both require proper and judicious use of data.

[11] Edward Tufte, The Visual Display of Quantitative Information. Graphics Press, 1983. Page 74.

[12] A Brief History of Cybercrime https://arcticwolf.com/resources/blog/decade-of-cybercrime/

While the presence of errors is inherent in risk modeling—as long as the errors are unbiased (neither systematically understated nor overstated)—risk reporting requires precision. Precision means that numbers are correctly retrieved from systems of record, classified properly, and presented appropriately. Modeled outputs can be "roughly right", but "roughly right" reporting is unacceptable. The governance and infrastructure to ensure accuracy will be covered in more detail in Chapter 7.

4.4 Transparency: Clarity, consistency and comparability

The principle of transparency means that the information contained in RMAR means what the evaluator is led to believe it means. Benefits include risk reduction and nothing else. Expenses include everything they should. Double-counting is avoided. *Clarity* depends on clear definitions and labeling so an evaluator understands what he or she is looking at. Defining units helps provide clarity. Subtotals help provide clarity. The snippet from a hypothetical report in Figure 4-3 below lacks clarity because it fails to define the units of impact. Is it damage in dollars? Acres flooded? The amount of water volume released? An evaluator may not know what to do with the data provided and will move on, resulting in an opportunity to impart helpful information being wasted. Worse, the evaluator could misinterpret and inadvertently misuse the information.

Modeled Flood Impact	2024	2025	2026
	250	150	80

Figure 4-3. Insufficient clarity due to poor labeling.

Another common error in reporting is omitting helpful subtotals. Table A (Figure 4-4) below shows the distribution of spending across mitigation categories over a three-year period. Without a subtotal, it is impossible to decipher (without forcing the evaluator to do the math) the purpose of the table. Is it presenting the allocation of spending by mitigation for each year (columns each add to 100%) or the three-year allocation for each mitigation (rows each add to 100%)?

Mitigation Spending Allocation			
Table A	**2024**	**2025**	**2026**
Wildfire	40%	35%	35%
Cybersecurity	15%	30%	40%
Hydropower	25%	20%	15%
Other	20%	15%	10%

Figure 4-4. Insufficient clarity due to missing subtotals.

By contrast, the subtotal row in the otherwise identical Table B (Figure 4-5) below makes it clear how to read and interpret the data.

Mitigation Spending Allocation			
Table B	**2024**	**2025**	**2026**
Wildfire	40%	35%	35%
Cybersecurity	15%	30%	40%
Hydropower	25%	20%	15%
Other	20%	15%	10%
Total	**100%**	**100%**	**100%**

Figure 4-5. Subtotals make it clear that the data is aligned by column.

Consistency means that data that is presented together is "apples-to-apples"; it is defined in the same way and created using the same methodology. Figure 4-3 would be inconsistent and incomprehensible if the units in the 2024 column were in acres, while those in the 2025 column were in dollars. More subtly, Table B (Figure 4-4 above) would be compromised if the changes in percentages between 2025 and 2024 were solely due to an accounting change. An example of an accounting change would be a revised fixed expense allocation methodology for 2025 that shifted expenses to cybersecurity from the other risk events.

RMAR may encompass many years (e.g., ten or more) so changes in organization, data, models, and methodologies are inevitable. Maintaining consistency despite such changes will be covered in chapter 7.

Comparability follows from consistency and means that comparisons are meaningful and appropriate. Comparability is also the foundation for the context principle in Section 4.2 so it is essential that all RMAR comparisons are legitimate and insightful. Comparing the full-year results of one year against a quarterly result of another would not ordinarily make sense, nor would comparing the operating expenses of cybersecurity mitigation with the capital expense of hydro-power mitigation.

4.5 Comprehensiveness: Multi-dimensionality

By its nature, a comprehensive analysis of risk is highly multi-dimensional, and the RDF examines risk in at least 10 dimensions:

1. **Hierarchy.** Based on organizational structure, e.g., circuit, substation, region, division, high fire threat district (HFTD), and enterprise. Hierarchy defines how reports and tables are grouped, the "parent-child" relationships.
2. **Scenario**. Actuals, plan, or forecast.
3. **Version**. Model or methodology.
4. **Risk events.** All risks, wildfire, gas incidents, cyberattack, hydro-power, etc.

5. **Tranches.** Risk event-dependent.[13]
6. **Mitigations.** Risk event-dependent. For wildfire—includes undergrounding, covered conductor, vegetation management, etc.
7. **Attribute.** Safety, reliability, financial.
8. **Risk measure.** Average risk, tail-average risk.[14]
9. **Accounts (line-items).** This dimension contains all the calculations we are interested in: Pre-mitigated risk, mitigation value, post-mitigated risk, CBR, risk tolerance, capital expenses, operating expenses, likelihood of risk event (LoRE), consequence of risk event (CoRE), and natural units.
10. **Time**. Periods under consideration can be months, quarters, years, or GRC Cycle (i.e. PG&E's 2027 GRC).

RMAR tables can comfortably handle 6–8 dimensions, which is why the consolidated statement of risk may require numerous tables to capture every dimension. Figure 4-6 below shows the dimensionality of a typical RMAR table:

Hierarchy				
Risk Event				
Version				
Scenario I		**Scenario II**		**"Compared to What?"**
Risk Measure	**Time=>**	**Risk Measure**	**Time =>**	**Scenario I B(W) Scenario II**
Attribute A		**Attribute A**		
Line item 1		Line item 1		
Line item 2		Line item 2		
Attribute B		**Attribute B**		
Line item 1		Line item 1		
Line item 2		Line item 2		

Figure 4-6. Reporting table layout in 8 dimensions: Hierarchy, risk event, version, scenario, risk measure, attribute, line item, and time.

[13] See D.24-05-064, Appendix A, Row 14

[14] As discussed in detail in the Phase 4 Workshop #2 Staff Proposal on Overall Residual Risk, Risk Tolerance and Simple Optimization, risk-based decisions should capture tail risk in addition to average risk. Correspondingly, RMAR must report on tail risk reduction.

Figure 4-7 below is a sample table based on a hypothetical RMAR. It presents risk information in 7 dimensions and provides multiple comparisons—actuals to the original plan, new forecast to the original plan, and critically, progress towards meeting risk tolerance standards.

RMAR Dimensions:

1. *Hierarchy*: Entity level
2. *Scenario*: actuals for years 1-3, new forecast for years 4-10.
3. *Version*: Model 2.1
4. *Time*: 10 years, annual
5. *Risk Event*: Wildfire
6. *Risk Measure*: Average risk
7. *Line items*: a) circuit data in natural units, b) risk benefits and c

"Compared to What":

A. Actuals versus Plan
B. Forecast vs Plan
C. Progress towards meeting Risk Tolerance standard.

1	**Hierarchy**	Entity Level
2	**Scenario**	Actuals/FC
3	**Version**	Model 2.1
4	**Period**	Actuals: Years 1-3; Forecast Years 4-10

5 **WILDFIRE RISK ACTUALS/FC VS. PLAN**

			A			B		
	Table 1: Circuits			**Act B(W) Plan**				
7a	**Circuit Miles**	**Actuals Y1-3**	**Plan Y1-Y3**	**#**	**%**	**Forecast**	**Plan**	**$**	**%**
	UG	1,000	1,400	(400)	-29%	1,320	1,400	(80)	-6%
	CC	380	400	(20)	-5%	380	400	(20)	-5%
	Total	**1,380**	**1,800**	**(420)**	**-23%**	**1,700**	**1,800**	**(100)**	**-6%**

	Table 2. Summary			**Act B(W) Plan**				**FC B(W) Plan**	
6	**Average Risk**	**Actuals Y1-3**	**Plan Y1-Y3**	**$**	**%**	**10Y Forecast**	**Plan**	**$**	**%**
	Pre-mitigated risk	**$870**	**$870**			**$870**	**$870**		
7b	**Risk reduction**	**$106**	**$143**	**($37)**	**-26%**	**$135**	**$143**	**($8)**	**-6%**
	Post-mitigated risk Y3	$764	$727	($37)	-5%	$735	$727	($8)	-1%
	Risk tolerance	$200	$200			$200	$200		
C	% Risk tolerance gap reduced	16%	21%		-6%	20%	21%		-1%

Figure 4-7. Hypothetical RMAR actuals vs plan and forecast.

Additional tables can be added to include other dimensions, which may require substituting other dimensions to maintain readability. For example, a table designed to take a closer look at risk reduction by each risk event and attribute may need to collapse the time dimension.

Chapter 4 has examined the structure of the RMAR. The next chapter will discuss key concepts in creating the RMAR.

5 Creating the consolidated statement of risk

5.1 The risk reporting unit, plan phase, and results phase

The consolidated statement of risk includes three building blocks. The first is the risk reporting unit (RRU), which is the basic building block of the RMAR. The second is the planning phase and the third is the results phase. The planning and result phases capture the relationship between projections (plans and forecasts) and results. They also present the time exposure to risk through the timing, pacing, and sequencing of risk reduction actions.

5.2 Risk Reporting Unit (RRU)

Defining the RRU is a critical first step in designing the RMAR. The RRU is the root of the RMAR's hierarchical structure; all aggregations begin with the RRU. The RRU contains all the data elements and dimensions that will be reported in the RMAR; as such, the RRU is a microcosm of the RMAR. Any information not included in the RRU cannot be aggregated to a higher level, and therefore cannot be included in the RMAR.

Figure 5-1 below presents how risk data flows to an RRU. The first category of data is unique identifiers. These form the foundation for the utility's risk-reporting hierarchy and enable aggregation. An RRU may not be identified with more than one risk event—it would be highly unusual for risk data for wildfires to be the same for cybersecurity. The second category is the actual risk data, which can be aggregated based on unique identifiers.

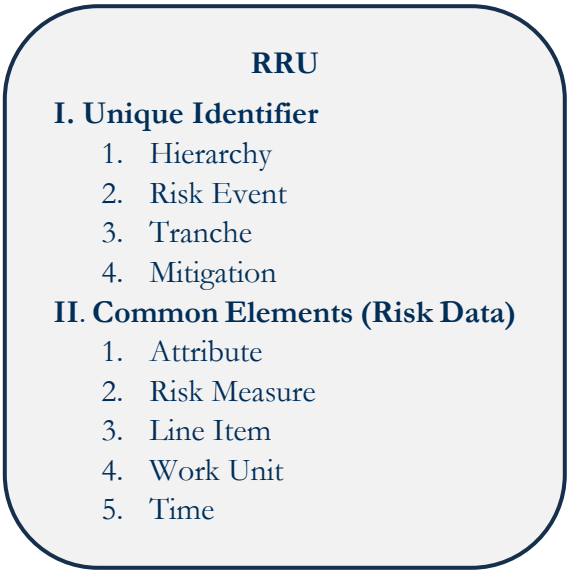

Figure 5-1. How an RRU is organized (microcosm of RMAR).

For example, we can produce a table that aggregates the risk data for a risk event, such as a Large Unplanned Water Release (LGUWR) from a hydro-power facility. All the RRUs that have the unique identifier for LGWUR are collected, and the common elements for those RRUs are aggregated to produce a view of risk reduction from a mitigation program within the context of the LGUWR risk.

The following diagrams show how different aggregations can be created from RRUs. Figure 5-2 below shows a straightforward aggregation of RRUs to different risk events:

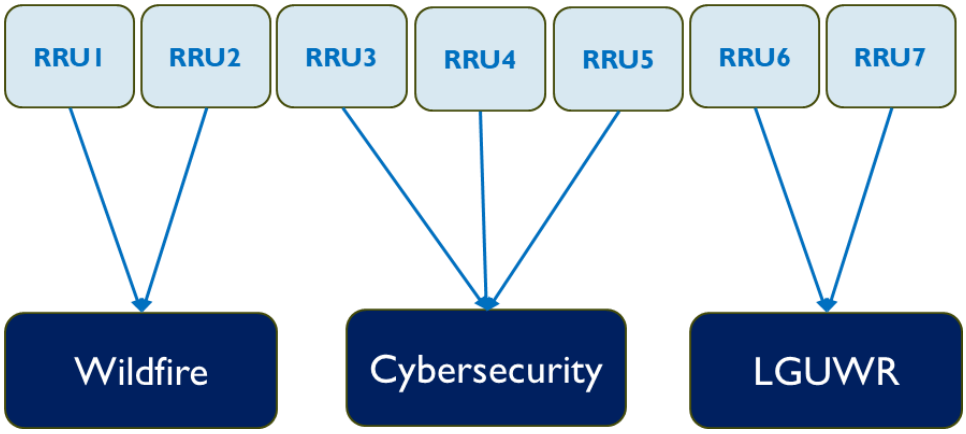

Figure 5-2. RRUs aggregating to risk events.

Figure 5-3 below illustrates a more complicated aggregation. Since each RRU contains risk information for each attribute, RRUs can be aggregated to total Safety, Reliability, and Financial according to those three roll-up points.

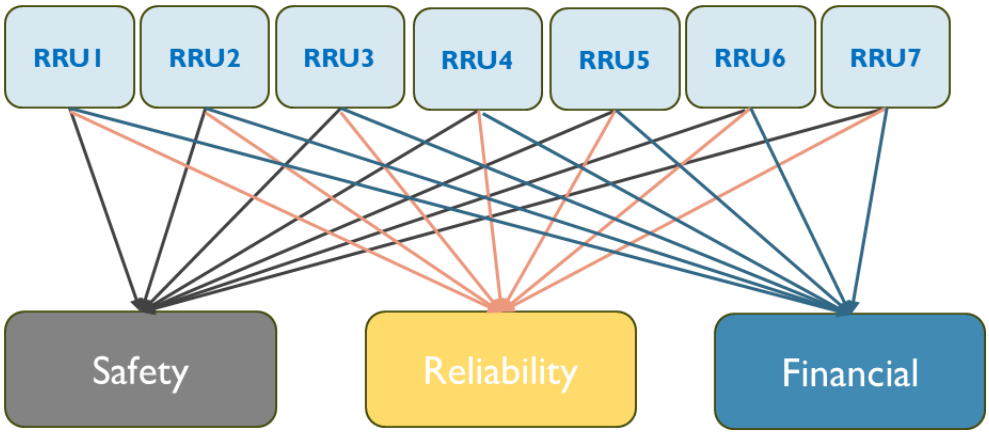

Figure 5-3. RRUs aggregating to attributes.

What is the right level of granularity for an RRU? Here, the "Goldilocks principle" applies.

- *Overly granular*: Choosing the most granular level possible, such as a circuit segment or gas pipe segment, is often the most tempting. Granularity does enable more flexibility in aggregating the data and defining hierarchy points. However, an overly granular approach may result in thousands or tens of thousands of RRUs, each one requiring modeled results, forecasts and plans, and risk and expense details. Overly granular could be unwieldy.
- *Overly aggregated*: While fewer RRUs are easier to manage, they may be inflexible for further aggregating. If an RRU contains multiple mitigations, or multiple tranches, or includes portions of HFTD and non-HFTD, then RRUs cannot be aggregated to create reports for these dimensions because it would defeat the purpose.

A reasonable starting point for an RRU is a project or scoped work. The following diagrams will help in deciding how to define the RRU. Ideally, data that flows to an RRU will exhibit a simple mapping to the RRU structure. This means that if an RRU includes three attributes (safety, reliability, and financial), a lower-level entity feeding the RRU will not have added all the attributes together into one, nor will it try to send a fourth attribute. Figure 5-4 below illustrates a simple mapping, also known as "one-to-one", for two wildfire mitigations, undergrounding (UG) and covered conductor (CC).

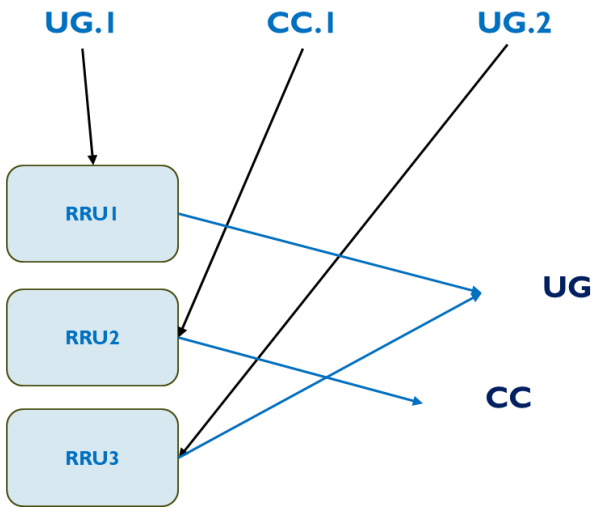

Figure 5-4. Wildfire mitigations mapping "one-to-one" to RRU.

Each mitigation type maps to an RRU—two underground segments map one each to RRU1 and RRU3, and the covered conductor segment maps to RRU2. This allows the RRUs to be aggregated to create the total for the UG mitigation program and the total for the CC mitigation program.

However, if the mapping is complex (e.g. 'many to one' or 'many to many'), the diagram can look like Figure 5-5 below. RRU2 and RRU3 include a mix of UG and CC segments, which means the RRUs can no longer be aggregated to a total UG and total CC.

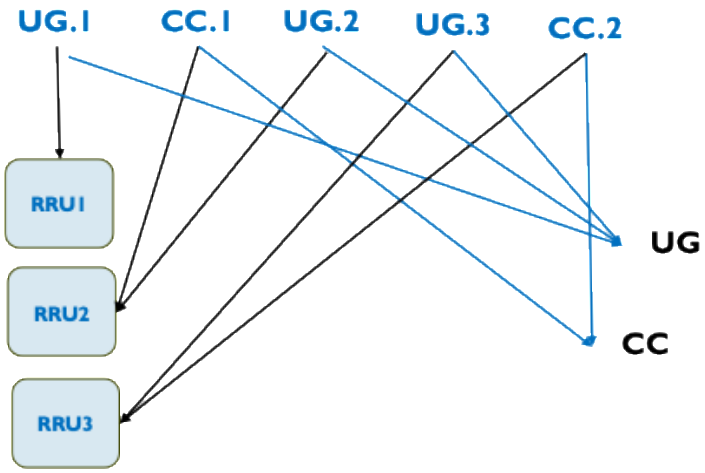

Figure 5-5. "Many to one" mapping. RRUs can no longer be used to aggregate for mitigations.

The aggregation to the total UG mitigation program and the total CC mitigation program must be done from the mitigation segment, which means that two hierarchy structures would have to be maintained (one for mitigation segments to mitigations, another for RRUs to everything else). This would defeat the purpose of defining an RRU.

Additionally, the "one to many" mapping of RRU is highly discouraged. Take, for instance, the mapping of RRUs to Tranche 1, Tranche 2, and Tranche 3 in Figure 5-6 below.

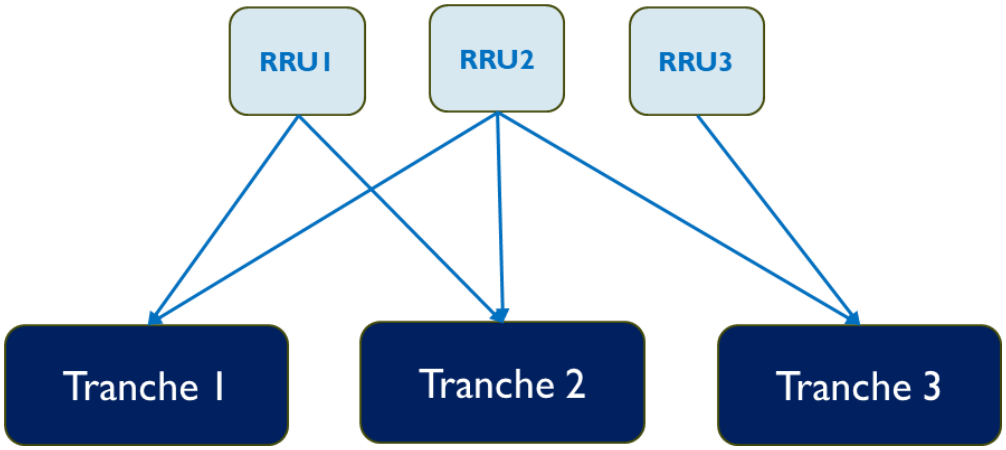

Figure 5-6. "One to many" mapping of tranches.

It is not clear how much risk reduction achieved by RRU2 is reducing risk from Tranche 1, Tranche 2 or Tranche 3. While a utility could in theory say that 40% of risk reduction achieved by RRU2 is reducing risk from Tranche 1, another 40% from Tranche 2, and another 20% from Tranche 3, this would be very difficult to audit, which is a foundational requirement of the RRU. In other words, a "one to many" mapping of an RRU can allow for the possibility of double counting.

However, complex mapping may be necessary in some instances. Let's take the example in Figure 5-7 below. The undergrounding and covered conductor mitigation segments properly display a One-to-One Mapping with three distinct RRUs. Those RRUs may have risk reduction benefits for more than one risk. For instance, the undergrounding segment (UG.1) in RRU2 has risk reduction benefits for Wildfire, public safety power shut-off (PSPS), and Failure of Electric Distribution.

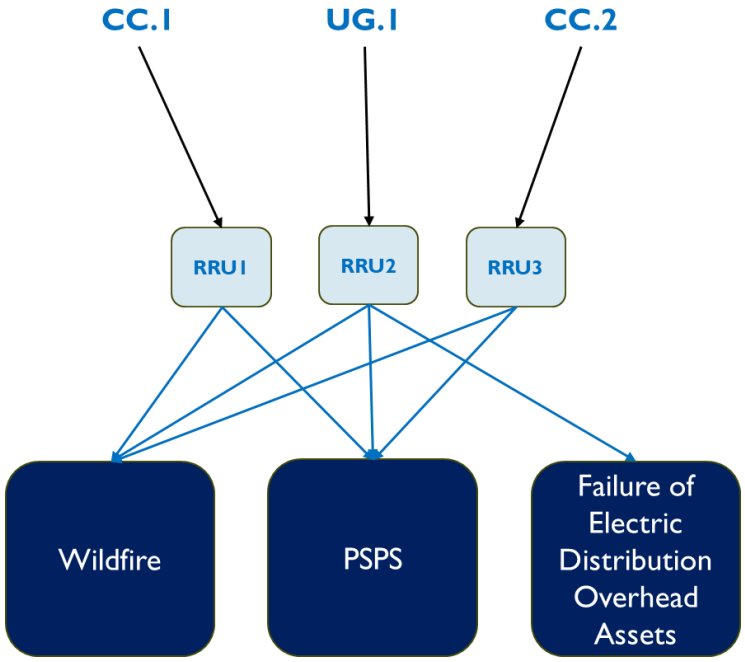

Figure 5-7. A complex mapping of RRUs to Risk Events.

While the utility may be able to calculate how much risk reduction is achieved by RRU for each risk event, known as "splitting the RRU", this is an ill-advised approach. It would be preferable to create additional RRUs to preserve one-to-one mapping.

However, a remaining issue is how to allocate costs when a single mitigation impacts multiple risk events, regardless of how the RRUs are set up. In Figure 5-8 below, we can see three different methods for allocating costs associated with UG1 across the three risk events.

- *Method 1* recognizes that the primary goal is to reduce wildfire risk. The total cost is allocated strictly in the context of the wildfire risk; therefore a benefit-cost ratio (BCR) cannot be calculated for the marginal benefits that accrue to PSPS and Failure of Electric Distribution Overhead Assets risk events.
- *Method 2* allocates costs proportionately to the risk reduction achieved for all three risk events, which allows a BCR calculation for all three events. The BCR will be the same for all three risk events, which may or may not be a reasonable approximation.
- *Method 3* references the total cost for the mitigation when calculating a BCR for each of the three risk events and divides the BCR among the risk events. It gives the correct BCR for total risk, but mathematically dubious results for the risk events individually.

Cost Allocation Method		Wildfire	PSPS	Failure of Electric Distribution Overhead	Total
Method 1	Benefit	$90	$20	$20	$130
	Cost	$100			$100
	BCR	**0.9**	**n/a**	**n/a**	**1.3**
Method 2	Benefit	$90	$20	$20	$130
	Allocated Cost	$69.23	$15.38	$15.38	$100
	BCR	**1.3**	**1.3**	**1.3**	**1.3**
Method 3	Benefit	$90	$20	$20	$130
	Allocated Cost				$100
	BCR	**0.9**	**0.2**	**0.2**	**1.3**

Figure 5-8. Cost allocation for a one-to-many mapping.

With shared costs, the correct approach is not always clear, as a tradeoff would occur in each case. For instance, with Method 1, RRUs could only be ranked in the context of the Wildfire risk event, but not in the other two. Method 2 can work if assigning the same BCR to all shared risk events is reasonable. With Method 3, the BCR for the non-primary risk events (PSPS and Failure of Electric Distribution Overhead Assets) will likely be severely undervalued.

Some of the complications associated with the One-to-Many mapping will be easier to address within the context of portfolios, and creating portfolios of mitigations, which is covered in Level 4's report on Risk Tolerance and Simple Optimization.

As a final comment on RRU, they should be as granular as possible to provide the most flexibility for aggregating, without proliferating to the point of being unmanageable.

5.3 The Plan Phase

RMAR always starts with the Plan Phase. The beginning of any risk program starts with a plan or business case which is a set of projections and promises based on data, models, and subject matter expertise. The plan phase must be carefully thought out, with all the relevant dimensions included. If a dimension is not included in the plan phase, it cannot be evaluated later in the results phase.

In the context of the RDF, the RAMP ideally would serve as the Plan Phase (which could be updated in the GRC) to avoid having two versions of mitigation plans. This would require modifying the RAMP and GRC to include all the dimensions that will be reported.

The plan phase is entirely forward-looking—there are no actual results to evaluate. It is part projection and part promise. Evaluators can analyze the plan phase to make sure that standards such as risk tolerance are met and CBR thresholds are exceeded. Other techniques, such as reference class forecasting (covered in chapter 8), can be used to assess whether the projections are realistic.

Original RAMP Backcast. Given that the first RAMPs were filed in 2016, there has been a significant risk of "buy down" in the last eight years. Ideally, the risk reduction projections of future RMARs would reference the level of pre-mitigated risk as of 2016, the risk reduction achieved since 2016, and the related mitigation capital and operating expenditures. The backcast would not need to be at the same level of detail as RMAR and would serve to capture a more holistic view of risk and risk reduction since the beginning of the S-MAP process. This backcasting approach will also be addressed through the presentation of overall residual risk, as discussed in the Phase 4 Scoping Memo. The presentation of overall residual risk is also crucial for the implementation of risk tolerance.

Figure 5-9 below is a visualization of what backcasting pre-mitigated risk to 2016 levels compared to the RAMR period might look like.

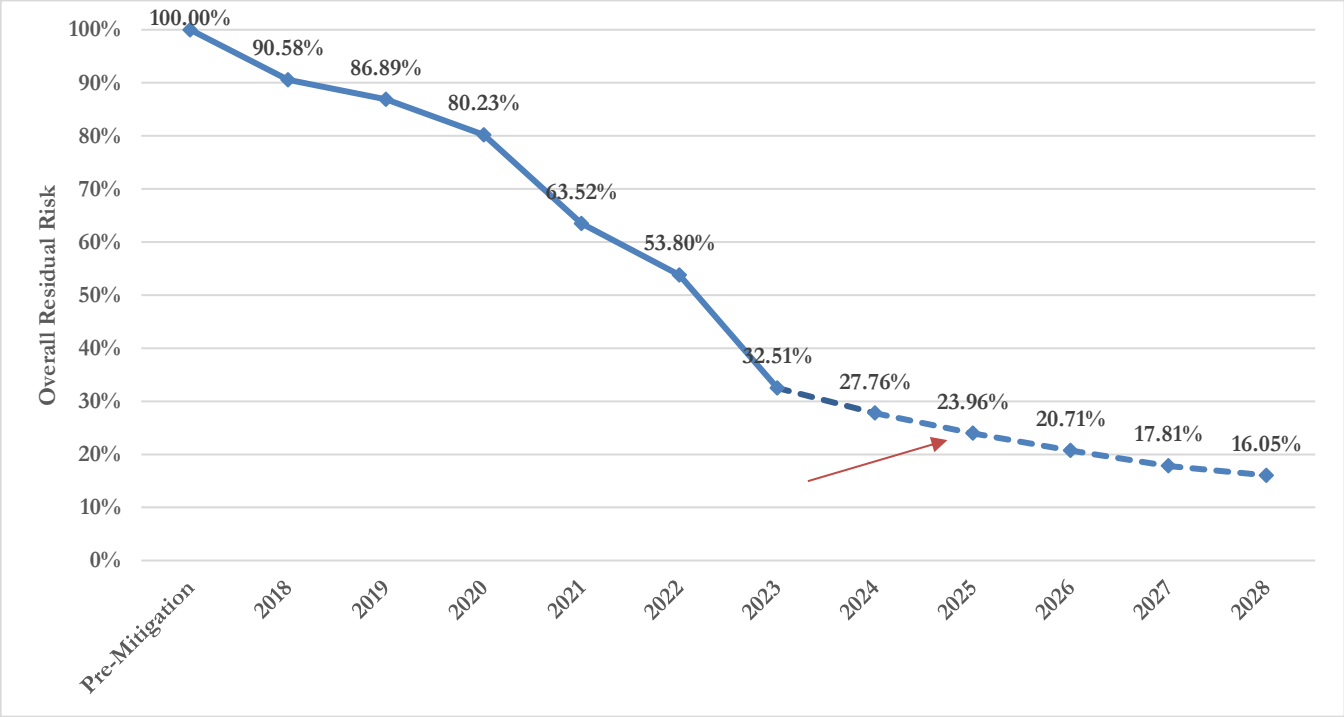

Figure 5-9 Backcasting pre-mitigated risk.

5.4 Results phase

With the passage of time, projections turn into actual outcomes and results. Mitigations are implemented, and modeled risk reduction is realized. Actual risk events occur—wildfires, cyber-attacks, and threats. All the new information is captured and stored as risk data, models are improved and updated, and new projections of the future are made.

The results phase contains the plan, results, and revised projections, and makes comparisons between them. The components of the results phase will be covered in detail in chapter 6. Figure 5-10 below is a visualization of the plan phase and the results phase of RMAR.

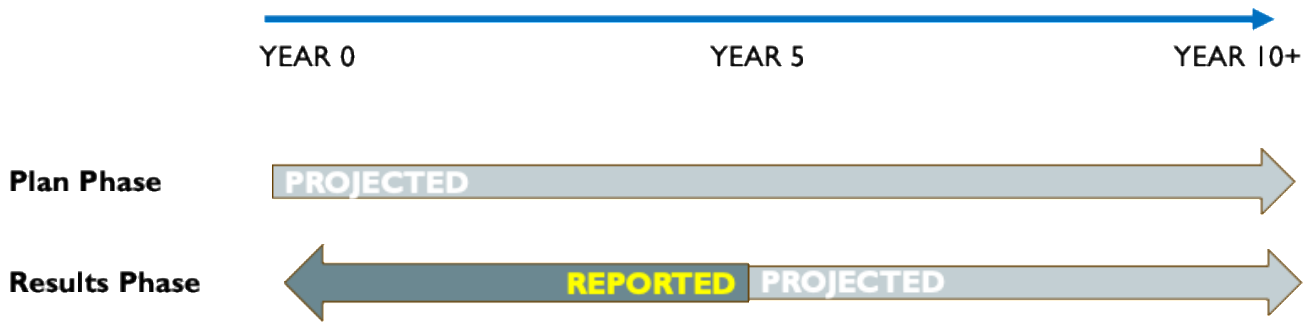

Figure 5-10. The phases of RMAR.

6 RMAR Report Structure

6.1 Scenarios and Classes

The RMAR report—the body of numerical tables and narrative—is made up of *scenarios* (which is an RMAR dimension). Scenarios include plans, outcomes, results, and forecasts.

- *Plan*. The plan scenario is the original plan from the base year.
- *Outcomes* are the impacts of risk events that have occurred during the reporting period and prior report periods.
- *Results* are the calculations of mitigation benefits and costs for the reporting period and prior report periods.
- *Forecasts* are new projections based on new information based on outcomes, modeled results, and advancements in risk modeling.

The plan phase includes only the plan scenario, while the results phase includes all the scenarios. It is the relationship of the scenarios in the results phase that creates context in the RMAR, allowing it to answer the questions "compared to what?" and "why?" (see section 4.2).

Within each scenario, numerical tables are organized into two *classes* based on the concept of stock vs. flow.

- *Flow* tables feature the mitigation benefits and costs. Flow tables can depict mitigation benefits for a given reporting period, the sum of all reporting periods, and the sum of the plan periods or forecast periods. Flow tables are additive. BCRs are calculated from flow tables.
- *Stock tables* feature pre-mitigated risk, risk reduction, post-mitigated risk, and risk tolerance. Stock tables focus on a point-in-time result, usually the end-of-period though sometimes the average between periods. Stock tables are not additive.

Figure 6-1 below explains stock vs. flow, and how the two classes relate to each other. Stock line items are shown in blue. We start with a level of pre-mitigated risk at the point in time before any new mitigations are considered. Risk reduction is the point-in-time impact of mitigation activities. Post-mitigated risk is the point-in-time level of remaining risk after risk reduction. Risk tolerance is the maximum level of expected risk at a given point in time.

The interpretation of the stock items is that pre-mitigated risk begins at a level of $100, risk reduction is $10 in Y1 and $20 in Y2 and Y3, which results in post-mitigated risk of $90 in Y1 and $80 in Y2 and Y3. Post-mitigated risk remains above risk tolerance in all three years.

	Y1	Y2	Y3	Total
Pre-mitigated risk	$100			
Mitigation benefit (risk reduction)	$10	$20	$20	$50
Mitigation cost	$40			$40
BCR				1.25
Post-mitigated risk	$90	$80	$80	
Risk tolerance	$60	$60	$60	

Flow items are shown in green in Figure 6-1. Mitigation benefits and costs are the sum of those line items over the three-year period, which for benefits is $50 and costs is $40. We calculate BCRs based on the flow of mitigation benefits and costs, which in this example is 1.25 (undiscounted for simplicity.)

Figure 6-1. Stock vs. Flow.

The dam visual in Figure 6-1 illustrates the relationship between stock and flow, where the change between before- and after-stock is equal to the flow. This leads to a critical observation: mitigation impact can be interpreted as either a stock (point-in-time) or flow (additive) line item. This duality is what relates stock and flow tables. To avoid confusion, when mitigation impact is used as a flow line item, we will use the term "mitigation benefit", and when it is used as a stock line item, we will use the term "risk reduction".

6.2 RMAR Tables: Plan Phase

The plan phase is forward-looking and contains only the plan scenario. There is no history of actual events to evaluate. The schema in Figure 6-2 below describes the structure of the plan phase reports. Y1 denotes the first year of the plan, and YZ the final year

I. Mitigation Cost and Benefit (Flow)

Average Risk

- Modeled benefit Y1-YZ
- Modeled cost Y1-YZ
- BCR.

Tail Average Risk

- Modeled benefit Y1-YZ

II. Risk Reduction (Stock)

Average Risk

- Pre-mitigated risk
- Risk reduction (YZ)
- Post-mitigated risk (YZ)
- Risk Tolerance
- % of risk tolerance gap closed

Tail Average Risk

- Pre-mitigated risk
- Risk reduction (YZ)
- Post-mitigated risk (YZ)
- Risk Tolerance
- % of risk tolerance gap closed

Figure 6-2. Plan phase table structure.

The following examples from a hypothetical RMAR illustrate how plan phase tables might look. Figure 6-3 below is a summary table for mitigation benefits and costs (flow) at the enterprise level. It tells an evaluator that the plan is for a $1,930 average risk mitigation benefit over ten years at a cost of $1,155 for BCRs of 1.97 to 2.51 depending on the discount method. Tail average risk mitigation benefit is projected to be $9,905.

Mitigation Benefit Overview

10-Year Plan Horizon	**Average Risk**	**Tail Avg. Risk**
Total mitigation benefit	$1,930	$9,905
Total mitigation cost	$1,155	
Net mitigation benefit	$775	
BCR:		
Financial discount	1.97	
Social discount	2.51	
Social discount (benefits), financial discount (costs)	2.32	

Figure 6-3. Hypothetical plan phase mitigation costs and benefits.

Below is the related risk reduction and risk tolerance (stock) table. It tells an evaluator the level of pre-mitigated risk for average risk and tail average risk, $1,700 and $8,400 respectively. The average risk reduction from mitigation activities is projected to be $215, while tail average risk reduction is projected to be $1,099. Post-mitigation risk is calculated for each risk measure and compared to risk tolerance.

Post-mitigated risk remains higher than risk tolerance for each risk measure; risk reduction in this round of mitigation planning has closed the gap between pre-mitigated risk and risk tolerance by 18% for average risk and 17% for tail average risk. More risk reduction will need to occur to meet risk tolerance.

Risk and Risk Tolerance Overview

	Average Risk	Tail Avg. Risk
Pre-mitigated risk at time 1	**$1,700**	**$8,400**
Risk reduction	$215	$1,099
Post-mitigated risk, year 10	**$1,485**	**$7,301**
Risk Tolerance	$500	$1,800
% of risk tolerance gap reduced	18%	17%

Figure 6-4. Hypothetical plan phase risk reduction and risk tolerance table.

Plan phase tables can add further dimensions such as time (years 1 through year 10), risk events, attributes, mitigation details, and tranches.

6.3 RMAR Tables: Results Phase

In contrast to the plan phase, the results phase is backward and forward-looking. It includes all four scenarios—plan, outcomes, results, and forecasts—and may include multiple comparisons between the scenarios.

Results phase tables may also have multiple views of the time dimension (report period, prior report periods, prior and future periods, etc.). We will use the following notation to describe the time dimension for the results phase:

- *Y1*. Base plan year
- *YN*. Reporting year. For example, Y3 means the RMAR is discussing year 3 outcomes and results.
- *YZ*. Final year of the plan
- *Y1YN*. The history of outcomes and results. Y1Y3 would include year 1 through year 3.
- *Forecast*. Includes results for Y1YN and projections after Y1YN through YZ.

6.3.1 Outcomes

Outcomes are the monetized impact of risk events that have occurred in a year. Wildfire outcomes would include the safety, reliability, and financial attributes of all wildfires in a year, multiplied by the monetized values for safety, reliability, and financial attributes. If the RMAR YN was Year 3, there would be wildfire outcomes for year 1, year 2, and year 3 (outcomes can be zero for a risk event).

The schema in Figure 6-5 below depicts how outcomes are reported in RMAR. Risk outcomes can be presented as a flow and compared to the plan for modeled risk or as a stock and compared to risk tolerance.

I. Risk Outcomes	
Flow: ○ Outcomes vs. plan average modeled risk, Y1YN ○ Outcomes vs plan tail average modeled risk, by year	**Stock:** ○ Average Outcomes vs average risk tolerance Y1YN ○ Outcomes vs. tail average risk tolerance, YN

Figure 6-5. Risk outcomes schema.

The following examples from a hypothetical RMAR show how outcomes tables in the results phase might look. In Figure 6-6 below, is a flow table, risk outcomes across all risk events for the enterprise in year 3 were $3,100, and the total from year 1 through year 3 was $3,500. These outcomes are compared to the modeled risk in the Plan for average risk and tail average risk.

Since risk outcomes can be lumpy, a single-year result is best compared to the tail average modeled risk to check for a "breach"—breaches of the tail average should occur very rarely. Multiple-year outcomes will smooth the lumpiness and can be compared to the average modeled risk. In this example, both risk outcomes are less than 100% of their comparisons to the modeled results used in the plan.

Hierarchy	Enterprise
Risk Events	All
Version	Actuals/FC
Model	Model 2.1
Period	Year 3

ACTUALS/FC VS. PLAN

		Modeled Risk		Actual %
Risk Outcome	**Actual**	**Avg**	**Tail Avg**	**of Modeled**
Risk outcome, Year 3	**$3,100**		$7,301	**42%**
Risk outcome, Years 1-3	**$3,500**	$4,675		**75%**

Figure 6-6. Risk outcomes flow table.

Figure 6-7 below presents the related outcomes stock table and expands the time dimension to include all three years of outcomes. This table clearly depicts a major risk occurrence in year 3 following two relatively low-risk years. The average risk outcome over the three years is considerably higher than the average risk tolerance. The risk outcome in year 3 has breached tolerance for tail risk, signaling that year 3 incurred an unacceptable level of risk.

Risk outcomes by year	Actuals				
	Year 1	**Year 2**	**Year 3**	**Total**	**Average**
Risk outcome	**$250**	**$150**	**$3,100**	**$3,500**	**$1,167**
Average risk tolerance					$500
Risk outcome B(W) than risk tolerance					($667)
Tail average risk tolerance	**$1,800**	**$1,800**	**$1,800**		
Risk outcome B(W) than risk tolerance	$1,550	$1,650	($1,300)		

Figure 6-7. Risk outcomes stock table.

Taken together, an evaluator can see that while the large risk occurrence in year 3 was within modeled expectations, they also significantly breached tolerance for average and tail average risk. This is likely because the level of modeled risk after mitigations was significantly higher than risk tolerance as of year 3 (which was clear in the plan phase tables in Figure 6-4).

6.3.2 Mitigation benefits and costs

Mitigation benefits and costs are the modeled impacts of mitigations as flow tables. A mitigation activity such as replacing an old gas line segment can have a mitigation benefit over many years, for the life of the asset. The costs may include capital costs over a single year or multiple years, and operational costs over the life of the asset as well. The mitigation costs and benefits are discounted using an appropriate methodology to determine the BCR.

Figure 6-8 below describes flow tables for mitigation benefits and costs. Similar to outcomes, the mitigation benefit and cost flow tables cover YN and Y1YN. They may also include a forecast, if future projections have changed from plan due to outcomes and other changes from the base year, such as new learnings and improved models.

II. Mitigation Benefit and Cost (Flow)	
Average Risk: ○ Modeled benefit vs. Plan, YN ○ Modeled benefit vs. Plan, YIYN ○ Forecast benefit vs. Plan, Y1YN ○ CBR based on Forecast	**Tail Average Risk:** ○ Modeled benefit vs. Plan ○ Modeled benefit vs. Plan, Y1YN ○ Forecast benefit vs. Plan

Figure 6-8. Mitigation benefit and cost flow table schema.

The next set of hypothetical RMAR tables includes the attribute dimensions. In Figure 6-9 below, the mitigation benefits are shown by attribute for the reporting years' (Y1YN) "actuals" and a new projection for years 4 through 10. The tables include comparisons to the plan. The tables show that mitigation benefits were significantly below plan for each attribute in years 2 and 3—by 50% in year 2 and over 20% in year 3. Based on new information, mitigation benefits are projected below the plan for the remainder of the plan period, though the variance will be lower. For the forecast as a whole, mitigation benefits will be worse than the plan by $249, which is about $12 lower than the plan of $1,930. The largest variance to the plan is in the reliability attribute, which is forecasted to be $114 below plan.

Mitigation Benefit Forecast vs. Plan	Actuals			Forecast			
Average Risk:	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 10**	**Total**
5e. Safety: Actuals/Forecast	$19	$19	$51	$56	$56	$56	$481
Safety: Plan	$19	$37	$57	$57	$57	$57	$512
Actuals/Forecast B(W) Plan	**$0**	**($18)**	**($6)**	**($1)**	**($1)**	**($1)**	**($31)**
5f. Reliability: Actuals/Forecast	$24	$24	$59	$71	$71	$71	$604
Reliability: Plan	$28	$50	$80	$80	$80	$80	$718
Actuals/Forecast B(W) Plan	**($4)**	**($26)**	**($21)**	**($9)**	**($9)**	**($9)**	**($114)**
5g. Financial: Actuals/Forecast	$24	$24	$58	$70	$70	$70	$596
Financial: Plan	$28	$48	$78	$78	$78	$78	$700
Actuals/Forecast B(W) Plan	**($4)**	**($24)**	**($20)**	**($8)**	**($8)**	**($8)**	**($104)**
5e. Total Actuals/Forecast	**$67**	**$67**	**$168**	**$197**	**$197**	**$197**	$1,681
Total: Plan	**$75**	$135	$215	$215	$215	$215	$1,930
Actuals/Forecast B(W) Plan	**($8)**	**($68)**	**($47)**	**($18)**	**($18)**	**($18)**	**($249)**

Figure 6-9. Mitigation benefits by attribute.

The next table, in Figure 6-10 below, shows mitigation benefits and costs by risk event and helps to determine why benefits are below plan through year 3. An evaluator can quickly see that two risk events are driving the negative variances to plan: wildfire (lines 5e. and 5f.) and hydropower (lines 5i. and 5j.). In particular, delays in the implementation of wildfire mitigation from year 2 to year 3 are apparent in line 5f, and delays in the implementation of hydropower mitigation from year 1 to year 3 are seen in line 5j. These delays are also reflected in the timing of mitigation benefits vs plan.

Forecast Mitigation Benefit	Actuals			Forecast			
Average Risk:	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 10**	**Total**
Wildfire							
5e. Wildfire benefit: actuals/forecast	$55	$55	$106	$135	$135	$135	$1,161
Wildfire benefit plan	$63	$63	$143	$143	$143	$143	$1,270
Actuals/Forecast B(W) Plan	**($8)**	**($8)**	**($37)**	**($8)**	**($8)**	**($8)**	**($109)**
5f. Wildfire cost: actuals/forecast	$200	$310	$260	$10	$10	$10	$840
Wildfire cost plan	$200	$510	$10	$10	$10	$10	$790
Actuals/Forecast B(W) Plan	**$0**	**$200**	**($250)**	**$0**	**$0**	**$0**	**($50)**
Cyber							
5g. Cyber benefit: actuals/forecast	$12	$12	$12	$12	$12	$12	$120
Cyber benefit plan	$12	$12	$12	$12	$12	$12	$120
Actuals/Forecast B(W) Plan	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
5h. Cyber cost: actuals/forecast	$5	$5	$5	$5	$5	$5	$50
Cyber cost plan	$5	$5	$5	$5	$5	$5	$50
Actuals/Forecast B(W) Plan	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Hydro							
5i. Hydro benefit: actuals/forecast	$0	$0	$50	$50	$50	$50	$400
Hydro benefit plan	$0	$60	$60	$60	$60	$60	$540
Actuals/Forecast B(W) Plan	**$0**	**($60)**	**($10)**	**($10)**	**($10)**	**($10)**	**($140)**
5j. Hydro cost: actuals/forecast	$0	$200	$15	$15	$15	$15	$320
Hydro cost plan	$180	$15	$15	$15	$15	$15	$315
Actuals/Forecast B(W) Plan	**$180**	**($185)**	**$0**	**$0**	**$0**	**$0**	**($5)**
Total							
5k. Total benefit actuals/forecast	**$67**	**$67**	**$168**	**$197**	**$197**	**$197**	$1,681
Total benefit plan	**$75**	$135	$215	$215	$215	$215	$1,930
Actuals/Forecast B(W) Plan	**($8)**	($68)	($47)	($18)	($18)	($18)	**($249)**
5L. Total cost: actuals/forecast	$205	$515	$280	$30	$30	$30	$1,210
Total cost plan	$385	$530	$30	$30	$30	$30	$1,155
Actuals/Forecast B(W) Plan	**$180**	**$15**	**($250)**	**$0**	**$0**	**$0**	**($55)**

Figure 6-10. Mitigation benefits and costs by risk event.

6.3.3 Risk reduction and risk tolerance

Risk reduction and risk tolerance tables (stock) present the level of risk before and after mitigation and compare risk levels to risk tolerance. Figure 6-11 below shows the format of risk reduction and risk tolerance tables, this time focusing on tail average risk. An evaluator can see how risk is reduced over time for each risk event, with progress toward meeting risk tolerance for each risk event.

For example, no tail risk reduction for Hydro is apparent until year 3, when the tail average risk is reduced by $325. This amount of risk reduction closes the gap between pre-mitigated risk and risk tolerance by 12%.

	Actuals			Forecast		
Forecast Tail Avg. Risk	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 10**
Wildfire						
Pre-mitigated risk	$4,600					
Risk reduction	**$250**	**$250**	**$528**	**$686**	**$686**	**$686**
Post-mitigated risk	$4,350	$4,350	$4,072	$3,914	$3,914	$3,914
Risk tolerance	$800	$800	$800	$800	$800	$800
% of risk tolerance gap closed	7%	7%	14%	18%	18%	18%
Cyber						
Pre-mitigated risk	$1,160					
Risk reduction	**$72**	**$72**	**$72**	**$72**	**$72**	**$72**
Post-mitigated risk	$1,088	$1,088	$1,088	$1,088	$1,088	$1,088
Risk tolerance	$594	$594	$594	$594	$594	$594
% of risk tolerance gap closed	13%	13%	13%	13%	13%	13%
Hydro						
Pre-mitigated risk	$3,480					
Risk reduction	**$0**	**$0**	**$325**	**$325**	**$325**	**$325**
Post-mitigated risk	$3,480	$3,480	$3,155	$3,155	$3,155	$3,155
Risk tolerance	$766	$766	$766	$766	$766	$766
% of risk tolerance gap closed	0%	0%	12%	12%	12%	12%
Total						
Pre-mitigated risk	$8,400					
Risk reduction	**$365**	**$365**	**$916**	**$1,061**	**$1,061**	**$1,061**
Post-mitigated risk	$8,035	$8,035	$7,484	$7,339	$7,339	$7,339
Risk tolerance	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800
% of risk tolerance gap closed	6%	6%	14%	16%	16%	16%
**Tail risk is not additive*						

Figure 6-11. Risk reduction and risk tolerance by risk event for tail average risk.

6.3.4 Other table structures

RMAR also supports reporting for other formats that may be useful for work units, tranches, or other views. In Figure 6-12 below, wildfire mitigation is reported for the work unit circuit miles and compared to the plan. It reveals that mitigations have been completed for 1,740 circuit miles, about 3% fewer than originally planned.

WILDFIRE: ACTUALS/FC VS. PLAN BY MITIGATION TYPE

			Actuals B(W) Plan				Forecast B(W) Plan	
	Actual Y1-Y3	Plan Y1-Y3	$	%	Forecast	Plan	$	%
1b. Circuit Miles								
UG	1,000	1,400	-400	-29%	1,320	1,400	-80	-6%
CC	380	400	-20	-5%	380	400	-20	-5%
Total Mitigated	**1,380**	**1,800**	**-420**	**-23%**	**1,700**	**1,800**	**-100**	**-6%**

Figure 6-12. Wildfire mitigation results by work unit.

6.3.5 RMAR table cohesion

An important feature of RMAR tables is how they relate to each other to tell a consistent and comprehensive story. An evaluator will easily see how the 23% shortfall in mitigated circuit miles as of Y3 in Figure 6-12 relates to the delay of wildfire mitigation expenses and benefits in Figure 6-10, and how the delay in wildfire mitigation benefits contributes to the enterprise shortfall of mitigation benefits in Y2 and Y3 in line 5e of Figure 6-9.

6.4 Summary

The large number of dimensions in a consolidated risk statement means there are an unlimited number of possible tables and comparisons. In this report, we have provided some hypothetical tables as examples of what should be included in an RMAR, and we encourage the reader to further explore the structure of those tables[15]. RMAR designers will need to determine the most important issues that must be addressed and evaluated and design the tables for those issues. Over time, the issues may change, and the RMAR will change accordingly. For example, the statement of cash flows wasn't introduced into financial reporting until 1987. Significant new changes in reporting and disclosure requirements will be added in 2027.[16]

15 https://level4ventures.com/case_study/california-public-utilities-commission-2/

16 https://www.ifrs.org/news-and-events/news/2024/04/new-ifrs-accounting-standard-will-aid-investor-analysis-of-companies-financial-performance/. Accessed 11/08/2024.

7 Version and Change Control over Multiple Periods

7.1 Difference between financial reporting and risk reporting

Unlike financial reporting, risk reporting involves comparing results to an original plan over a period of ten years or longer. This creates challenges since organizations, models, and data change over time.

Financial reports are backward-looking and are generally concerned with data presented quarter-over-quarter and year-over-year. It is usually sufficient to restate the base year for organizational or accounting changes, but not years prior. In addition, financial reporting is primarily focused on actuals, not plans or forecasts.

By contrast, RMAR includes aspects of forward-looking business cases and backward-looking financial reporting. RMAR results phase reporting in a given year includes actual risk events for the prior years, modeled risk reduction for the prior years, the original risk reduction plan for prior years and future years, and new risk reduction forecasts for future years. It will be no surprise if the result phase ends up differing from the plan phase, which may have been completed years earlier. Variances to the original plan phase occur for two reasons:

1. *Real changes to the risk environment*. These include changes to pre-mitigated risk, possibly due to new data regarding climate change; changes in mitigation timing and mitigation effectiveness, perhaps due to improved technology; and variances in capital and operating expenditures, etc.
2. *Changes due to organization, models, and data, or subjective factors such as assumptions or opinions related to risk modeling*. These changes have nothing to do with real changes in risk or real mitigation impact. They are inevitable over the long periods covered by RMAR and are often desirable—we should embrace improvements to risk models and data collection, even if it complicates reporting.

The purpose of RMAR is to enable evaluation based on the first type of change, involving real changes to the risk environment. We need to capture and adjust for the second type of change, potentially impacting many years retroactively and many years into the future, which is the subject of the following sections.

7.2 Organization changes

Organizations are in constant flux. In electrical distribution, circuit segments can be merged or renamed, and territory boundaries and risk tranches can be redefined. All these changes would make comparisons to original mitigation portfolios problematic. The onus is on the utility to make sure that historical comparison remains possible.

RRU structure. The first line of defense against muddled reporting due to organizational changes is a thoughtful RRU definition. As discussed in section 5.2, establishing RRUs at the optimal level of granularity enables more

reporting flexibility. When the organization changes, RRUs can be re-arranged to reflect the new organization while freezing the original arrangement allows recasting.

Hierarchy freeze. Freezing and storing the hierarchy at plan submission is a requirement and makes recasting possible.

Tranches. Tranches provide an interesting organizational challenge since by design they will change as risk reduction occurs. We expect—and want—the highest risk tranches to be targeted by risk mitigations, which could reshuffle the tranches. Tranches may change for other reasons as well; they may be redefined added or subtracted. Utilities must preserve the original tranche structure and provide a "bridge" to new structures to preserve the ability to make meaningful comparisons through time.

7.3 Model changes

Models are updated and improved, and new or better data sources are developed over time. These are positive changes but can make comparisons to pre-change plans, forecasts, and results difficult. How would an evaluator know whether a variance was caused by an unexpected change in mitigation effectiveness or simply a change in a model or data?

For recasting purposes, utilities would be required to maintain all models used to create the original plan. The utilities will have to develop the following capabilities:

- *Model and data storage*: Models and data from the original plan phase will need to be kept for use in later recasts. Given RMAR requirements for probability distributions, this means the ability to store probability distributions and preserve the interrelationships between them.
- *Data capture and validation*. As much as possible, data must continue to be captured in the form that was used in the planning phase. This may become increasingly difficult, even impossible, as models and data evolve and improve over time. For example, new climate models may not be based on backward-compatible data sets. Great care must be taken to ensure data consistency with the plan phase for as long as possible.

As utilities develop better, more accurate models, they must develop the ability to perform backcasts, applying the new models to prior data and controlling for any other changes. Backcasting is an RMAR requirement, and the onus is on the utility to develop and maintain the ability to backcast.

Model and data management, including the management of probability distributions, will be covered more in-depth in Level 4's Guidance on Interrelationships Report.

7.4 Subjective Changes

All models include subjective elements and assumptions that may change over time. Any subjective inputs used in risk models, such as structured scorecards or meeting minutes, should be documented and stored. As with organizational and model changes, the utilities must be able to restore the original subjective inputs from the planning phase for change management.

7.5 A Program for Multi-period Change Management

Utilities will have to develop infrastructure and processes, including audits, to manage risk reporting through changes over time. This will include:

1. Storing and accessing each version of a plan, forecast, and model.

2. The ability to compare and report on the current vs. original plan phase version and current vs. prior forecast version. This latter requirement becomes necessary if the original plan is updated with new forecasts multiple times, which is possible over an RMAR period that spans many years.

It will likely be infeasible to report every possible change from version to version and back to the original. Doing so would require a replica RMAR for each combination of version changes. Instead, RMAR should include several "bridging" tables and narratives that capture the key impacts of the changes, and establish that RMAR trends, variances, and comparisons are truthfully representing the risk environment, not organizational and methodology changes. The processes to enable these "bridging" tables and narratives include:

- *Recasting*. Recasting is modeling the current scenario as if the original state of the organization was still in place. Recasting ensures that the current scenario is "apples-to-apples" with original baselines, business cases, and plans. Any variances and other changes can be attributed to real changes in the risk environment. The CPUC Advice Letter 7150-E-A of May 2024 to PG&E requires the utility to "describe how baseline risk and risk reduction will be calculated…and explain how PG&E will use its Wildfire Distribution Risk Model version (v)2, v3, or any future risk model to calculate baseline risk and forecasted risk"—this is recasting.[17]

  Recasting requires organizations to maintain organizational hierarchies, models, and data from the original plan, which ordinarily should not be a problem. The downside to recasting is it fails to capture any useful information due to improved models, data, and new learnings about the risk environment.

- *Backcasting*. Backcasting achieves the same "apples-to-apples" comparison with the original plan, this time by restating the history in terms of current models, data, and knowledge. Backcasting has the advantage of incorporating the most current views on the risk environment. For backcasting to be possible, models and data must be backward-compatible with risk modeling history and the original plan.
- *Replanning*. If enough drift has occurred from the original plan's assumptions and models, then a re-plan may be warranted. In this case, the original plan, including history and future years, is restated based on current reality. Restatements should be rare events and should require a stringent regulatory approval process, such as an Advice Letter that allows party comment.

Level 4 believes that preserving the ability to recast and backcast is mandatory, and that utilities should be required to have the processes and controls in place to perform recasts and backcasts. Guidelines and approval processes for replanning should be developed by the Commission.

[17] CPUC Advice Letter 7150-E-A, May 30, 2024, Page 2.

8 Mitigation Selection and Impact Analysis

Just as a consolidated financial statement includes a management discussion of financial results, the consolidated statement of risk should include a rigorous discussion of risk mitigation selection and results. The details of how utilities validate their data and model results and perform statistical testing of outcomes and results are beyond the scope of the RMAR. RMAR is a vehicle for disclosing these validation processes and tests, and for providing evaluators with key information on how these disclosures may impact RMAR reports, via a thoughtful management discussion section.

8.1 Standards, Criteria, Methodologies, and Benchmarks

Perhaps no decision matters more for reducing risk than the choice of mitigation portfolio[18]. It is critical for evaluators to understand the standards, criteria, methodologies, and benchmarks used in the selection process.

Standards. Standards include risk tolerance levels for average risk and tail risk and minimum BCR thresholds. RMAR should discuss how the chosen mitigation portfolio achieves these standards, compared to alternative portfolios.

Criteria. Criteria for mitigation selection can include factors such as safety vs. reliability trade-offs and time exposure. RMAR should discuss how decision criteria and others are factored into the mitigation portfolio selection.

Methodologies. RMAR should discuss key methodologies for use in calculating mitigation benefits and costs. Examples include how the weighted average cost of capital was calculated for financial discount rates, and how useful life was estimated for assets.

Benchmarks. Risk models are only as good as the quality of their inputs and assumptions. Techniques such as reference class forecasting[19] compare model results to a database of results for similar projects and have been shown to reduce systematic errors in planning and forecasting.

RMAR should present the utility's case for the chosen mitigation and why it is optimal compared to the next best alternatives. This narrative should instill confidence that the utility's process was rigorous and free of bias.

[18] Level 4's report on Risk Tolerance and Simple Optimization describes why risk reduction should be evaluated based on a portfolio of mitigations rather than by individual mitigation.

[19]Batselier and Vanhoucke, "Practical Application and Empirical Evaluation of Reference Class Forecasting for Project Management". https://www.or-as.be/sites/default/files/files/blog_files/Batselier%20and%20Vanhoucke%2C%20PMJ%2C%202016.pdf

8.2 Evaluating Real Mitigation Impact

In the planning phase, utilities should discuss their confidence in model results. For example, how confident are they in the mitigation impact assumptions used, based on internal data or industry norms? What is the confidence interval for key results such as total risk reduction and BCR?

Similarly, in the results phase, utilities should discuss the extent to which observed results were due to mitigation effectiveness as opposed to other factors such as chance, or changes in models, data, assumptions, or impacts from other risk drivers.

- *Outcome and results analysis*. How to interpret risk event outcomes in the context of mitigations in place.
- *Input analysis*. For rare events there may not be sufficient volumes of outcomes to analyze, so indirect methods such as evaluating upstream drivers can help impute mitigation impact.
- *Statistical techniques* such as hypothesis testing where applicable.

Figure 8-1 summarizes different methods for evaluating real mitigation impact.

High Frequency	Rare Events
Outcome/Result Analysis (Direct)	**Input Analysis (Indirect)**
○ **Trend analysis of outcomes** ○ **Test and control for outcomes** ○ **Outcomes vs. modeled results** ○ **Reference class forecasting (for modeled results)**	○ Mitigation implementation effectiveness ○ Trend analysis of key risk drivers ○ Test and control for key risk drivers ○ Near-miss analysis

Figure 8-1 Evaluating risk mitigation impact vs. chance, based on the volume of risk events

Outcome/results analysis (direct). If risk events, outcomes, or modeled results have a sufficient sample size, then trend analysis, test and control processes, or reference class forecasting, can be used. For the first two methods, the actual or modeled results are compared to a baseline representing what would've occurred absent the mitigations. For trend analysis, the baseline is the pre-mitigated level of risk, and for test and control the baseline is measured by the control group. Reference Class Forecasting is a different approach, in which the comparison is to results based on a database of similar projects.

An example of a risk event amenable to outcome analysis is wildfire ignitions due to utility equipment. PG&E reports 4,197 ignitions between 2015 and 2021.[20]

Input analysis. Some risk events are so rare that there isn't enough data to analyze. An example is cybersecurity, where actual attacks in any year are few and can be zero. Physical attacks on hydropower facilities are another example of rare events that would be zero in most years. For such risk events, we can infer mitigation

[20] PG&E 2023 WMP, table 6.2.1-2, page 160. https://www.pge.com/assets/pge/docs/outages-and-safety/outage-preparedness-and-support/pge-wmp-r6-07052024.pdf

effectiveness by analyzing the risk drivers, which may have sufficient volumes for statistical analysis. In cybersecurity, risk drivers such as attempted and successful phishing attacks may have suitable volumes.

There are several ways to infer mitigation effectiveness based on risk drivers. One is to assess the implementation itself. A common mitigation for cybersecurity is training employees to recognize and avoid phishing attacks—what percentage of employees have completed the training? Trend analysis and test and control methodologies can be used. "Near misses" are not technically risk drivers but may be considered a close proxy for risk events and can be analyzed if sufficient in number.

Statistical analysis. The goal of the statistical analysis is to determine whether the observed differences between actual or modeled risk and the baseline could have occurred by chance. There is a group of statistical techniques under the umbrella of hypothesis testing that can help us determine if risk reduction is real and due to mitigation efforts.[21]

8.2.1 Risk Reduction: Attribution

Assigning attribution for risk reduction is a two-step process. The first is to determine whether there was any real risk reduction in the first place, as described in Section 8.2 above. If risk reduction is deemed to be real, then we look for ways to infer attribution.

A basic way to infer attribution is to examine the completeness and effectiveness of mitigation implementation. Did 100% of employees successfully complete the training on avoiding phishing attacks? Were all the safety inspections on the portfolio of dams performed on schedule? If the mitigation was not implemented or was implemented in an incomplete or ineffective way, we would be less inclined to attribute much or any risk reduction to it.

Attribution also requires examining whether fluctuations in risk drivers have more to do with changes in risk driver volumes. Could an unexpectedly low level of wildfire ignition be the result of cooler, wetter weather patterns?

8.3 Sensitivity analysis

Since RMAR depends heavily on modeled results as well as modeled plans and forecasts, sensitivity analysis should be performed on each model. Sensitivity analysis helps evaluators (and the modelers) to understand whether mitigation decisions would change if model inputs and assumptions are changed. Suppose a risk model relies on an input for which data is sparse either because of low quality or portions are missing altogether. If it turns out that the model is sensitive to this data, meaning that a small change in the accuracy or completeness of the data could result in a different choice of mitigation, it may be worth investing in improving the data.

[21] For more background on hypothesis testing see https://en.wikipedia.org/wiki/Statistical_hypothesis_test

Another use of sensitivity analysis is for version control, discussed in section 7.3. Sensitivity analysis can help determine the impact of a new model version on risk model output.

Transparency pilots. CPUC decision D21-11-009 and modified by D24-05-064 authorized transparency pilots for the utilities to test the quality of assumptions, models, and results for risk modeling. These pilots are a form of sensitivity analysis and could be used to provide tables and structure to an RMAR section on sensitivity analysis.[22]

[22] CPUC ruling R20-07-013. See Figure 2, page A13.

9 Generally Accepted Risk Mitigation Accountability Reporting Principles

Over time as the RMAR process matures, the CPUC will observe differences in data quality, counting methodologies, definitions, and other factors that lead to discrepancies in reporting between utilities—and possibly even within utilities.

Principles leading to standards and rules will be developed to resolve these discrepancies, much as they have in financial reporting over the years via GAAP (Generally Accepted Accounting Principles) for financial reporting. The process of developing standards and principles for better reporting will not be simple or quick, but that should not delay the launch of RMAR. After all, the standards for financial reporting have been evolving for 90 years!

Year	Milestone
1934	In response to the stock market crash, the Securities and Exchange Commission (SEC) was created by the Securities Exchange Act.
1938	"Generally Accepted Accounting Principles" introduced.
1973	Creation of an independent Financial Accounting Standards Board (FASB)
1978-2000	Development of the "Conceptual Framework", seven statements of financial accounting concepts.
2002 – ongoing (in fits and starts)	Norwalk Agreement—convergence of principles between FASB and the International Accounting Standards Board (IASB).

Figure 9-1. Major milestones in the continuous improvement of financial reporting standards23.

As part of RMAR, CPUC should create a risk reporting standards development process, with the mission to standardize risk reporting where it is most critical to do so.

[23] https://corpgov.law.harvard.edu/2022/07/20/the-long-and-winding-road-to-financial-reporting-standards/

10 Accountability and the Art of Holding Accountable

Accountability is a key feature of RMAR and separates it from run-of-the-mill informational reporting. Investments in risk reduction are determined from business cases which are uncertain projections into an uncertain future. But more than that, they are promises and commitments to spend limited resources judiciously and effectively.

Utilities—and individuals within the utilities—should be held accountable to these promises and commitments, recognizing that some errors in projections are "good faith" due to the nature of uncertainty. Good faith errors have the characteristic of being randomly positive and negative, and over time can partially self-cancel, which reduces their impact. However, other errors are due to biases that lead to systematic underestimating (of costs) and overestimating (of benefits). Systematic errors tend to increase in magnitude over time. Sadly, errors due to intentional deception and fraud cannot be ruled out. The CPUC needs to have a layered approach to enforcing accountability:

The following table in Figure 10-1 lays out an approach for determining the seriousness of infractions and levels of corrective action. Responses by the Commission range from warnings to financial penalties and other enforcement actions. Corrective action by the utility includes fixing errors in time for the next RMAR cycle, restating the current RMAR, and overhauling internal processes related to RMAR.

Error Type	Materiality	Impact	Corrective Action
I. "White flag": (delays in reporting, one-time blips, unintentional). II. "Yellow flag": repeated delays, repeated errors, suggestive of poor control environment. III. "Red flag": systematic errors, refusal to comply.	**Immaterial**—errors would not change how the report is viewed and interpreted. **Material** —errors could change how the report is viewed and interpreted.	**Decision**. Would the error have impacted important decisions, such as mitigation portfolio selection? **Financial:** Would the error have caused financial harm to any stakeholder?	**Next cycle**. Root causes are fixed and corrections are in place for subsequent RMAR. Additional penalties were possible based on the error type. **Restate**. Root causes are fixed, and RMAR is restated based on materiality and impact thresholds. Additional penalties were possible based on error type and impact of errors.

Figure 10-1. Framework for determining corrective action.

Figure 10-2 below lists hypothetical examples of RMAR infractions along with possible CPUC enforcement actions and utility corrective actions.

Hypothetical Infraction	Error Type	Materiality	Impact	Commission Action	Utility Action
1) Staff evaluators discover risk accounting errors	I	Immaterial	None	Staff sends Warning Email.	Utility will submit a corrective action plan for the next RMAR cycle within 7 days.
2) Lack of supporting data in work papers	I	Immaterial	Decision	Staff issues Notice of Violation.	Utility will submit a corrective action plan within 21 days.
3) Staff evaluators discover incorrect aggregation of risk data	II	Material	Decision, Financial	Staff sends Warning Email to utility. Based on utility response, determines whether restatement is necessary.	Utility will submit work papers related to the aggregation errors. May have to restate RMAR.
4) Utility files incomplete RMAR and misses deadlines for submitting corrections and data requests, even after extensions granted	II	Material	Decision	Staff issues a Notice of Violation, and automatic fines for non-compliance may be triggered.	Utility will submit justification for delay within 7 days and a corrective action plan within 21 days.
5) Repeated instances of infractions 1, 2, and 3 above.	III	Material	Decision, Financial	Staff issues an Administrative Enforcement Order with appropriate penalties. Based on utility response, determines whether restatement is necessary.	Utility will submit a corrective action plan within 21 days. Utility can file a Request for Hearing within 30 days. May have to restate RMAR.
6) Utility refuses to comply with data requests.	III	Immaterial	Decision	Staff issues an Administrative Enforcement Order with appropriate penalties.	Utility must immediately comply with Commission directives.
7) Utility fails to meet the conditions of the Corrective Action Plan within the deadline.	III	Material	Decision, Financial	Staff issues an Administrative Enforcement Order with appropriate penalties	Utility must immediately comply with Commission directives.

Figure 10-2. Hypothetical infractions and enforcement and corrective actions.

The hypothetical infractions in Figure 10-2 above are listed in order of increasing severity. There should always be a path for the utility to make amends and fix the root causes of systematic errors, though the bar for remediation is higher at each stage.

It is important that consequences are directed toward systematic errors and not good-faith errors. Otherwise, the pendulum will swing entirely the other way, and costs will be systematically overstated (sandbagging) and

benefits will be under-promised. The unintended outcome will be fewer positive CBR business cases will make the cut, and those that do will be implemented less efficiently.[24]

Finally, there is the issue of organizational versus individual accountability. At some point, individuals must be held accountable for continued or egregious systematic errors, and certainly for intentional deception and fraud.[25]

[24] Projects with sandbagged budgets have a way of coming in on budget anyway. The sandbagged portion ends up being spent.

[25] Several examples of holding individuals accountable for gross neglect or gross misrepresentation in Flyvbjerg and Bester, "The Cost-Benefit Fallacy: Why Cost-Benefit Analysis is Broken and How to Fix it", Cambridge University Press on behalf of the Society for Benefit-Cost Analysis, 2021. Page 407.

11 Recommendations

This section provides a discussion of recommendations in more detail than presented in section 2.2.

Recommendation	Description
R1. Integrate the RMAR into the RDF	Utilities should be required to file updates to the RMAR on a regular basis.
R2. Required RMAR structure	To ensure a consistent and comprehensive report, the guidelines for RMAR should include requirements for key structural components. These include: 1. The definition of an RRU that enables aggregation of reports. 2. Separate sections for the Plan phase and the Reports phase. 3. A Narrative section that describes and interprets each table. 4. Required tables. An initial set of table requirements is included in section 12.1. The required tables may be expanded as the evaluation needs to change.
R3. Change-control procedures	RMAR may span many years and there must be flexibility to make changes to past or future periods, or both. Changes to RMAR must conform to change-control procedures that maintain consistency and comparability between prior and future periods and between plans, outcomes, results, and forecasts. A narrative description must explain any discrepancies between the modeled risk and the actual outcomes recorded during the previous GRC cycle. *1. Recasting* is modeling the current scenario as if the original state of the organization was still in place. Recasting ensures that comparisons to the plan are still valid. *2. Backcasting* restates history in terms of current models, data, and knowledge. *3. Replanning*. In rare circumstances, drift over time from the plan due to numerous model changes and unforeseen events may require a restatement of the plan. There must be strict regulatory approval processes for a Replan, such as an Advice Letter that allows party comment.
R4. RMAR must result in accountability	Accountability for RMAR accuracy needs to be supported by escalated enforcement actions. Errors or misinformation in RMAR could result in suboptimal mitigation decisions or incorrect energy cost increases. A possible escalation approach for enforcement actions is outlined in Chapter 10.
R5. Discuss and certify underlying model accuracy	RMAR should include a narrative section that discusses model and data quality, and a sensitivity analysis, and certifies that internal quality control requirements have been met. RMAR is only as good as the data and models used to construct it. As in financial reporting, accuracy requires data and model validation, along with internal audit processes. The details of validation and internal audit programs should be addressed outside an RMAR decision.
R6. Streamline overlapping elements between RMAR, RAMP, GRC, RSAR, and other reports.	Parts of RMAR may overlap with other reporting processes, which presents the opportunity to identify and reduce duplication. Over time, the RMAR plan phase should converge with RAMP and GRC. Expenses and work units from RSAR and risk event outcomes captured within SPMR could be fed directly into RMAR. Definitions for structural components such as RRU, risk measures, and portfolios should not differ across reports.

12 Appendices

12.1 List of required elements to be included in RMAR

1. Minimum of ten years of reporting, including the Report Year, the Report Years to date, and the Forecast years.
2. All tables must include the following roll-up points
    a. **Hierarchy.** This must be based on the utility's organizational structure, including, but not limited to, circuit, substation, region, division, HFTD, and enterprise. Hierarchy defines how reports and tables are grouped, the "parent-child" relationships.
    b. **Scenario**. Actuals, plan, or forecast.
    c. **Version**. Model or methodology.
    d. **Risk events.** All risks included in RAMP and GRC Applications.
    e. **Tranches.** Risk event-dependent.[26]
    f. **Mitigations.** Risk event-dependent.
    g. **Attribute.** Safety, reliability, financial.
    h. **Risk measure.** Average risk, tail-average risk.
    i. **Accounts (line-items).** This dimension contains all the calculations we are interested in: Pre-mitigated risk, mitigation value, post-mitigated risk, CBR, risk tolerance, capital expenses, operating expenses, likelihood of risk event (LoRE), consequence of risk event (CoRE), and natural units.
    j. **Time**. Periods under consideration—can be months, quarters, or years.
3. Tables that must be included in the RMAR:
    a. Risk Outcomes Flow Table
    b. Risk Outcomes Stock Table
    c. Average Risk Mitigation Benefit by Attribute Table
    d. Average Risk Mitigation Benefit and Cost by Risk Event Table
    e. Average Risk Mitigation Benefit and Cost by Tranche Table
    f. Average Risk Reduction and Risk Tolerance by Risk Event Table
    g. Tail Average Risk Reduction and Risk Tolerance by Risk Event Table
    h. Average Risk Reduction and Risk Tolerance by Portfolio Table
    i. Tail Average Risk Reduction and Risk Tolerance by Portfolio Table
    j. Mitigation Work Unit Results by Risk Event Table

[26] See D.24-05-064, Appendix A, Row 14

4. Include a narrative description of every table listed in Item 3.
5. Include a narrative description of a Risk Reporting Unit (RRU) that enables aggregation of reports.
6. Include a narrative description of any discrepancies between the modeled risk and the actual outcomes recorded during the previous GRC cycle.
7. Include a narrative section that describes any new tranche structures that were not used in a previous RAMP or GRC Cycle. Provide details of the key that is used as a bridge between the old and new tranche structures.
8. Include a narrative description of any subjective elements and assumptions related to each mitigation that have changed during the most recent update to the RMAR. The narrative must explain how the change has affected any RMAR information from the Plan Phase.
9. Include a narrative justification for assigning attribution for risk reduction from each mitigation. The utility must explain the causal mechanism that allows them to infer attribution. The utility must also highlight any additional factors other than the mitigation itself that could have contributed to any apparent risk reduction. Any assumptions or SME judgments must be made transparent.
10. Include a narrative discussion that describes the model and data quality as well as certifies that internal quality control requirements have been met. This section should include a description of any sensitivity analysis that was conducted on various model inputs or assumptions for each mitigation. This section can draw from the results of the Transparency Pilot or whatever sensitivity analyses are required by a future Decision in this or a successor proceeding or a Staff Resolution. The utility must also provide tables or work papers to back up any sensitivity analysis results discussed in this narrative section.

12.2 The disconnected sources of risk data

In the absence of RMAR in the format of a consolidated statement of risk, an evaluator would need to stitch together data from RAMPs, SPMR, and RSAR to reconstruct outcomes, results, plans, and forecasts. Figure 12-1 below shows an effort to do so and reveals the obstacles an evaluator would encounter. For this example, the risk event is gas overpressure incidents for PG&E.

Due in part to the different purposes of each report, it is difficult to line up "apples-to-apples" comparisons. The years don't quite line up. Costs in RSAR are disaggregated over many line items and are not sub-totaled by risk event. SPMR and RAMP also include mitigation costs, and it is unclear how they relate to each other or RSAR. In the RAMP, risk-benefit is presented (flow) but not risk reduction (stock) so we don't know what post-mitigated risk is. Finally, there is no presentation of risk tolerance.

Line item	Years	Source	Comment
Outcome	2023	2023 SPMR Tables 30A and 30B	Outcome tables mixed in with mitigation activity tables.
Modeled Risk (pre-mitigated)	2020	2020 RAMP Table 9.2	Also presented in Bow-tie format.
Mitigation Benefit, Actuals	N/a	N/a	Focus of RMAR.
Mitigation Benefits, FC, and Plan	2020-22 FC 2023-26 Plan	2020 RAMP: Table 9.9 2020 RAMP: Table 9.12	Calculated as flow, but not as risk reduction (stock).
Mitigation Costs, Actuals vs Plan	2023	2023 RSAR: Gas Dist Expense: 9 line-items Gas Dist Capital: 4 line-items GTS Expense: 16 line-items GTS Capital: 5 line-items	Minutely disaggregated; sub-totals for maintenance activity types (MAT) but not for Risk Events.
Mitigation Costs, FC, and Plan	2023-26 Plan	2020 RAMP: Tables 9.11(expense); 9.12 (capital)	Difficult to sync with RSAR.
Mitigation Costs, actual vs GRC	2023	2023 SPMR Tables 4.3 and 4.4, Line 3	Not clear how "imputed adopted costs" relate to Plan or Forecast.
Post-mitigated Risk	N/a	N/a	Not calculated.
Risk Tolerance	N/a	N/a	Not presented.

Figure 12-1. Disconnected sources of risk data.

12.3 Abbreviations

Abbreviation	Meaning
BCR	Benefit-Cost Ratio
BIS	Bank of International Settlements
CC	Covered Conductor
CoRE	Consequence of Risk Event
CPUC	California Public Utilities Commission
FASB	Financial Accounting Standards Board
FC	Forecast
GAAP	Generally Accepted Accounting Principles
GRC	General Rate Case
HFTD	High Fire Threat District
IASB	International Accounting Standards Board
IFRS	International Financial Reporting Standards
LGUWR	Large Unplanned Water Release

LoRE	Likelihood of Risk Event
O&M	Operating and Maintenance
PG&E	Pacific Gas and Electric
PSPS	Public Safety Power Shut-off
RAMP	Risk Assessment and Mitigation Phase
RDF	Risk-Decision Framework
RMAR	Risk Mitigation Accountability Report
RRU	Risk Reporting Unit
RSAR	Risk Spend Accountability Report
S-MAP	Safety Model Assessment Proceeding
SCE	Southern California Electric
SDG&E	San Diego Gas and Electric
SEC	Securities and Exchange Commission
SHAR	System Hardening Accountability Report
SPD	Safety Policy Division
SPMR	Safety Performance Metrics Report
UG	Undergrounding
Y1	Year 1
Y1YN	Years between Y1 and YN, inclusive
YE	Year-end
Year N	Current reporting year
YZ	Final reporting year

12.4 Definitions

Term	Definition
Account	An account is a line in the RMAR with values associated with it. Also known as line-item. See work units, pre-mitigated risk, mitigation benefit, mitigation cost, post-mitigated risk, and risk tolerance.
Attribute	An observable aspect of a risky situation that has value or reflects a utility objective such as safety or reliability. Changes in the levels of attributes are used to determine the consequences of a risk event (CoRE). The attributes

	in a cost-benefit approach should cover the reasons that a utility would undertake risk mitigation activities.
Average risk	The average of the probability distribution of risk, also known as expected value (EV).
Backcast	A process to adapt RMAR that enables apples-to-apples comparisons between past and future periods when organization and model changes occur. Backcast applies current models and organization structure to history.
Class	Class determines table structure and interpretation in RMAR. There are two classes, stock tables and flow tables.
Cost-benefit ratio	The ratio of mitigation benefits to mitigation costs.
Flow	Describes tables where the values accumulate over time and can be added. Line-items associated with flow include mitigation benefits and costs, and CBR.
Forecast	A projection of future line-item values in RMAR.
Hierarchy	A map of how lower levels of an organization roll-up through the organization. Ensures that double counting is avoided.
Line-item	A line in the RMAR with values associated with it. Also known as an account.
Mitigation benefit	The monetized value of mitigations, presented as a flow.
Mitigation cost	The cost of mitigations, presented as a flow.
Natural units	The non-monetized units of measurement. For example, the natural unit of a safety attribute may be fatalities.
Outcome	The final resolution or end result of a risk event.
Plan	The initial projections of RMAR accounts that will be used for comparing results and outcomes.
Plan phase	The section in RMAR that lays out the plan.
Post-mitigated risk	The risk that remains after mitigations are applied, presented as stock. Can be thought of as an accepted risk.
Pre-mitigated risk	The current level of risk, before any new mitigations are applied, presented as stock.
Recast	A process to adapt RMAR that enables apples-to-apples comparisons between past and future periods when organization and model changes occur. Recast is based on the organization structure and models in use at the time of the original plan.
Reference class forecast	Reference class forecast is a technique to compare internally generated assumptions and projections with standards compiled from external data. See https://www.pmi.org/learning/library/nobel-project-management-reference-class-forecasting-8068
Replan	Replan is when changes to the organization, to models, or to the environment are so large, the original plan is no longer relevant for

	comparing results and outcomes. In such cases, a restatement of the plan may be warranted. Replans should rarely be necessary.
Results	Results are the mitigation benefits and costs and work units that have occurred and can be compared to plan.
Results phase	The section of RMAR that compares outcomes and results to plan and forecast.
Risk event	In the context of RMAR, the category of risk, such as Wildfire, Hydropower, Cybersecurity, Gas Overpressure, etc. It can also mean occurrence of risk, when the possibility of a risk becomes a certainty, i.e., the risk occurs. In particular, the occurrence of a risk event changes the levels of some or all of the attributes of a risky situation.
Risk measure	How risk is presented, e.g. average risk or tail average risk.
Risk reduction	Risk reduction is how much risk has been reduced from pre-mitigated risk. It is a stock item.
Risk Reporting Unit (RRU)	The lowest hierarchy level for collecting information used in RMAR. The RRU contains all the data elements and dimensions that will be reported in the RMAR.
Risk tolerance	The maximum amount of residual risk that an entity or its stakeholders are willing to accept after the application of risk control or mitigation. Risk tolerance can be influenced by legal or regulatory requirements.
Scenario	Scenario is the set of tables used for comparisons. Outcomes and results, plans, and forecasts are scenarios. If there are multiple forecasts, each forecast is a scenario.
Sensitivity analysis	Analysis and statistical tests to determine how various sources of uncertainty in a mathematical model contribute to the model's overall uncertainty.
Stock	Stock describes tables where the line-items represent point-in-time values. Stock line-items include pre-mitigated risk, post-mitigated risk, risk reduction, and risk tolerance.
Tail average risk	A measure of tail risk, calculated as the average of risks above a given percentile.
Tail risk	Risk that is reflected in the tails of a probability distribution. Tail risk focuses on the consequences of rare events.
Tranche	A logical disaggregation of a group of assets (physical or human) or systems into subgroups with like characteristics for purposes of risk assessment.
Version	Version reflects the model or methodology in place for the report.
Work unit	Work units are the activities or assets related to mitigations, reported in natural units. An example would be circuit miles.