Safety and Enforcement Division Evaluation Report on the Risk Evaluation Models and Risk-based Decision Frameworks in A.15-05-002, et al.

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Executive Summary

Background

Pursuant to the September 9, 2015, Scoping Memo in consolidated proceedings A.15-05-002, et al., hereafter referred to as the first Safety Model Assessment Proceeding (S-MAP), the Safety and Enforcement Division (SED) was tasked by the Assigned Commissioner to prepare an evaluation report on the risk assessment models and risk management approaches as presented in the applications filed by Pacific Gas & Electric Company (PG&E), Southern California Edison (SCE), and the two Sempra Utilities companies, Southern California Gas Company (SoCalGas), and San Diego Gas & Electric (SDG&E).

The primary purpose of the report is to help the Commission determine "whether a particular risk assessment and risk management approach or model that a utility is using, or a variant of an alternative model, can be used as a basis for each energy utility's Risk Assessment Mitigation Phase (RAMP) filing in its respective GRC."[1] The RAMP filings will describe how the utility has assessed the most effective ways to use its budget and its expertise to mitigate risk to make California safer. The RAMP filing will lay out the priorities the utility has chosen, the costs of those decisions, and the steps that the utility plans to take.[2]

This report presents the results of SED's evaluation along with SED's recommendations.

[1] Scoping Ruling, A.15-05-002, et al., at 10.

[2] The elements of RAMP were determined in D.14-12-025, the Phase 1 decision for the CPUC's *Rulemaking Incorporating a Risk-Based Decision-Making Framework into the General Rate Case Plan*, R.13-11-006. RAMP will be further described and refined in a later part of this report.

As outlined in the Scoping Memo, the purpose of the first S-MAP is to:

- Undertake a comprehensive analysis of each utility's risk-based decision making approach;
- Compare the different approaches that each energy utility may use;
- Identify whether there are common elements among the approaches and models that the utilities use; and
- Assess whether elements developed by one utility can be adapted for use by the other utilities.

Evaluation Scope and Approach

Using a modified approach based on the 10-step process developed by the Cycla Corporation to evaluate PG&E's Test Year 2014 rate case,[3] SED applied the same evaluation process to analyze the risk assessment models and the risk-based decision framework. The evaluation covers two primary aspects of the utilities' S-MAP applications. First, the evaluation looks at the risk assessment portion. Then it looks at the risk mitigation and resource allocation decision framework. The evaluation incorporates all useful and relevant information gained from the workshops.

Risk Evaluation Formulas

In order to compare the risk evaluation models, SED modified the utilities' original risk evaluation formulas to produce mathematically equivalent forms by using the same definitions for f (frequency) and C (consequence):

[3] *Evaluation of PG&E's 2014 Gas Distribution GRC Filing*, by Cycla Corporation, June 2014.

Modified Equivalent Risk Evaluation Formulas

PG&E: $RS = f^{(1/4)} \times [W_1C_1 + W_2C_2 + W_3C_3 + W_4C_4 + W_5C_5 + W_6C_6]^{(1/2)}$

SCE: $RS = f_1C_1 + f_2C_2 + f_3C_3 + f_4C_4 + f_5C_5$ for each scenario

Total RS = sum of all scenario risk scores

Sempra: $RS = W_1f_1C_1 + W_2f_2C_2 + W_3f_3C_3 + W_4f_4C_4$

Despite the similar appearance of the formulas, the risk scores are not comparable across the utilities. PG&E's formula emphasizes high consequence events, whereas SCE's and Sempra's formulas do not. All three formulas give higher weight to safety.

Summary of Major Findings (More details can be found in the body of the report)

1. **Good progress has been made by all four utilities to develop a risk-based approach to manage their operations and assets and to inform rate case decisions.**
   To various degrees of maturity, all four utilities have embarked on a journey to adopt a risk-based approach to enhance safety and reliability. All four utilities have a risk-based decision framework that can be mapped to the Cycla 10-step process.
2. **The Rulemaking has provided extensive opportunity for the Commission and Parties to review and attempt to understand the Utilities' approaches.**
   One of the twin functions of the S-MAP proceedings is to allow parties a process "to understand the models the utilities propose to use to prioritize programs/projects intended to mitigate risks."[4] This has been largely accomplished by the filed testimonies, the series of workshops where parties had ample opportunity to ask the

[4] Scoping Memo in A.15-05-002, P.3.

utilities questions, associated workshop presentation materials, workshop summaries, and the parties' individual efforts to gain understanding of the models through their own data requests and direct informal meetings with the utilities.

3. **There is no specification of risk tolerance.**

Risk tolerance is not explicitly considered in any of the utility applicants' risk calculation models or risk-based decision frameworks. The utilities expressed in the workshops that their proposed programs/projects and proposed expenditures "**imply**" the individual utility's level of risk tolerance. There are two problems with this assertion.

By failing to provide an explicit specification of risk tolerance, the utilities are handicapping the ability of other stakeholders to make an informed decision as to whether the utilities' rate case proposals would have the desired risk reduction effect in relation to the desired level of risk tolerance. By failing to provide an explicit risk tolerance, the utilities would in effect be asking the stakeholders to accept in blind faith that the proposed programs and projects are necessary and sufficient (and no more than necessary or sufficient) to mitigate the risk down to a level that the utilities can tolerate, whatever that level is. No stakeholder would be able to verify this because the risk tolerance is not specified. This problem is compounded by the fact that, except in the case of PG&E's nuclear operations, their risk assessment models are a mixture of relative risk ranking models, where the scores produced by these models have no physical interpretation in the real world.

To some degree, this problem has been ameliorated by the utilities' use of performance metrics, benchmarks, industry best practices, and other performance measures in relation to industry peers in deciding their risk mitigation activities.

However, measuring risk mitigation performance relative to metrics, benchmarks, industry best practices, and industry peers is not equivalent to providing an explicit risk tolerance, since these measures still provide at best only an implied level of risk tolerance. The body of this report will provide a more detailed explanation of this shortcoming.

4. **Utilities' risk assessment models are still predominantly indexing models where Subject Matter Experts (SMEs) assign integer logarithm-scale scores to describe relative frequency and consequence rankings to produce risk scores.**
With the exception of PG&E's nuclear operations, utilities' risk evaluation models are based on a relative risk ranking approach. Despite the progress the utilities, particularly PG&E, have made over the last several years to improve their risk models, the risk score evaluation models presented by the utilities in this proceeding are still indexing models producing dimensionless risk ranking scores. There are many well-known limitations and drawbacks with indexing models. This finding should be interpreted as an observation rather than a criticism of the utilities since it has only been two years since the previous rate cases where this observation was made and in this short period of time we do not expect the utilities to have been able to make any significant improvements in their data collection to deviate from the relative risk ranking models.

The indexing approach based on a logarithmic scale of integer scores creates significant distortion in perception of the true magnitude of frequency and impact variables and the resulting risk scores. Human perception of numerical magnitude is innately based on a linear scale. A good demonstration of this human perception always thinking in linear-scale terms can be seen in PG&E's Risk Informed Budget Allocation (RIBA) process. Despite the calibration sessions, PG&E's SMEs created

an additional frequency score of 4.5 apparently because 4.5 is midway between 4 and 5 as if the numbers were on the linear scale, even though the RIBA scores are explicitly on the log scale. In this instance, PG&E's SMEs simply fell back into the trap of thinking in linear-scale terms on what they intended to be a log scale because it is simply not in human nature to perceive the world in terms of the logarithmic scale. A score of 5 on the log scale is 10 times as frequent as a score of 4 on the same scale.

5. **The weights on impact dimensions were not chosen based on true equivalence and convertibility of different dimensions.**

   The utilities' risk models obtain the risk score for a risk driver (or threat) and consequence scenario by summing (or weighting) the dimensionless contributions from different impact dimensions. (Summing the different impact dimension scores without applying weights is in fact equivalent to assigning equal weight to all the impact dimension scores.)

   The risk scores defined as such would lack physical interpretation. The weights establish equivalence relationships among the different impact dimensions. For example, if a utility's formula uses 30% weight on safety impact and 25% weight on reliability, it in effect establishes that 30 units of safety impact are to be treated as equal to 25 units of reliability impact.

   The current process is similar to adding 2 rotten apples, 7 rotten oranges, and 2 missing dollars and then calling that weighted sum a risk score. Such a summation of different dimensions with different implied or explicit physical units is inherently nonsensical unless the disparate impact dimensions had weights that were objectively chosen based on detailed analysis to establish the conversion among the

different impact dimensions. This, however, was not the case with the current weights chosen by the utilities. The Commission could impose uniform conversion weights by regulatory fiat, but then the same criticism about the weights would still remain.

Alternatively, the Commission could dispense with the use of weights by dictating that all impact dimensions be expressed in terms of one common unit of measurement, such as inflation-adjusted dollars. Then the weights, which act as conversion factors among impact dimensions, would be necessary. When a utility evaluates the risk score for a failure scenario, it would then have to evaluate each of the impact dimensions in inflation-adjusted dollar terms and the weights would not be used in the risk calculation equation.

6. **Shareholder financial interests crept into enterprise and operational risk management focus.**

The utilities' risk assessment models and risk management frameworks as presented in this proceeding are based on enterprise and operational level risk management (EORM). With EORM, a utility manages risks at both the operational level and the enterprise level explicitly for the benefit respectively of the operation and of the enterprise. Implicit in EORM are the beneficiaries of the actions taken to reduce risks. When a utility practices risk management, it in effect acts as a fiduciary to mitigate risks for the benefit of the public at-large, utility workers, contractors to the utility, the environment, utility regulators, utility customers, intervenors in Commission proceedings, other stakeholders, and shareholders. The interests of these different beneficiary groups are reflected in the categories used by the utilities to characterize the potential consequence (or impact) and evaluate impact scores in the risk scoring formulas.

7. **There is no optimization of portfolio of risk mitigation activities.**

   None of the utilities have a way to optimize their portfolio in a mathematically rigorous sense. There is no explicit consideration of optimization. Programs and projects are prioritized but not optimized. Prioritization is only an interim substitute for optimization but is not a replacement for it.

   Inherent in risk management is the unavoidable fact of limited resources and other constraints. Without resource constraints, an operator could simply apply an infinite amount of an infinite number of risk mitigation activities and the risks would be driven to zero. Clearly this is reduction of the argument to an absurdity. Therefore, risk management always assumes recognition of some constraints (rate shock, availability of trained personnel, and limitation of resources). And, optimization is always tied to risk tolerance. These concepts are all tied together.

8. **Prioritizing based on cost effectiveness measures is not optimization.**

   Prioritizing a portfolio based on cost effectiveness measures, such as risk reduction per dollar spent, is not equivalent to optimizing a portfolio, and will probably produce a sub-optimal result from a total portfolio perspective. Although cost-effective measures such as risk spend efficiency or risk reduction per dollar spent give valuable information, their limitations should be recognized. Where information from risk reduction per dollar spent could be most useful is to provide a basis for weeding out grossly cost-ineffective mitigation activities.

9. **Risk evaluation models emphasizing high consequence events will not yield the same portfolio of risk mitigation activities compared to an approach using the traditional formula of risk = frequency x consequence.**

   PG&E's RET model emphasizes high consequence events and produces a relative risk score that is not based on a traditional risk = frequency x consequence on a

linear scale. The emphasis on high consequence risks can create a risk prioritization that differs from one based on linear-scale risk scores. There could be valid societal reasons for emphasizing high consequence events, but distortion in risk rankings due to this emphasis should be recognized.

10. **The risk scores are not comparable across utilities.**

    For the risk scores to be comparable across utilities, the Commission would have to impose a uniform RET formula, with uniform definitions of frequency ranges, uniform impact dimensions, and uniform definitions of impact. The Commission would also have to require that calibration sessions be held across the utilities.

    Furthermore, in order for the risk scores to be comparable across utilities of unequal sizes, the frequency and consequence scores would need to be adjusted based on company size.

11. **None of the models produce absolute risk scores.**

    The risk scores are either relative (PG&E model) or quasi-absolute (SCE and Sempra risk models). Relative risk scores distort perception of the magnitude of a risk and are useful only for prioritization purposes but not optimization. The Commission should resolve this by imposing formulas that calculate linear-scale, absolute risk scores.

12. **The models are marked by weak transparency and questionable repeatability.**

    To various degrees the utilities have made good progress in creating a structured risk management framework that can be described in terms of the Cycla 10-step process, but the decision-making process leading from risk evaluation to the eventual portfolio mix of proposed risk mitigation programs and projects is still only vaguely described. The most transparent and verifiable step seems to be the one offered by SCE: that SCE intends to prioritize their portfolio based on a risk spend efficiency scores.

13. **The risks models currently only take into account single risk drivers and do not consider interacting risk drivers (interacting threats) and synergy in mitigation across multiple risks.** The "Bowtie-diagram" approach used by SCE partially addresses this problem in a graphical way. Consideration of interacting risk drivers and the synergy in mitigation across multiple risks is a complex mathematical problem. The utilities should devote effort to develop quantitative methods to account for these interacting and synergy effects.

14. **Model granularity should be improved.**

    As was mentioned in the second S-MAP workshop, increasing granularity in the risk register is a double-edged sword. On the one hand, increasing granularity would help narrow down the threat and scenario identification and risk evaluation, and would thus enhance more targeted and more cost-effective risk mitigation strategies. On the other hand, increasing risk identification granularity would mean fewer data points for a specific failure scenario to support the risk evaluation and would thus increase the uncertainty surrounding the risk scores and increase overall uncertainty in the entire risk-informed resource allocation framework. The utilities should consider using parallel models, one with high granularity and another one with low granularity with each model giving a different view.

15. **Both the As Low As Reasonably Practical (ALARP) framework and the Joint Intervenors' proposed framework are valuable alternatives for consideration by the Commission.** ALARP is an overarching framework meant to be used in conjunction with whatever risk evaluation tool that a utility may use (including the Joint Intervenors' proposed approach). ALARP tends to be more useful in the longer horizon as the models mature and can incorporate more fully probabilistic approaches. However, the risk tolerance and gross disproportionality concepts in ALARP can be used even in the absence of fully probabilistic approaches. The

downward-sloping risk tolerance limit lines in ALARP automatically emphasize avoiding high severity risks without needing to artificially boost the consequence term in the risk formula.

The Joint Intervenors' alternative approach is intended to replace the utilities' existing risk evaluation tools. The Joint Intervenors' alternative approach tends to be more useful primarily in the immediate future as a bridge between the current non-probabilistic state and a more probabilistic state as the utilities' models mature.

16. **Individual models should be further refined to correct inconsistencies or improve clarity.**

SCE's model uses the CP (consequence percentage) factor to denote the percentage of failure events that actually leads to safety related results. SCE's current model assumes that the CP stays the same both before and after mitigation. In reality, mitigation could, and probably would, reduce the consequence percentage of trigger events.

Recommendations

1. **The Commission should adopt explicit risk tolerance standards.**

Consideration of risk tolerance is integral to risk management. The concept of risk tolerance is a sensitive subject in an atmosphere where the public has little tolerance for anything less than perfect safety. What the general public may not always be conscious of is the tradeoff between unrealistically high expectations of safety and utility rate affordability. The moment the Commission embarked on a risk-based approach to safety, it implicitly recognized that absolute safety rarely exists within any finite amount of safety budget. The Commission should therefore confront the issue by making an explicit recognition of this tradeoff by defining acceptable levels of risk tolerance.

Consideration of risk tolerance could be part of the larger picture to consider whether an ALARP approach should be adopted. The Commission should consider addressing whether explicit risk tolerance standards should be set for the utilities in their rate cases. The failure to adopt explicit risk tolerance standards will hinder the utilities' ability to apply optimization techniques to their risk mitigation portfolios.

2. **It is premature to prescribe a common risk evaluation methodology in the first S-MAP.**

   For this first S-MAP, the Commission should continue to encourage increasing commonality among the utilities by giving explicit directions on what common approaches the Commission would like to see in the next S-MAP. Without formal orders from the Commission, it is unlikely that the utilities would adopt common risk management approaches at a pace and to the extent that the Commission and intervenors might desire.

   We caution against imposing common approaches too quickly simply for the sake of imposing commonality without fully vetting the strengths and weaknesses in the risk evaluation models and the feasibility of imposing unique elements in those models across all utilities. Great strides have been made in this first S-MAP to understand the different models and risk-based approaches. However, to fully understand the strengths and weaknesses of the various model elements requires a much deeper level of familiarity that can only come from actually putting the various models through their paces, something that has not been done with SCE's and Sempra's nascent risk-based approaches. Instead of adopting common elements in this first S-MAP beyond what the utilities have identified in their Uniformity Report, we recommend that the most desirable features from the risk models be

identified for possible adoption in the next S-MAP or perhaps in Phase 2 of the first S-MAP:

a) Risk evaluation formulas should produce linear-scale, absolute (or at least quasi-absolute) risk scores. The risk formulas should therefore follow the traditional aggregate risk formula (Risk = frequency x consequence) without any exponentials applied to the terms.

b) The consequence percentage term, CP, in SCE's formula gives the model a more realistic representation of trigger events and resulting consequences. The CP term will need to account for pre-mitigation vs. post mitigation. SCE's risk evaluation formula seems to be the most suitable formula for consideration as a common approach after correcting for the CP term to account for the effects of mitigation.

c) Emphasis on high consequence events should be replaced with decreasing risk tolerance for high risk events.

d) Risk scores should be comparable across utilities. This can only be accomplished if calibration sessions are held across utilities.

3. **All common elements identified in the "*Combined Utilities S-MAP Uniformity Report*" introduced in the S-MAP workshop on December 4, 2015, should be adopted in this S-MAP.**

4. **The Commission should prescribe uniform impact dimensions and a uniform methodology to derive the impact dimension weights. The Commission should <u>not</u> prescribe uniform weights.** Alternatively, the Commission could dispense with using weights by specifying that all impact dimension scores be expressed in one common equivalent unit of measurement, such as inflation-adjusted dollars. A uniform methodology to derive impact dimension weights would enhance inter-utility risk score comparability, but uniform weights that do not take into account

the different cost structures and loss experience across utilities would paradoxically make the risk scores non-comparable.

5. **The utilities should continue to improve their risk management models and data collection efforts to support increasing use of fully probabilistic risk management models.**
6. **The utilities should develop methods to optimize their risk mitigation portfolios.** The current methods employed by the utilities entail prioritization, which is not the same as optimization.
7. **The utilities should consider having two parallel risk assessment models, with one having high granularity and another having low granularity to compare the results obtained from both methods.**
8. **The utilities should remove shareholders' financial interests from consideration in their risk models and decision frameworks used to support rate case expenditure proposals.**
9. **In the next S-MAP, the Commission should consider whether common risk evaluation formulas for ranking pipe segments be used in the gas distribution and gas transmission integrity management programs.**
10. **The Commission should continue to use the Cycla 10-Step Evaluation method as a common yardstick for evaluating the maturity of utility Risk Assessment and Mitigation models.** The method will gain in usefulness as utilities advance subsequent General Rate Cases that are subject to the full Risk-Based Framework adopted in D.14-12-025 and refined in this and future S-MAP cycles.
11. **The Commission should adopt SED's recommended Guidance for RAMP and the ten major components that should be included in RAMP filings.**

Ten Major Components of Ramp Filings Recommended by SED

Step	Description
Overall, the utility should show how it will use its expertise and budget to improve its safety record. To do so, <u>each utility should</u>:	**The goal of the S-MAP proceeding is to make California safer by identifying the mitigations that can optimize safety**
• **Identify its top risks**	SED currently foresees this including those risks ranked 4 or higher on the 7x7 matrices
• **Describe the controls or mitigations currently in place**	Creates a baseline for understanding how safety mitigation improves over time
• **Present its plan for improving the mitigation of each risk**	Includes analysis of execution feasibility, affordability, and any constraints
• **Present two alternative mitigation plans that it considered**	D.14-12-025 calls for the presentation of two alternative plans
• **Present an early stage "risk mitigated to cost ratio" or related optimization**	Pilot calculations are attempting to measure this item, although they are in an early stage
• **Identify lessons learned in the current round to apply in future rounds**	Lessons learned by one company will also inform the RAMP filings of the other companies
• **Move toward probabilistic calculations to the maximum extent possible**	While not all of a utility's lines of business may have the data needed, some areas can move toward these calculations in the short term
• **For those business areas with less data, improve the collection of data and provide a timeframe for improvement**	By beginning in S-MAP #1, the utilities can position themselves to make major improvements in risk assessment in S-MAP #2 and #3
• **Describe the company's safety culture, executive engagement, and compensation policies**	Should show how compensation is tied to safety performance, board and executive engagement in safety, and organizational structure related to safety
• **Respond to immediate or short-term crises outside of the RAMP and GRC process**	The RAMP and GRCs follow a three-year cycle and are not designed to address immediate needs; the utilities have responsibility for addressing safety regardless of the GRC cycle

Background

On November 14, 2013, the Commission opened Rulemaking (R.) 13-11-006, *Order Instituting Rulemaking to Develop a Risk-Based Decision-Making Framework to Evaluate Safety and Reliability Improvements and Revise the Rate Case Plan for Energy Utilities (the Risk OIR)*. The purpose of this rulemaking was to incorporate a risk-based decision-making framework into the Rate Case Plan (RCP) for the energy utilities' General Rate Cases (GRCs).[5] Such a framework and associated parameters would assist the utilities, interested parties, and the Commission, in evaluating how energy utilities assess their safety risk, and how they propose to manage, mitigate, and minimize such risks.

For the large energy utilities, two new procedures were established to feed into GRC applications in which utilities request funding for such safety-related activities: 1) May 1, 2015, filing of a Safety Model Assessment Proceeding (S-MAP) by each of the large utilities, which were consolidated on June 19, 2015, and are the subject of this proceeding[6]; and 2) a subsequent Risk Assessment Mitigation Phase (RAMP) filing for the upcoming GRC wherein the large energy utility files its RAMP in the S-MAP approved report format describing how it plans to assess its risks, and to mitigate and minimize such risks. The RAMP submission, as clarified and modified in the RAMP proceeding, will then be incorporated into the large energy utility's GRC filing. In addition, the large energy utilities are required to file two annual accountability reports following the GRC decisions.

[5] In addition, this would apply to jurisdictional gas corporations' Gas Transmission and Storage (GT&S) rate cases.

[6] Consolidated as A.15-05-002, et al.

The twin purposes of S-MAP are to: 1) allow parties to understand the models the utilities propose to use to prioritize programs/projects intended to mitigate risks; and 2) allow the Commission to establish standards and requirements for those models. Following the format that the Commission used to establish Long Term Procurement Plans (LTPP) proceedings, the idea is for each successive S-MAP to become more sophisticated, be able to respond to changing circumstances, and be able to build on its predecessor S-MAP to tackle increasingly difficult issues.

D.14-12-025 provided that the S-MAP is expected to accomplish several objectives:[7]

- Undertake a comprehensive analysis of each utility's risk-based decision making approach;
- Compare the different approaches that each energy utility may use;
- Detect whether there are common elements among the approaches and models that they use; and,
- Assess whether elements of one utility can be adapted for use by the other utilities.

On September 9, 2015, Assigned Commissioner Michael Picker issued a Scoping Memo in this proceeding that laid out a path for resolution of S-MAP issues through the use of workshops, comments, and – potentially – evidentiary hearings (EH).[8]

[7] D.14-12-025 at 27.

[8] A. 15-05-002, et al., Scoping Memo at 8.

Additionally, the Scoping Memo directed the Safety & Enforcement Division (SED) to publish a report to evaluate whether a particular risk assessment and risk management approach or model that a utility is using, or a variant of an alternative model, can be used as a basis for each energy utility's RAMP filing in its respective GRC. Respondents and parties will have an opportunity to comment on this report and a proposed decision will be issued that incorporates the results of the workshops and SED report consistent with scoping memo objectives.

The Scoping Memo also described and scheduled four workshops to be organized, noticed and led by SED. These workshops were held as scheduled, but covered issues in a slightly different order than were initially described in the Scoping Memo. The listings below represent the actual agenda items for the workshops:

1. Workshop #1 on August 3, 2015

a) Utility applicants presented their proposed risk assessment models
b) SED presented Cycla Corp.'s 10-step risk management program evaluation criteria
c) A working group was formed to develop a proposed Risk Lexicon for this proceeding

2. Workshop #2 on September 20-21, 2015

a) Status update from Risk Lexicon Working Group
b) Consideration of common risk management standards used for judging utilities' risk management programs
c) Detailed discussion of utilities' risk-informed decision-making approach
d) Detailed discussion of utilities' risk models

e) Prioritization of mitigations, cost effectiveness, optimization of portfolio

f) Discussion of elements in risk models that should be made uniform

g) Data issues

3. Workshop #3 on October 6, 2015

a) Lexicon update

b) Utilities' presentations on examples of low-frequency, high-consequence events

c) Discussion of sufficient levels of granularity in risk models

d) Discussion of whether factors besides safety should be used in determining risk rankings

e) Guidance on the Risk Assessment Mitigation Phase (RAMP)

f) Roadmap for future S-MAP proceedings

g) General comments about the S-MAP workshop process

4. Workshop #4 on December 4, 2015

a) ALARP[9]

b) Presentation on utilities' efforts to identify possible common risk assessment/management approaches[10]

c) Residual questions about RAMP

d) General discussion of accountability reporting

[9] ALARP (As Low As Reasonably Practicable) refers to a risk management framework that is used to decide whether risk mitigation is needed, when it is needed, and how much should be spent before the benefits of mitigation are disproportionately outweighed by the additional cost.

[10] *Combined Utilities S-MAP Uniformity Report*, December 4, 2015.

Following Workshop #4, intervenors The Utility Reform Network (TURN), Indicated Shippers (IS) and Energy Producers & Users Coalition (EPUC) requested an additional workshop (fifth workshop) to provide an alternative approach to the IOUs' risk scoring approaches. This workshop was conducted on January 25, 2016, and consisted of presentations based on a white paper by two consultants,[11] and a question/answer session moderated by TURN's representative Thomas Long. There was also a presentation by Joseph Mitchell, representing intervenor Mussey Grade Road Alliance, and SED began the process of establishing a working group on Safety performance metrics that could potentially be used to assess the success of S-MAP in improving safety outcomes.

With the exception of Workshops #4 and #5, SED produced a report following each workshop that was subject to formal comments, clarifications, and corrections by Parties, so the content and outcome of the workshops could be included in the record of the consolidated proceeding. The final reports, as well as presentations from each of the workshops, are available on the CPUC web site and Docket Card.[12]

[11] *Intervenor Perspective Regarding an Improved Methodology to Promote Safety and Reliability of Electric and Natural Gas Service in California*, prepared for the S-MAP Workshop January 25, 2016, by Charles D. Feinstein, Ph.D. and Jonathan A. Lesser Ph.D. on behalf of The Utility Reform Network/Indicated Shippers/Energy Producers and Users Coalition," revised January 28, 2016

[12] http://www.cpuc.ca.gov/General.aspx?id=9099

Scope and Approach of Evaluation

SED's evaluation distinguishes two major aspects of the utilities' submissions:

1. The risk assessment process consisting of threat identification and risk evaluation.

2. The risk-based decision process using outcomes from the risk assessment process to inform risk mitigation decisions.

The grouping of the risk-informed resource allocation framework into these two major processes is artificial but is designed to facilitate the evaluation by isolating the part of the framework most closely tied to mathematical models from the rest of the risk-informed decision-making and resource allocation framework. Together, these two components comprise a utility's risk-based resource allocation framework in rate cases.

In approaching this evaluation, SED relied on the directives laid out in D.14-12-025 and in the Scoping Memo. The S-MAP is expected to:

- Undertake a comprehensive analysis of each utility's risk-based decision making approach;
- Compare the different approaches that each energy utility may use;
- Detect whether there are common elements among the approaches and models that they use; and
- Assess whether elements of one utility can be adapted for use by the other utilities.

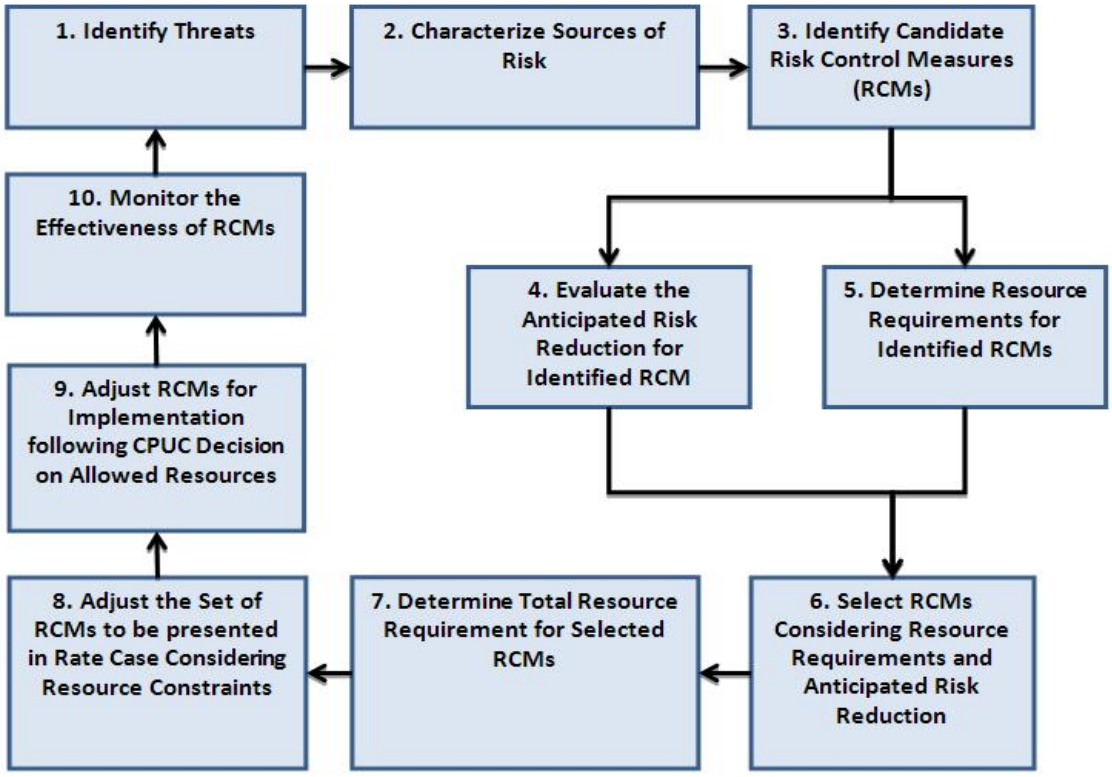
SED took a similar approach in this evaluation as that in SED's evaluation of the risk assessment model and risk management process in the still pending PG&E Gas Transmission and Storage Rate Case, A.13-12-012. In the current evaluation the Cycla 10-steps are used again, but only as a background document to guide our evaluation and not as a rigid grading structure to evaluate the utilities' risk frameworks.

There are two primary reasons for this modified approach. The first is that the Cycla 10-steps are primarily applicable to evaluate actual rate case applications where documentations (or the fact that documentations are missing) are used as basis to gauge the strengths or deficiencies in a utility's risk-based decision process and actual proposals. In this proceeding, most of the Cycla criteria would wind up referring to risk-based frameworks that are still works-in-progress for a couple of the utilities. As we progress down the full list of 10 steps in the absence of an actual rate case, their applicability in this first S-MAP proceeding becomes increasingly vague and tenuous.

Since the emphasis of this first S-MAP is largely on identifying commonalities and differences in the risk models and decision frameworks, we do not believe that grading the still-nascent SCE and Sempra risk-based decision frameworks would add too much to the conversation. Some of the steps in the Cycla process are simply not applicable in the absence of an actual rate case filing. Secondly, the emphasis of this proceeding is predominantly on the risk calculation models. An effective evaluation can be performed on the risk calculation models without resorting to the specifics of the full Cycla process. The evaluation will thus gravitate heavily towards the first few steps. Still, regardless of our modified approach, it is instructive to understand the Cycla 10-step process since actual rate case filings are always just around the corner.

The primary focus of the Cycla criteria is on evaluating the reasonableness of the set of programs and projects presented by the utility to mitigate recognized risks. To accomplish this, the Cycla 10-step criteria are used to gauge the robustness, thoroughness, and maturity of the utility's risk management program in the context of rate case proceedings by focusing on 10 key aspects (expressed as sequential steps on a flowchart) in the utility's risk-informed resource allocation process. The Cycla 10-step process is summarized in the following diagram.

Figure 1[13]



Although the Cycla process was originally developed to gauge PG&E's gas distribution risk management program, the Cycla process has sufficient flexibility and

[13] *Evaluation of PG&E's 2014 Gas Distribution GRC Filing*, by Cycla Corporation, Attachment 3, page 2, Figure 3-1.

generality to be readily adapted to an energy utility's other lines of business, such as gas transmission and storage, electric distribution and transmission, electric supply, and nuclear generation.

SED chose to retain the Cycla criteria in the S-MAP proceeding because of the criteria's specific applicability to risk-informed decision frameworks in rate cases, their relative simplicity and ready availability, and stakeholders' familiarity with and acceptance of the criteria through their earlier use in previous Commission rate case proceedings. The method will gain in usefulness as utilities advance subsequent General Rate Cases that are subject to the full Risk-Based Framework adopted in D.14-12-025 and refined in this and future S-MAP cycles.

Two notable differences exist between SED's evaluation approach in this first S-MAP and those used in previous rate cases. The first is that SED has the benefit of having conducted five workshops in connection with this S-MAP and valuable insights from these workshops have been used to evaluate the S-MAP applications. The second difference is that, having previously reviewed the utilities' risk assessment and risk management approaches in rate cases from 2012 to 2014, SED can now gauge the degree of any progress or improvements in the utilities' risk models and their risk management approaches.

One of the twin functions of the S-MAP proceedings is to allow parties a process "to understand the models the utilities propose to use to prioritize programs/projects intended to mitigate risks."[14] This has been largely accomplished by the filed testimonies, the series of workshops where parties had ample opportunity to ask the

[14] Scoping Memo in A.15-05-002, P.3.

utilities questions, associated workshop presentation materials, workshop summaries, and the parties' individual efforts to gain understanding of the models through their own data requests and direct informal meetings with the utilities.

This report's function, on the other hand, is to provide SED's independent evaluation of the utilities' risk assessment models and risk-informed decision frameworks rather than to serve as a second-source comprehensive descriptive document on the utilities' risk models and decision frameworks. Since detailed descriptions of the utilities models and risk-informed frameworks have been furnished in formal testimonies and other presentation documents provided by the utilities at the workshops, this report will only provide those detailed descriptions that are necessary to support an observation or conclusion.

Risk evaluation and risk modelling can take on many forms. The most common and traditional way to evaluate risks is to calculate the expected product of frequency and consequence of a range of outcomes potentially emanating from an identified threat. Using a mathematical formula to represent the expected frequency and expected consequence of potential outcomes from the threats, this process typically evaluates a separate risk score for a threat and risk scenario both before risk mitigation is applied and again after proposed risk mitigation.

There are other ways of performing risk assessment without calculating risk scores in the traditional way mentioned above. Good examples of these alternative approaches include the wildfire risk management tools, such as Fire Risk Mitigation ("FiRM"), Reliability Improvements in Rural Areas Team ("RIRAT") and a computer model known as the SDG&E Wildfire Risk Reduction Model ("WRRM"), that SDG&E

has developed to model wildfire behavior and to help identify potential wildfires before they occur.[15] Other good examples of these non-traditional risk assessment approaches are the dedicated cybersecurity risk management programs. These specially-built risk models do not typically represent risks using simple formulas to calculate frequency multiplied by consequence as in the traditional risk models (R = f x C), but they are no less valid and no less important in a utility's overall approach to risk management.

The S-MAP proceeding contemplates both the traditional risk scoring models and any risk assessment/management programs associated with major risk categories, such as cybersecurity and wildfires. This report likewise does not confine its evaluation to only traditional risk calculation models and will comment on the specially-built risk evaluation models, as appropriate.

SED views the risk evaluation models and risk-informed decision frameworks presented by the utilities in this first S-MAP as works-in-progress that are still evolving. In order to capture the most up-to-date information practicable, SED also selectively reviewed documents outside of the S-MAP proceeding. These included testimonies filed by PG&E in its 2017 Test Year GRC (A.15-09-001) and Gas Safety Plans filed by the gas utilities pursuant to SB 705. These additional sources of information provided additional details to help SED gain a more complete understanding of the utilities risk-informed decision frameworks. Where SED used these reference sources that present additional information not already found in the S-MAP testimonies and S-MAP workshop presentation materials, these documents will be referenced in the report.

[15] *Prepared Direct Testimony of Mason Withers on Behalf of San Diego Gas & Electric Company*, p.MW-1, A.15-05-002, et. al

Risk Lexicon

A common risk lexicon was submitted by all the utility applicants in their original applications. At the direction of the assigned administrative law judge, a Risk Lexicon Working Group (RLWG) was formed to further refine the risk lexicon for use in this proceeding. The Risk Lexicon Working Group produced the following risk lexicon:

Table 1

Risk Lexicon Working Group Lexicon

Risk Lexicon Working Group Agreed upon Terms for Common Lexicon	
Term	**Definition**
Risk	The potential for the occurrence of an event that would be desirable to avoid, often expressed in terms of a combination of various outcomes of an adverse event and their associated probabilities. Different stakeholders may have varied perspectives on risk.
Inherent Risk	The level of risk that exists without risk controls or mitigations.
Event	An occurrence or change of a particular set of circumstances that may have potentially adverse consequences and may require action to address.
Frequency	Number of events generally defined per unit of time. (Frequency is often incorrectly treated as synonymous with probability or likelihood).
Probability	The relative possibility that an event will occur, probability is quantified as a number between 0% and 100% (where 0% indicates impossibility and 100% indicates certainty). The higher the probability of an event, the more certain we are that the event will occur. (Often informally referred to as likelihood or chance).
Impact (or Consequence)	The effect or outcome of an event affecting objectives, which may be expressed, by terms including, although not limited to health, safety, reliability, economic and/or environmental damage.
Mitigation	Measure or activity proposed or in process designed to reduce the impact/consequences and/or likelihood/probability of an event.
Outcome	The final resolution or end result
Risk Driver	Factor(s) that could cause one or more risks to occur (Risk driver may also be commonly referred to as “threat”).
Risk Response Plan	Collection of mitigations
Control	Currently established measure that is modifying risk
Alternative Analysis	Evaluation of different alternatives available to mitigate risk
Residual Risk	Risk remaining after current controls.
Planned or Forecasted Residual Risk	Risk remaining after implementation of proposed mitigations.
Risk Score	Numerical representation of qualitative and/or quantitative risk assessment that is typically used to relatively rank risks and may change over time.

Risk Tolerance	Maximum amount of residual risk that an entity or its stakeholders are willing to accept after application of risk control or mitigation. Risk tolerance can be influenced by legal or regulatory requirements.

As a result of further insights gained through review of the usage of the lexicon terms, SED proposes to modify the RLWG lexicon in two ways:

1. The RLWG's definition for "risk" conflicts with the intended meaning of the term "risk" as used by parties and the Commission in this proceeding. The RLWG's definition for risk omits mention of the unique risk drivers (threats) that give rise to the adverse outcomes. The current RLWG definition does not distinguish between two risks with identical adverse outcomes and identical probabilities of occurrence but which are caused by two completely different sets of risk drivers. For example, internal corrosion and external corrosion on steel gas pipelines are different risk drivers. Just because they may possibly lead to identical probabilities of failure and identical consequences does not mean they are identical risks. It would be entirely incorrect to confuse a risk caused by internal corrosion with a risk caused by external corrosion, since they require completely different methods of risk mitigation. The only way to remedy this deficiency is to include risk drivers in the definition for risk.

2. In the RLWG's lexicon, the term "likelihood" is mentioned and retired by being subsumed into the definition of "probability." SED initially supported this approach in the RLWG's lexicon, but as SED's understanding of the usage of these two terms has evolved, SED now recognizes that probability and likelihood have distinct connotations and neither should be subsumed into the definition of the other.

Although the two terms have the same denotative meaning, probability connotes a more precise number obtained by the use of a probability distribution function to model the stochastic behavior of trigger events; whereas likelihood connotes an average value of the probability obtained from an SME estimate without the use of a probability function. With this distinction, if an SME estimated the parameters (either based on historical data or opinion) to describe a probability function to produce a probability value, then the term probability would be used. If an SME simply estimated a probability number without first going through the rigor of defining a probability function, then the term likelihood should be used instead of probability.

This distinction is important in this proceeding.

The distinction is relevant, for example, in the white paper *"Intervenor Perspective Regarding an Improved Methodology to Promote Safety and Reliability of Electric and Natural Gas Service in California"* introduced by the Joint Intervenors (TURN and IS/EPUC), in which the SME estimated likelihoods are referred to as "probabilities" because the numbers are bounded between 0 and 1, just as true probabilities are. Simply because a likelihood number is bounded between 0 and 1 does not mean that this likelihood mirrors the same stochastic character between the two end points as true probability does.

For these reasons, SED proposes the following lexicon to recognize these distinctions. The shaded portions highlight the changes made to the original RLWG lexicon. A clean copy of the SED Proposed Risk Lexicon is included as an attachment at the end of this report.

Table 2

SED Proposed Risk Lexicon

Risk Lexicon Proposed by SED (modifications highlighted in grey)	
Term	**Definition**
Risk	The potential for the occurrence of an event that would be desirable to avoid, often expressed in terms of a combination of risk drivers, a scenario in which risk drivers lead to various outcomes of an adverse event, and the associated probabilities of the outcomes. Different stakeholders may have varied perspectives on risk.
Inherent Risk	The level of risk that exists without risk controls or mitigations.
Event	An occurrence or change of a particular set of circumstances that may have potentially adverse consequences and may require action to address.
Frequency	Number of events generally defined per unit of time. (Frequency is often incorrectly treated as synonymous with probability or likelihood).
Likelihood	The expected value of possibility that an event will occur. Likelihoods are point values estimated by subject matter experts and are not derived from probability functions. Likelihood is quantified as a number between 0% and 100% (where 0% indicates impossibility and 100% indicates certainty). The higher the likelihood of an event, the more certain we are that the event will occur.
Probability	The relative possibility that an event will occur. Probability is quantified as a number between 0% and 100% (where 0% indicates impossibility and 100% indicates certainty). The higher the probability of an event, the more certain we are that the event will occur. (Often informally referred to as likelihood or chance. See Likelihood for distinction in usage between likelihood and probability).
Impact (or Consequence)	The effect or outcome of an event affecting objectives, which may be expressed, by terms including, although not limited to health, safety, reliability, economic and/or environmental damage.
Mitigation	Measure or activity proposed or in process designed to reduce the impact/consequences and/or likelihood/probability of an event.
Outcome	The final resolution or end result
Risk Driver	Factor(s) that could cause one or more risks to occur (Risk driver may also be commonly referred to as “threat”).
Risk Response Plan	Collection of mitigations
Control	Currently established measure that is modifying risk
Alternative Analysis	Evaluation of different alternatives available to mitigate risk
Residual Risk	Risk remaining after current controls.
Planned or Forecasted Residual Risk	Risk remaining after implementation of proposed mitigations.
Risk Score	Numerical representation of qualitative and/or quantitative risk assessment that is typically used to relatively rank risks and may change over time.
Risk Tolerance	Maximum amount of residual risk that an entity or its stakeholders are willing to accept after application of risk control or mitigation. Risk tolerance can be influenced by legal or regulatory requirements.

Utilities' Risk Models and Decision Frameworks

This section briefly describes the utilities' risk models and risk decision frameworks as presented in their applications in the S-MAP proceeding. The descriptions that follow are not meant to be comprehensive, but are intended only to give highlights of elements that we deem to be important to point out in order to compare the different approaches employed by the utilities.

PG&E's Risk Model and Decision Framework

PG&E has advanced farther along the development and experience curve of using risk calculating models than either SCE or Sempra. Although there have been minor improvements in the risk evaluation model since its first appearance in PG&E's 2012 Test Year gas distribution GRC, PG&E's risk evaluation model is still essentially unchanged and is still marked by many of the same problems that SED identified in the 2014 Test Year GT&S rate case.

PG&E's risk-based resource allocation framework presented in this proceeding was developed from an enterprise and operations risk management (EORM) perspective. Operational Risk Management (ORM) is a subset of enterprise risk management (ERM), but PG&E's application distinguishes ORM from the broader and higher level ERM and refers to the aggregate framework as enterprise and operational risk management.

PG&E is four years into its current risk management process and looks at the process as a continuing journey. The aim of this EORM framework is to make a risk

management culture a company-wide conversation. Governance oversight is the hallmark of PG&E's risk management program. PG&E has organized its risk management process into four main sessions:

1. Session D, where senior management is made aware of top enterprise risks and other main compliance issues.
2. Session 1, where discussions are held to consider strategies for managing line of business priorities, including plans to manage top risks.
3. Risk Informed Budget Allocation (RIBA), in which risk mitigation activities are evaluated by subject matter experts (SMEs), with risk scores calculated for the risk mitigation programs and projects, and the programs and projects prioritized subject to system and execution constraints. Executive leadership is involved in the discussion at the end of this process.
4. Session 2, where resources are prioritized and allocated to execute the risk mitigation decisions resulting from RIBA.

The two main tools of PG&E's risk management framework are the risk evaluation tool (RET) and the risk-informed budget allocation process (RIBA). RET was first presented to the Commission in PG&E's Test Year 2014 general rate case filed in 2012 (A.12-11-009). RIBA was introduced in the GT&S rate case proceeding (A.13-12-012) filed in 2013. Both RET and RIBA have gone through revisions and refinements since their initial appearance, but the essential shape and form of both RET and RIBA have remained unchanged.

RET 2.1

RET is a Microsoft Excel spreadsheet-based risk evaluation model that can be loosely viewed as a spreadsheet representation of graphical fault-tree analysis. PG&E's RET consists of only operational risks that line of business subject matter experts deem important enough to include for consideration in the RET model. The term "risk register" is used by PG&E to refer to the roster of all threat causes (defined below) developed in RET.

The primary function of RET is to help top corporate officers in the Risk and Compliance Committee in Session D become aware of the most significant (top 10) operational risks that have the potential to affect the operation and viability of PG&E as an ongoing enterprise. RET's secondary function, using the same input and output, is to help asset family owners in Session 1 at the line of business to see all top operational risks at once in order to prioritize top operational risks for mitigation strategies. The output of RET and the risk scores are mapped to a 7x7 matrix with the frequency in the vertical axis and the impact (consequence) in the horizontal axis. PG&E does not have a definite cut-off risk score in RET below which a risk is considered insignificant enough that mitigation spending is not warranted.

The current version of RET is 2.1. Each line of business (e.g. gas operation, electric operation, energy supply, nuclear, etc.) uses the same RET model, but each line of business creates its own risk register and estimates its own set of risk drivers, failure modes, consequence scenarios, and risk scores. Subject matter expert (SME) input is used throughout the RET process ranging from threat identification to risk score evaluation. The RET model has a hierarchical structure. First, SME input is used to populate potential threats affecting the assets within the line of business. Then SME

input is used to estimate potential failure modes of the asset elements and their associated consequence scenarios. PG&E refers to a threat (risk driver), the threat cause, a consequence scenario, together with its associated risk score, as a "risk."

In PG&E's RET model, a "risk" is an entry that comprises of a risk driver (which is typically asset-based), a failure mode due to the risk driver, a 95th-percentile consequence scenario based on the failure mode, a frequency of the failure mode, and finally the resulting risk score.

For each threat cause, an integer (1 to 7) impact (consequence) score is estimated by the SMEs for each of six impact dimensions (safety, reliability, environment, compliance, trust, financial) based on an estimated 95th-percentile probable worst case outcome scenario. PG&E refers to this as a "P95" scenario. In other words, given that a failure event has occurred, the P95 scenario is meant to capture the potential consequence at the 95th-percentile of all possible unfavorable outcomes.

The RET risk score represents an estimated 95th-percentile probable worst outcome of (residual) risk if no (additional) risk mitigation measures are taken. Calibration sessions are used to ensure consistency of SME-assigned scores across threat causes and across asset families.

The latest improvement reflected in RET 2.1 is that for threat causes where PG&E has reliable actual frequency data, these data may be used instead of frequencies based on SME opinions. PG&E has expressed a desire to move toward more rigorous quantification using actual frequency data. The stumbling block has been the

unavailability of data for failure events that are either very rare or have not even occurred yet.

The RET formula is described in Chapter 2, Attachment A of PG&E's testimony.

Figure 2

$$RS_{(Event)} = k^{[0.5 \text{ Log } (f_{(Event)}) + I_{(Event)}]}$$

Where	**f** is the number of occurrences expected over a one-year time horizon
And	***I*** is the weighted impact of the event
And	**k** is the scalar and is a fixed value of 3.16 (the square root of 10)
And	**0.5** s a standard factor used to calculate the variance of the aggregate impact of uncorrelated events.

$$I_{(Event)} = \text{Log}\left(\sum_{j=1}^{6} Wj * 10^{Ij}\right)$$

Where	$I_{j\ (Safety,\ Environmental,\ Reliability,\ Financial,\ Reputation,\ Compliance)}$ is the impact level of an impact group of an event
And	$W_{j\ (Safety,\ Environmental,\ Reliability,\ Financial,\ Reputation,\ Compliance)}$ is the weight applied to the impact group of an event

If we introduce a linear-scale variable C to stand for consequence, we will show in the following pages that PG&E's RET formula can be equivalently restated as:

$$\mathbf{RS = f^{(1/4)} \times [W_1C_1 + W_2C_2 + W_3C_3 + W_4C_4 + W_5C_5 + W_6C_6]^{(1/2)}}$$

Except in cases where PG&E has reliable frequency data, SMEs are used to estimate one of seven broad logarithmic ranges into which frequencies fall. In PG&E's

RET formula, frequencies are evaluated at the right end of a logarithm range. For example, if the frequency range is estimated to fall into "once every 30 to 100 years". Then the right end of the range is 100 years and the frequency is 1/100. The representative logarithm of this frequency range is
-2. Any event within this "once every 30 to 100 years" would have the same log f equal to -2.

The top frequency range has a description of "> 10 times per year." In reality, PG&E assigns an upper frequency value of 100 times per year to this range. In other words, the current RET model limits failure events to a maximum frequency of 100 times per year for any particular threat and failure scenario.

By substituting $k = 10^{0.5}$ and by simple algebraic manipulation, PG&E's original RET formula can be transformed into this mathematically equivalent form:

$$RS = f^{(1/4)} \times 10^{(0.5 \times I_{Event})} \qquad \text{(Eq. 1)}$$

By substituting the definition of I_{Event} into the above equation, the RET RS formula in Eq. 1 can also be equivalently expressed as:

$$\mathbf{RS = f^{(1/4)} \times [W_1 10^{(I_1)} + W_2 10^{(I_2)} + W_3 10^{(I_3)} + W_4 10^{(I_4)} + W_5 10^{(I_5)} + W_6 10^{(I_6)}]^{(1/2)}} \qquad \text{(Eq. 2)}$$

To gain further insight into PG&E's RET formula, we introduce the variable, C, to represent the linear scale consequence value on an impact dimension. Since the (1 to 7) integer impact scores, *I*, represent logarithms of the linear scale consequence values,

raising the logarithm of a consequence value to the power 10 recovers the original linear scale consequence value:

$$\mathbf{10}^{I} = \mathbf{10}^{\log(C)} = \mathbf{C}$$

PG&E's RET formula can now be equivalently expressed as:

$$\mathbf{RS = f}^{(1/4)} \mathbf{x\ [W_1C_1 + W_2C_2 + W_3C_3 + W_4C_4 + W_5C_5 + W_6C_6]}^{(1/2)} \qquad \text{(Eq. 3)}$$

In other words, a RET score calculated using PG&E's RET formula is proportional to the expected annual frequency raised to the 1/4 power. The RET score is also proportional to the square root (i.e. raised to the ½ power) of the weighted sum of linear scale consequence values. Equations 1, 2, and 3 are mathematically equivalent to PG&E's original RET formula. By using the same definitions of frequency and consequence, the equivalent form of PG&E's RET formula in Eq. 3 facilitates comparison with the risk scoring formulas used by SCE and Sempra, as we will see later on in this report.

A risk score produced by PG&E's RET formula would differ from that produced by the traditional expression of absolute risk (i.e. risk = frequency x consequence)[16] due to the distortion created by the frequency term being raised to the 1/4 power and the

[16] There are two different commonly used expressions to calculate risk. One form (risk = probability of a single element failure x consequence of failure for an element) expresses risk for an element within an asset class (e.g. risk for a single power pole failing). The other form (risk = aggregate frequency of failure for an entire asset class x average consequence of failure for an element) expresses risk on an aggregate basis for an entire asset class (or group) of similar elements (e.g. aggregate risk for all similar wooden power poles failing). The aggregate form is based on the fact that for very small probabilities, frequency of failure for one element is very nearly equal to the probability of failure for that element. The aggregate form (Risk = frequency x consequence) is the approach used in the utilities' current risk evaluation models. We refer to the aggregate form as the "traditional" risk formula.

weighted sum of the linear scale consequence values being raised to the 1/2 power. The effect of raising the consequence term to 1/2 power and the frequency term to only 1/4 power is to emphasize high consequence events and de-emphasize high frequency low consequence events. With the emphasis on high consequence events, the overall effect is that for certain combinations of frequency and consequence values, PG&E's RET could produce relative risk rankings that would differ from those produced by the traditional absolute risk formula (risk = f x C) as the hypothetical risk scenarios in Table 3 below show:[17]

Table 3

			Risk Score by Formula		Risk ranking by risk score	
Risk scenario	frequency (f)	Consequence (C)	f x C	PG&E RET	f x C	PG&E RET
A	10	100,000	1,000,000	562	1	3
B	0.001	300,000,000	300,000	3,080	2	1
C	0.02	10,000,000	200,000	1,189	3	2
D	100	400	40,000	63	4	5
E	1	10,000	10,000	100	5	4

There may be valid societal reasons for placing disproportional emphasis on low frequency but very high consequence risks (catastrophic wildfires, for example). However, modifying the traditional risk formula (risk = f x C) in order to emphasize high consequence events undermines the whole notion of using risk formulas and risk scores to evaluate risks. A risk score is meant to allow an objective comparison so that two different risks with equal risk scores should be equally undesirable, whether or not one is high frequency/low consequence and the other is low frequency/high consequence. Furthermore, a portfolio of risk mitigation activities prioritized to favor mitigating low frequency/very high consequence events would almost certainly not

[17] This table uses a single consequence dimension to simplify the computations in order to illustrate the conclusions, but the conclusions would remain unchanged for six consequence dimensions.

yield an optimal solution from a portfolio optimization standpoint of trying to achieve either lowest rate increase or highest aggregate (i.e. enterprise-wide) risk reduction, or some combination. Whether or not this suboptimal solution is an acceptable tradeoff from a rate case perspective is a policy question that does not have a right or wrong answer.

It is worth noting that adopting the downward-sloping risk tolerance limit lines in an ALARP framework would obviate the need to artificially boost the consequence term in the RET formula in order to emphasize high consequence events. An ALARP framework has emphasis on avoiding high consequence risks built into the risk tolerance limit lines. This is because the downward-sloping risk tolerance limit lines in ALARP place ever lower limits on risks as the consequences of risks increase.[18]

RIBA

RIBA is a risk scoring model applied to all risk mitigation programs and projects in the operational business lines. Its main purpose is to help prioritize (but not optimize) the portfolio of mitigation activities (programs and projects) at the enterprise-level investment planning sessions.

To help prioritize risk mitigation activities, RIBA uses the same risk calculation formula as RET. Whereas RET evaluates the risk for threats and failure scenarios, RIBA is applied to evaluate the risk for programs and projects designed to mitigate those threats and failure events. The frequency and impact components measure the frequency and impact of the underlying risks that the programs and projects are meant

[18] See Figures 3a, 3b, and Figure 5 in SED Staff White Paper on ALARP.

to mitigate. To accomplish this, RIBA uses three impact (or consequence) dimensions versus six in RET:

	RET	RIBA
Safety	x	x
Reliability	x	x
Environmental	x	x
Compliance	x	-
Trust	x	-
Financial	x	-

Whereas RET's outputs are mapped to a 7x7 matrix, RIBA has an additional gradation in the frequency level of 4.5 to result in an 8 x7 (frequency by consequence) matrix. Since RIBA uses the same RET formula, all the observations we made concerning RET applies to RIBA as well, namely, that the RIBA risk score is proportional to the expected annual frequency raised to the 1/4 power. The RIBA score is also proportional to the square root (i.e. raised to the ½ power) of the weighted sum of linear scale consequence values. Similarly, RIBA places emphasis on high consequence events and that RIBA could lead to prioritizing programs and projects with high consequence events ahead of other lower consequence events, even if a strictly frequency x consequence risk score might indicate otherwise.

Besides RET and RIBA, PG&E also relies on specific operational level programs to manage certain asset and operational risks. On the gas side, these include gas transmission integrity management program (TIMP) to management transmission and storage assets and gas distribution integrity management program (DIMP) to manage distribution assets to comply with gas safety codes. On the electric distribution and transmission side, there are Generation Risk Information Tool (GRIT) used to evaluate

risks associated with PG&E's hydroelectric assets and Electric Tool for Asset Risk (STAR) used for evaluating risks in PG&E's electric operations.

One way to look at these operational level special programs is that they help to manage risk components within an asset family for risk mitigation prioritization purposes. Whereas RET and RIBA are used to identify enterprise level risks and help prioritize risk mitigation activities at an enterprise level, operation-specific programs such as DIMP and TIMP help to identify, evaluate, and prioritize risks within the operational level. RET and particularly RIBA help to determine the scope and pace of risk mitigation activities and funding allocation at an enterprise level across lines of business and asset families. Once that RIBA process has been completed, the operational programs help to determine allocation of funding, to prioritize, and to determine the scope and pace of mitigation activities within the lines of business and asset families. There is two-way communication between the enterprise level risk management tools (RET and RIBA) and the operational risk management programs (TIMP, DIMP, GRIT, STAR, etc.) in that they act as input to the other and they influence the output of the other.

SCE's Risk Model and Decision Framework

Similar to PG&E, SCE's risk management framework is also based on an Enterprise Risk Management framework. SCE's ERM framework was derived primarily from the International Organization for Standardization (ISO) 31000 and, to a lesser extent, the Committee of Sponsoring Organizations of the Treadway Commission (COSO): 2004 Enterprise Risk Management.

SCE's ERM framework follows a six-step approach, which, according to SCE's testimony, corresponds to the Cycla 10-step process.

Table 4

SCE's ERM Framework	Cycla Process
1 - 2 Risk Identification / Risk Evaluation	1 Identify Threats
	2 Characterize Sources of Risk
3 Mitigation Identification	3 Indentify Candidate Risk Control Measures (RCMs)
4 Mitigation Evaluation	4 Evaluate the Anticipated Risk Reduction for Identified RCMs
	5 Detmine Resource Requirements for Identified RCMs
5 Risk-Informed Planning Approach (RIPA)	6 Select RCMs Considering Resource Requirements and Anticipated Risk Reduction
	7 Determine Total Resource Requirements for Selected RCMs
	8 Adjust the Set of RCMs to be Presented in GRC Considering Resource Constraints
	9 Adjust RCMs for Implementation following CPUC Decision on Allowed Resources
6 Monitoring & Reporting	10 Monitor the Effectivess of RCMs

Since SCE's risk model and risk calculation framework as presented in this application have only been recently developed, they are still evolving and have yet to be implemented.

SCE's risk model defines two groups of risks: asset-related risks and utility-wide risks. Asset-related risks are those that arise from physical assets and activities associated with the operation of the assets. Utility-wide risks arise from risks not associated with a particular asset, and include such risks as financial, economic risks, business model risks, legal and regulatory risks, compliance risks, and human resource risks.

SCE's risk identification approach revolves around the listing of risk statements. A risk statement identifies: a risk event (e.g., a pole failure), an outcome (e.g., a wildfire), and the impact of the outcome (e.g., safety). SCE uses a "Bowtie diagram" to map the progression of multiple risk drivers to eventual multiple impacts.

Figure 3

Bowtie Diagram

Since there could be multiple outcomes for each risk event, SCE calculates a risk score across five impact dimensions (safety, reliability, environmental, compliance, financial) for each outcome without applying any weights across the impact dimensions. The total risk score for the risk event is calculated as the simple, non-weighted sum for all the different outcomes resulting from that failure event. Since the risk contribution from all 5 impact dimensions are summed without applying weights, each of the five impact dimensions is effectively given equal weight.

SCE's also refers to its risk calculation formula as Risk Evaluation Tool (RET), but it differs from PG&E's RET formula.

SCE's RET formula for each impact dimension and each scenario is:

$$RS = TEF * CP * 10^{CI}$$

TEF is the trigger event frequency. TEF is the annual frequency of failure events described by the risk statement.

CP is the consequence percentage. It is defined as the percentage of trigger events that result in an adverse outcome across any of the 5 impact dimensions. The CP term appears in SCE risk formula but not in those of PG&E or Sempra.

CI is an integer logarithm-scale impact score across any of the 5 impact dimensions.

To aid comparison against PG&E's RET, we transform SCE's RET formula into a form similar to PG&E's RET formula. To accomplish this, we first substitute the following equation into the SCE's RET:

$C = 10^{\log(C)} = 10^{CI}$, where C is the linear-scale consequence value we previously defined in PG&E's RET.

With this substitution, SCE's RET formula for each scenario and each impact dimension can now be equivalently restated as:

RS = TEF * CP * C (Eq. 4)

Next we recognize that the product, TEF x CP, in SCE's RET formula can be treated as equivalent to the frequency term in PG&E's RET formula:

f = TEF x CP (Eq. 5)

Substituting Eq. 5 into Eq. 4 yields the familiar risk score formula:

RS = f x C for each scenarios and each impact dimension. (Eq. 6)

Since for each scenario, SCE's RET is to be summed over five impact dimensions, it can be equivalently restated as:

For each scenario, $\mathbf{RS = f_1C_1 + f_2C_2 + f_3C_3 + f_4C_4 + f_5C_5}$ (Eq. 7)

The total risk score for an asset (or operation) is the sum of all scenario risk scores for that asset or operation.

In Eq. 7, f_1 represents the frequency of only those trigger events that lead to a loss in the first impact dimension, etc. Consequence is the average per-event consequence taking into account only events that result in a loss.

Since SCE's RET formula is equivalent to the traditional risk formula (risk = f x C), the risk score it produces follows a linear scale. It is, however, not a true absolute risk score despite its linear scale and the f x C format because the impact dimension (consequence) scores are not all stated in a common unit of measurement. There is an

"apples plus oranges" effect in the risk score calculations. We, therefore, describe SCE's RET formula as a quasi-absolute risk score formula.

However, these quasi-absolute risk scores have little, if any, direct-physical interpretation in the real world. The first reason is that the different impact dimension scores that go into the risk score calculations are simply added together without any conversion into a common unit of measurement. This results in the aforementioned apples plus oranges effect of mixing non-comparable units. The second reason is that the logarithm-scale impact (consequence) index scores estimated by SMEs are not based on any uniform calibration standard that anyone else outside of SCE can relate to. For these two reasons, the quasi-absolute risk scores, though they have the appearance of being absolute and being on a linear scale, do not have the physical interpretation that truly absolute risk scores have.

An alternative way to manipulate SCE's original RET formula is to combine the CP term with C (instead of combining the CP term with the trigger event frequency, TEF) to form a new consequence variable, lower case c, i.e. c = CP x C. This lower case c would then be equivalent to the consequence term C in PG&E's RET. If we took this approach, SCE's RET formula could be cast into this equivalent form:

$$\mathbf{RS = f \times (c_1 + c_2 + c_3 + c_4 + c_5)} \qquad \text{(Eq. 8)}$$

In this formula, f represents the frequency of **all** trigger events, whether or not they lead to a consequence with a loss. Lower case c represents the average consequence for **all** trigger events whether or not a trigger event leads to an actual loss.

For simplicity when comparing SCE's model with PG&E's and Sempra's formulas, we will not use the alternative form in Eq. 8 and will use Eq. 7, instead. A comparison using Eq. 8 would be equally valid as one using Eq. 7 and would result in identical observations so long as we keep track of the nuances in the definitions of the various variables in the equations.

Risk Spend Efficiency

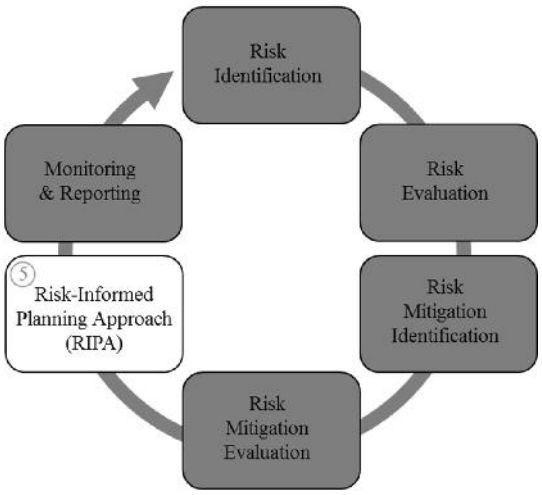
Alone among the utilities, SCE calculates a quantity known as *Risk Spend Efficiency* (RSE) for each program or project. It is defined as risk reduction (difference between pre-mitigation and post-mitigation risk scores) divided by the cost of the risk mitigation program or project. Programs and projects are prioritized by the risk spend efficiency numbers, subject to various operational constraints, and other non-risk considerations.

Since, as we pointed out, the quasi-absolute risk scores have little to no direct physical interpretation in the real world, the relative risk spend efficiency scores likewise have little to no direct physical interpretation. The RSE scores could, however, be very useful within SCE to inform decisions on mitigation activities. As part of its evolving risk-based planning approach, SCE intends to prioritize mitigation spending by taking Risk Spend Efficiency into consideration. We caution, however, that prioritizing a portfolio based on cost-effectiveness measures, such as the RSE, is not the same as choosing an optimal mix of mitigation activities based on some rigorous optimization routines. One in fact would expect that the results obtained by the two methods would not usually coincide. The information given by the risk spend efficiency calculations could be useful but the limitations should be recognized.

Risk-Informed Planning Approach (RIPA)

SCE is developing a Risk-Informed Planning Approach (RIPA) to manage its enterprise level risks. The objective of RIPA is to explicitly incorporate knowledge about risks into planning decisions. RIPA fits in SCE's overall enterprise risk management process as the fifth step as shown in the following diagram:

Figure 4



RIPA uses input from risk scores and risk spend efficiency scores to inform decisions to prioritize mitigation programs and projects. Since RIPA is an enterprise-wide tool, its use requires calibration across the whole enterprise to ensure common understanding and evaluation of different risks. SCE plans to pilot the RIPA process in the T&D operating unit over the next rate case cycle.

Sempra's Risk Model and Decision Framework

Similar to PG&E and SCE, Sempra's risk management framework is also based on an Enterprise Risk Management framework that closely follows the ISO 31000

standards. The two Sempra utilities, SoCalGas and SDG&E, share the same basic approach to evaluating enterprise risks and have the same risk-based decision framework.

Sempra continues to develop and evolve its risk model and risk calculation framework. In the near term Sempra intends to further develop its *qualitative* risk assessment processes, and in the long term it plans to achieve *quantitative* methods. It uses subject matter expertise that has been calibrated to fit its risk analyses and validates that expertise through supporting data.

Similar to SCE, Sempra has mapped its risk management steps to the Cycla 10-step process.[19]

Table 5

Cycla Model	Corresponding Step in SoCalGas and SDG&E's Risk Management Process
1. Identify Threats	1. Risk Identification
2. Characterize Sources of Risk 3. Identify Candidate Risk Control Measures (RCMs)	2. Risk Analysis
4. Evaluate the Anticipated Risk Reduction for Identified RCMs	3. Risk Evaluation
5. Determine Resource Requirements for Identified RCMs 6. Select RCMs Considering Resource Requirements and Anticipated Risk Reduction	4. Risk Mitigation Plan Development and Documentation
7. Determine Total Resource Requirement for Selected RCMs 8. Adjust the Set of RCMs to be Presented in GRC Considering Resource Constraints 9. Adjust RCMs for Implementation following CPUC Decision on Allowed Resources	5. Risk-Informed Investment Decisions and Risk Mitigation Implementation
10. Monitor the Effectiveness of RCMs	6. Monitoring and Review

[19] From p.4 of Sempra's PowerPoint presentation during S-MAP workshop #1 on August 3, 2015.

Sempra's risk evaluation tool is also referred to as RET, but it, too, is different from PG&E's formula. Sempra's RET formula is stated as:

$$\text{Risk score} = \sum_{i=1}^{n} weight_i * frequency_i * 10^{impact_i}$$

In this formula, $impact_i$ is a logarithm-scale whole integer (1 to 7) index score of impact (consequence).

Frequency follows a linear scale and is not modified by a logarithmic function. Sempra's model chooses a fixed point from each of the seven log-scale ranges of frequency to represent a frequency within a frequency range.

Sempra's risk model has four impact dimensions: safety, reliability, environment, financial. The safety impact dimension score receives a 40% weight. The remaining reliability, environment, and financial impact scores each receive a 20% weight.

Whereas PG&E and SCE have distinct impact dimensions for safety and environment, Sempra takes a different approach by putting any impact touching "health, safety, and environment" under an overarching Safety dimension. Therefore, Sempra's definition for the safety dimension is more inclusive but less completely oriented to safety. A case could be made that Sempra's approach more fully captures safety because health, safety, and environmental quality are all tied together and all three parts affect safety. A case could also be made that Sempra's approach diffuses the understanding of safety by including other characteristics. It is this overall safety impact dimension that receives a 40% weight in the total risk score. Regarding commonalities among the three utilities, this difference in categories is something to watch as the models evolve.

Sempra has recently communicated to SED that, similar to what PG&E does in its RIBA process, Sempra is also developing a process to evaluate risk scores for the risk mitigation programs and projects. The work-product for this development will not appear in this first S-MAP but will likely appear in future S-MAPs and may possibly even appear in Sempra's upcoming general rate case application.

SDG&E's top risks for its gas line of business are as follows:

- Catastrophic damage involving gas infrastructure (dig-ins)
- Catastrophic damage involving gas transmission pipeline failure
- Catastrophic damage involving medium and non-Department of Transportation pipeline failure

SoCalGas' top risks are as follows:

- Catastrophic damage involving gas infrastructure (dig-ins)
- Catastrophic damage involving gas transmission pipeline failure
- Catastrophic damage involving medium and non-Department of Transportation pipeline failure
- Catastrophic event related to storage well integrity
- Physical security of critical infrastructure

SDG&E's top risks for its electric line of business are as follows:

- Wildfires caused by SDG&E equipment (including 3rd party pole attachments)
- Distributed energy resources (DERs) safety and operational concerns
- Major disturbance to electrical services (e.g. blackout)
- Fail to black start

- Unmanned aircraft system incident
- Public safety events – electric
- Electric infrastructure integrity

Sempra also has cross-cutting risks common to both SDG&E and SoCalGas, as follows:

- Employee, contractor, and public safety
- Cybersecurity
- Workplace violence
- Records management
- Workforce planning
- Climate change adaptation
- Aviation incident

Sempra's top identified risk is wildfires linked to utility infrastructure (such as downed poles, wire contact with trees, or sparks from equipment, etc.). As a result, Sempra has developed an extensive software-based model and cultivated new sources of data including items such as wind patterns to assess and mitigate this risk. This software model is distinct from the risk assessment model presented above, which is parallel to those of the other utilities. Called Fire Risk Mitigation (FiRM), the model is a unique aspect of Sempra's approach. Sempra also has a related Wildfire Risk Reduction Model (WRRM), which the utility launched in 2013, and which performs computer simulations.

Sempra has recently stated that it is developing a risk spend efficiency calculation, and is attempting to move that tool forward in ways that none of the utilities have been able to yet. Its calculation will be a pilot, and will be expected to go

through iterations before becoming mature. SED plans to watch that calculation develop, but does not yet know to what extent it will succeed.

SED does not know what eventual form Sempra's risk spend efficiency will take, but our earlier caution regarding SCE's strategy to prioritize mitigation activities based on cost effectiveness measures alone being unlikely to yield an optimized mix also applies to Sempra's attempt to develop its own risk spend efficiency. So long as Sempra and other stakeholders recognize the limitation of cost effectiveness measures, risk efficiency measures could provide useful information to rate case proceedings.

Comparison of Risk Model Formulas

Having described all the utilities' risk score formulas, we can now list all the RET formulas at once to compare them. First we list the RET models in their original forms as presented by the utilities in their S-MAP applications:

PG&E: $$RS_{(Event)} = k^{[0.5\ \mathrm{Log}(f_{(Event)}) + I_{(Event)}]}$$

SCE: $$RS = TEF * CP * 10^{CI}$$

Sempra: $$\text{Risk score} = \sum_{i=1}^{n} weight_i * frequency_i * 10^{impact_i}$$

The above RET formulas in their original forms use different terms and different definitions and are clearly not conducive to easy comparison. To facilitate comparison

across the three models by using the same definitions of linear-scale f (frequency) and linear-scale C (consequence), we restate them in the modified equivalent forms we showed earlier:

Table 6: Modified Equivalent RET Formulas

PG&E: $\mathbf{RS = f^{(1/4)} \times [W_1C_1 + W_2C_2 + W_3C_3 + W_4C_4 + W_5C_5 + W_6C_6]^{(1/2)}}$

SCE: $\mathbf{RS = f_1C_1 + f_2C_2 + f_3C_3 + f_4C_4 + f_5C_5}$ for each scenario

Total RS = sum of all scenario risk scores

Sempra: $\mathbf{RS = W_1f_1C_1 + W_2f_2C_2 + W_3f_3C_3 + W_4f_4C_4}$

It should be pointed out that even though the terms f and C in the three formulas share the same meaning of frequency and consequence, the suffixes (1, 2, 3, 4, etc.) may refer to different dimensions across the formulas. For example, $\mathbf{W_3}$ in PG&E's formula is not the same as $\mathbf{W_3}$ in Sempra's formula, even though both terms have the same suffix 3. SCE's C_1 is not necessarily the same as the C_1 term in Sempra's or PG&E's formulas. $\mathbf{f_4}$ in SCE's formula is not the same as $\mathbf{f_4}$ in Sempra's formula, etc.

Observations on Risk Evaluation Formulas

The three models yield scores that are not comparable. PG&E's RET is a relative risk model that emphasizes high consequence events. Although SCE's and Sempra's models follow the traditional absolute risk formula (i.e. R = f x C), the scores they yield are also not comparable because the impact dimensions are different and the weights are also different. Additionally, SCE's model sums individual scenario risk scores over

multiple failure scenarios for the same asset or same incorrect operation, whereas Sempra's and also PG&E's RET are calculated for only one scenario at a time. SCE's RET simply sums the contributions to the total risk score from all impact dimensions, whereas PG&E and Sempra apply percentage weights to the impact dimension sub-scores before summation. All three models map their risk scores to a 7 x 7 log-scale matrix.

SCE's model uses the CP (consequence percentage) factor to denote the percentage of failure events that actually leads to safety related results. SCE's current model assumes that the CP stays the same both before and after mitigation. In reality, mitigation could, and probably would, reduce the consequence percentage of trigger events.

The similarities and differences among the utilities' risk evaluation models and risk management frameworks are summarized in the table below:

Table 7

Table of Comparison

Comparison of Risk Evaluation Formulas and Risk Frameworks			
	PG&E	SCE	Sempra
Risk Management Framework			
Risk framework based on Enterprise Risk Management	yes	yes	yes
impact dimensions consider shareholder interests and/or financial performance	yes	yes	yes
Input Type			
predominantly SME-estimated inputs	yes	yes	yes
Indexing method on frequency score selection(whole integer-only inputs, 1 to 7)	partially yes, but allows for override with actual frequency	no, uses continuous, linear-scale frequency	yes
Indexing method on consequence score selections (whole integer-only log-scale inputs, 1 to 7)	yes	yes	yes
Frequency			
number of frequency levels	7	7	7
representative position within log-scale frequency range	right hand of range	not applicable, uses linear scale frequency	fixed point value from each range
allows for actual frequency data input where available	yes	no	no
model specifically considers asset condition on a per-asset element basis when determining frequency	no	no	no
Consequence			
consequence evaluation standard	based on P95 (95th percentile) "probably worst case outcome"	based on "worst reasonable direct impact"	not specified
number of impact (consequence) dimensions	6	5	4
number of levels per impact dimension	7	7	7
uses weights on impact dimensions	yes	no	yes
impact (consequence) dimensions and weights	safety(30%), reliability(25%), environment(5%), compliance(5%), trust(5%), financial(30%)	safety, reliability, environment, compliance, financial, (not weighted, risk scores only summed)	safety(40%), reliability(20%), compliance(20%), financial(20%)
Risk Scores			
linear scale risk score?	no	yes	yes
relative or absolute risk score	relative	quasi-absolute	quasi-absolute
consequence scenarios in risk score	single scenario	multiple scenarios	single scenario
risk formula emphasizes high consequence events	yes	no	no
Other Areas			
takes into account threat interactions and their effects on frequency, impact, and impact dimensions	no	no	no
takes into account mitigation overlaps on different risks and resulting synergies	no	no	no
Risk framework calculates risk scores for programs and projects	yes	no	under consideration and possible development

Commonalities

Decision 14-12-025 stated, "…a goal of the S-MAP proceedings is to determine whether uniform and common standards can be developed for assessing, managing, mitigating, and minimizing the risks inherent in each energy utility's operations and services."[20] During the third workshop of the S-MAP proceeding, SED asked the utilities to meet to find areas of commonality among their models.

The utilities held a two-day meeting on October 29 and 30, 2015, at SDG&E's Century Park offices to discuss commonalities. The utilities discussed the frameworks used by each utility to assess and mitigate risks, and discussed areas where common approaches were attainable. Risk scoring algorithms were also discussed. A second session was held at PG&E's San Francisco offices on November 6, 2015, to review and discuss the risk scoring algorithms. After the November 6 meeting, each company analyzed how the adoption of a common algorithm might affect its individual risk prioritizations.

These discussions resulted in a "Combined Utilities S-MAP Uniformity Report" (Uniformity Report) presented by the utilities during the fourth S-MAP workshop.[21] Comments were also filed by the parties in response to the Uniformity Report and presentation on commonalities. The meetings among the utilities resulted in some movement toward standardization of the models, but also clarified some differences between the utility models that the utilities believe should remain. The Paper characterizes the changes the utilities can make in their models to move toward commonality, and the differences that the utilities plan to retain. SED believes that this

[20] D. 14-12-025 at 51.
[21] *Combined Utilities S-MAP Uniformity Report*, December 4, 2015

exercise brought increased clarity to the proceeding and the parties, and can serve as a step in a long-term process of improving risk assessment models and optimizing mitigations.

The utilities found one area of commonality that they considered obvious. It was the use of ISO 31000 risk management and ISO 55000 asset management criteria. The utilities also found several areas where the workshop discussions led to additional agreement on uniformity, and where they changed their methods to make them more common. These were:

- Common use of the Cycla process
- Common use of the 7x7 matrices for ranking risks
- Common use of the impact level descriptors on the 7x7 matrices
- Common use of the impact categories on the 7x7 matrices
- Common use of the likelihood level descriptors on the 7x7 matrices
- Common use of the likelihood criteria on the 7x7 matrices
- Common use of impact criteria on the 7x7 matrices
- 7x7 matrix impact vs. likelihood absolute vs. continuous values

SED agrees with the Combined Utilities that these should be adopted as common elements.

The utilities also found areas of uniqueness, on which they did not adapt their models toward commonalities. These were:

- The risk scoring algorithm
- Tools and methods to score risk categories

SED disagrees with the utilities on this. SED believes that a common risk scoring algorithm should be adopted, although not necessarily in this first S-MAP. It is definitely something that should be considered for either the next S-MAP or Phase 2 of the first S-MAP.

The utilities also laid out areas for future consideration. These are:

- Risk tolerance
- Risk reduction benefit per dollar invested
- Risk taxonomy

SED believes that risk tolerance standards should be considered by the Commission as soon as possible. On the question of whether there can be a common method to calculate risk reduction per dollar invested, the question boils down to whether there is common linear-scale risk formula that can be adopted. PG&E's RET formula does not lend itself to calculating risk reduction per dollar invested. SED believes that risk taxonomy can be considered in the first S-MAP.

One of the primary goals of the S-MAP process is to identify areas of commonality in the risk evaluation models and risk management frameworks. There is much value in having a high degree of commonality. In SED's opinion, more can be made common than expressed by the utilities in their Uniformity Report. For example, there is no unique geographical or operational reason why high consequence events are more important to PG&E than they are to SCE or Sempra. Consideration of high consequence events may be desirable, but it is counterbalanced by the distortion to human perception it creates to produce a non-linear-scale risk score formula. Any distortion in a risk evaluation formula renders the entire risk-based decision process less transparent. For this reason, SED recommends against applying exponential

powers to either the frequency or consequence terms in the risk formulas. Instead, SED recommends that downward sloping risk tolerance lines be adopted as discussed earlier to force decreasing tolerance for high consequence risks.

Likewise, the Commission could decide whether a single scenario (PG&E's and Sempra's approach) or multiple scenarios (SCE's approach) should be used to evaluate risk scores. The problem with the multiple scenario approach is that the resultant total risk score of all scenarios is influenced by the various scenarios that an SME can foresee. An imaginative SME could foresee more failure scenarios than one who is less imaginative.

Alternative Approaches

Two alternative risk management approaches were introduced into this first S-MAP proceeding. First, SED staff introduced an As Low As Reasonably Practicable (ALARP) white paper to address the lack of risk tolerance standards and the lack of a formal decision structure to decide when and to what extent mitigation activities must continue in a resource-constrained environment.[22] Subsequently, the Joint Intervenors (TURN, IS/EPUC) also introduced a white paper authored by their two consultants on an alternative methodology to evaluate and rank risks in a more intuitively understandable and transparent fashion.[23] Both alternative approaches mention

[22] *Safety and Enforcement Division Staff White Paper on As Low As Reasonably Practicable (ALARP) Risk-informed Decision Framework Applied to Public Utility Safety*, by Steven Haine, P.E., dated December 24, 2015. The ALARP white paper was entered into the record for the S-MAP proceeding by ALJ Ruling on December 28, 2015: http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M157/K359/157359431.PDF

[23] *Intervenor Perspective Regarding an Improved Methodology to Promote Safety and Reliability of Electric and Natural Gas Service in California*, prepared for the S-MAP Workshop January 25, 2016, by Charles D. Feinstein, Ph.D. and Jonathan A. Lesser Ph.D. on behalf of The Utility Reform Network/Indicated Shippers/Energy Producers and Users Coalition, revised January 28, 2016. This intervenors' white paper was entered into the record for the

optimization of the portfolio of mitigation activities as a necessary end goal. These two alternative approaches are compatible with each other in that they both deal with different aspects of risk management approaches.

Parties were given the opportunity to file formal comments on the ALARP white paper pursuant to Administrative Law Judge (ALJ) ruling on December 28, 2015.[24] Parties were also given the opportunity to file formal comments and reply comments on the Joint Intervenors' alternative approach pursuant to ALJ ruling on January 29, 2016.[25] The Commission is still reviewing these two proposed alternative approaches and parties' comments on them. The Commission will make any recommendations on these two alternative approaches in a proposed decision.

Brief Description of ALARP Approach

ALARP is a systematic risk-informed decision framework used to decide whether risk mitigation is needed and, when it is needed, how much should be spent until the mitigation costs are deemed to be grossly disproportionate relative to the benefits. It is a framework used to address the tradeoff between safety and utility rate affordability.

There are three essential components in a full ALARP framework:

1. The upper and lower risk tolerance limit lines define three regions: the intolerable region, the ALARP region, and the broadly acceptable region.
2. The cost/benefit gross disproportionality ratio.

S-MAP proceeding by ALJ Ruling on January 29, 2016:
http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M157/K902/157902630.PDF

[24] http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M157/K359/157359431.PDF

[25] http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M157/K902/157902742.PDF

3. "FN" curves (also known as loss exceedance curves).

For a full ALARP framework to work, all three components have to be present. Both the risk tolerance limit lines and the disproportionality ratio have to be established by regulatory action. However, the risk tolerance limit lines and the gross disproportionality ratio can be adopted separately or together. If only one component was adopted (i.e. either risk tolerance limits or gross disproportionality ratio), either component could still find application in the S-MAP proceeding outside of the ALARP framework.

The ALARP framework relies on external optimization routines to produce an optimal mix of risk mitigation activities.

Pros of ALARP Framework

1. It forces recognition of tradeoff between safety and rate affordability.
2. It treats tradeoff between safety and rate affordability in an explicit way.
3. It forces explicit recognition of risk tolerance.
4. The downward sloping risk tolerance limit lines automatically reduce tolerance for high risks (including both high consequence risks and high frequency risks) as the risk value increases, without needing to artificially boost only the consequence term in the risk evaluation formula.

Cons of ALARP Framework

1. A full ALARP framework relies on building probabilistic models to construct the loss exceedance curves (but a partial ALARP approach can make use of the risk tolerance limits and/or the disproportionality ratio without involving probabilistic models).

2. A full ALARP framework relies on explicit estimation of the value of statistical live (VSL).
3. It relies on explicit statements of risk tolerance.

Brief Description of Joint Intervenors' Approach

The Joint Intervenors' (JI) proposed approach is rooted in the desire to promote a more transparent and more intuitive process to evaluate risks. The process defines risk on the linear scale as risk = Likelihood of failure x consequence of failure, or **Risk = LoF x CoF**. A risk score produced by this equation produces a unit-less risk value that has a linear scale but does not otherwise have a direct physical interpretation in the real world.

LoF is defined as the likelihood (between 0 and 1) of failure within some specified time frame (usually one year). The process relies on subject matter experts (SMEs) to provide an estimated probability (likelihood) of failure of an asset based on the observed or estimated condition of the asset in question. The authors refer to a LoF obtained in this fashion as a condition-dependent hazard rate.

CoF is the obtained by using a multi-attribute utility function. "Attributes" are synonymous with "impact dimensions" in the utilities' risk models. The scoring process and scoring scale are, however, different between the utilities' approach and the JI approach. In the JI approach, upper and lower impact bounds are first defined. The upper and lower bounds set the corresponding 100% to 0% scale on the impact dimension score. For each asset element, SMEs are then used to estimate an impact score (between 0 and 100) for that attribute. This is done for all attributes. Weights are

then applied to all attribute scores obtained in this fashion and summed to produce the CoF. The JI paper pointed out that weights need to be carefully selected.

Risk scores are then calculated using the risk = LoF x CoF formula. Risk score is calculated for both before and risk mitigation. For all the identified risks in a utility's risk register, risk scores are calculated for both before and after mitigation. Using some optimization routine subject to various constraints, an optimal mix of risk mitigation activities could then theoretically be produced.

It is important to point out that the JI approach deals with a different way of calculating LoF and CoF, but the JI approach by itself is not an optimization technique. Rather, it relies on other external optimization techniques to produce an optimal portfolio.

Pros of Joint Intervenors' Approach

1. It allows for SME input to fill in the gap where data are missing.
2. It is relatively easier to understand and apply than the utilities' approaches.
3. Everything (LoF, CoF, and risk score) is based on a linear scale mapped and bounded by limits that people can relate to: LoF is between 0 and 1, attribute scores are between 0 and 100.
4. It does not involve building probabilistic functions, although it may be possible to do so if sufficient data are available to support building a probabilistic model.

Cons of Joint Intervenors' Approach

1. It relies heavily on SMEs to produce the LoF and CoF estimates.
2. The risk scores are not absolute risk scores, although they may relate to absolute risk scores in a linear fashion. The approach creates dimensionless risk unit scores that cannot be compared across utilities. A reduction of 10 risk units at one utility does not have the same meaning as the same reduction in 10 risk units at another utility.
3. Just like the utilities' models, the JI approach does not normalize or adjust to account for different utility sizes.
4. The process of computing weights involving safety impacts often indirectly estimates the value of a statistical life (VSL).

The following table adds an extra column to Table 7 to compare the Joint Intervenors' approach to the utilities' models.

Table 7a:

Table of Comparison including Joint Intervenors' Model

Comparison of Risk Evaluation Formulas and Risk Frameworks				
	PG&E	SCE	Sempra	Joint Intervenors
Risk Management Framework				
Risk framework based on Enterprise Risk Management	yes	yes	yes	not applicable
impact dimensions consider shareholder interests and/or financial performance	yes	yes	yes	not specified
Input Type				
predominantly SME-estimated inputs	yes	yes	yes	yes
Indexing method on frequency score selection(whole integer-only inputs, 1 to 7)	partially yes, but allows for override with actual frequency	no, uses continuous, linear-scale frequency	yes	no
Indexing method on consequence score selections (whole integer-only log-scale inputs, 1 to 7)	yes	yes	yes	no
Frequency				
number of frequency levels	7	7	7	model uses likelihood or probability
representative position within log-scale frequency range	right hand of range	not applicable, uses linear scale frequency	fixed point value from each range	model uses likelihood or probability
allows for actual frequency data input where available	yes	no	no	model uses likelihood or probability
model specifically considers asset condition on a per-asset element basis when determining frequency	no	no	no	yes
Consequence				
consequence evaluation standard	based on P95 (95th percentile) "probably worst case outcome"	based on "worst reasonable direct impact"	not specified	not specified
number of impact (consequence) dimensions	6	5	4	not specified
number of levels per impact dimension	7	7	7	not specified
uses weights on impact dimensions	yes	no	yes	yes
impact (consequence) dimensions and weights	safety(30%), reliability(25%), environment(5%), compliance(5%), trust(5%), financial(30%)	safety, reliability, environment, compliance, financial, (not weighted, risk scores only summed)	safety(40%), reliability(20%), compliance(20%), financial(20%)	Joint Intervenors advocate analytically derived weights to be uniformally imposed by the Commission
Risk Scores				
linear scale risk score?	no	yes	yes	yes
relative or absolute risk score	relative	quasi-absolute	quasi-absolute	quasi-absolute
consequence scenarios in risk score	single scenario	multiple scenarios	single scenario	single scenario
risk formula emphasizes high consequence events	yes	no	no	no
Other Areas				
takes into account threat interactions and their effects on frequency, impact, and impact dimensions	no	no	no	no
takes into account mitigation overlaps on different risks and resulting synergies	no	no	no	no
Risk framework calculates risk scores for programs and projects	yes	no	under consideration and possible development	not applicable

SED Observations

ALARP and the JI approaches address different deficiencies in the utilities' models. The JI approach could be a useful alternative in the immediate future while the utilities' models are still mostly SME-based. As the utilities' models gain maturity in the future and develop more frequent use of probabilistic models, the JI approach would become less relevant. Likewise, as the utilities' models mature in the future, the use of an ALARP approach would become increasingly feasible and relevant. Full implementation of ALARP is infeasible at this time due to the lack of fully probabilistic models. However, the risk tolerance limits (and also tolerance bands) and the gross disproportionality concepts in the ALARP approach do not conflict with JI approach. The risk tolerance bands and disproportionality concepts can be concurrently incorporated in the JI framework.

RAMP Guidance

The process and guidance for the Risk Assessment Mitigation Phase (RAMP) are part of the *Rulemaking Incorporating a Risk-Based Decision-Making Framework into the General Rate Case Plan*, R.13-11-006. In particular, Decision 14-12-025 of that rulemaking provides guidance for assessing risk and mitigating risk in future General Rate Cases.

Because of the timing of GRC filings under the new Framework, the first utilities to develop a RAMP filing will be San Diego Gas & Electric and Southern California Gas Company (a.k.a. Sempra Utilities) in fall 2016. Aside from addressing expectations for the RAMP as part of the S-MAP workshops, CPUC Staff from SED and the Energy Division have met with Sempra representatives to discuss how they intend to structure the RAMP filing for the next GRC. Some of the sections below reflect the attempt to achieve alignment between the guidance that was established in the Risk OIR and the utilities' filings. Final determinations of RAMP guidance are, of course, subject to Commission decisions in this proceeding and potential direction from an assigned Administrative Law Judge and/or Commissioner's Office when the RAMP is initiated as described below.

The early thinking that shaped the RAMP can be found in a straw proposal for R.13-11-006. However, that thinking has evolved considerably, and a second, more refined straw proposal advanced and clarified the guidance later in the proceeding. The refined straw proposal helped to shape D.14-12-025. When looking for guidance on the RAMP, D.14-12-025 is the place to look.

Decision 14-12-025 determined that it was "premature at this time to decide whether a specific risk approach, model or methodology should be adopted for use in the S-MAP and RAMP process."[26] Instead the Decision directed the S-MAP proceeding to establish the appropriate approach to risk assessment and mitigation. The Decision also specified that subsequent RAMP filings by the utilities would be reviewed for "consistency and compliance."[27]

Therefore, pursuant to D.14-12-025, the purpose of each RAMP filing will be to review the utility's RAMP submission for consistency and compliance with its prior S-MAP. The purpose will also be to determine whether the elements contained in the RAMP submission can be used in the utility's GRC filing to support its position on the assessment of its safety risks and its plans to mitigate those risks.[28] As a result of the RAMP filing, Commission staff, as well as other parties, will have an "opportunity to understand the analysis, data and assumptions underlying the utility's presentation and to present a response to the utility's presentation."[29]

The RAMP filing will describe how the utility has assessed the most effective ways to use its budget and its expertise to mitigate risks to make California safer. It will give insight into the upcoming General Rate Case process where that budgeting will take place. The RAMP filing will lay out the utility's goals for improving safety, the priorities it has chosen, and the costs of the steps that the utility plans to take.

The RAMP filing was discussed by the parties in S-MAP workshop #3, on October 6, 2015, and briefly in S-MAP workshop #4, on December 4, 2015. The RAMP

[26] D.14-12-025, Findings of Fact, 23.
[27] D.14-12-025, Findings of Fact, 26.
[28] D.14-12-025, Findings of Fact, 26.
[29] D.14-12-025, pp. 11-12.

filings also relate to other S-MAP documents such as the two accountability reports, one on spending that will be reviewed by the Commission's Energy Division and one on mitigation that will be reviewed by the Commission's Safety and Enforcement Division. Decision 14-12-025 states:

> "After a decision is rendered on the Safety Model Assessment Proceeding … [the utilities] shall send a letter, as described in this decision, to the Executive Director requesting that an Order Instituting Investigation (OII) be opened in the utility's respective upcoming General Rate Case application filing, and file and serve their respective Risk Assessment and Mitigation Phase submission by November 30 of the year preceding its next General Rate Case application filing in the newly opened OII."[30]

Content of the RAMP Filing per D.14-12-025

The refined straw proposal referenced in D.14-12-025 described the recommended content of the RAMP filing. It shall contain:

- The utility's prioritization of the risks it believes it is facing and a description of the methodology used to determine these risks.
- A description of the controls currently in place as well as the "baseline" costs associated with the current controls.
- The utility's prioritization of risk mitigation alternatives, in light of estimated mitigation costs in relation to risk mitigation benefits (Risk Mitigated to Cost Ratio).

[30] D.14-12.025, Ordering Paragraph 6.

- The utility's risk mitigation plan, including an explanation of how the plan takes into account: utility financial constraints; execution feasibility; affordability impacts; and any other constraints identified by the utility.
- For comparison purposes, at least two other alternative mitigation plans the utility considered and an explanation of why the utility views these plans as inferior to the proposed plan.

The straw proposal recommended that RAMP filings provide an evaluation of each utility's top 10 asset risks. But D.14-12-025 extends the filing:

> "Limiting the utility's RAMP submission to just 10 asset categories may prevent the Commission and interested parties from having a comprehensive view of the utilities potential safety risks, and its plans for addressing those risks," it states. "Since the RAMP will provide the first opportunity for parties to see how the utility prioritizes safety in terms of its assets and operations, the RAMP should not be limited to a maximum of 10 asset categories. Accordingly, the utility's RAMP submission shall include *all of its risk assessments and mitigation plans*." [emphasis added][31]

SED has held five workshops with the Parties to the S-MAP proceeding. In those workshops a consensus emerged that while ten risks are too few to include in the RAMP filings, trying to include all risks may not be practical. SED has heard proposals from the Parties on how many risks should be included in the RAMP filings. Current thinking is that for S-MAP #1, risks that score a 4 or above on the utilities' 7x7 risk

[31] D.14-12-025, pp. 39-40.

scoring matrices may be the ones to include in the RAMP filing — but this remains a topic under consideration. Whatever level is selected for S-MAP #1, that level may be reconsidered during S-MAP #2 or #3.

Content of the SED Report per D.14-12-025

After the RAMP filing is made, a public workshop will be hosted by the utility and Commission staff to provide an overview of the utility's RAMP submission. This will then be followed by an SED staff report on the utility's RAMP submission. The objective of this staff report is to evaluate the utility's risk assessment procedures, and to assess the technical merits of the utility's proposal. Instead of SED preparing both a draft report and final report, SED is directed only to issue and file a single report. D.14-12-025 does not adopt a proposal that the SED report on the utility's RAMP submission be included as part of the utility's GRC filing submission.

The SED report will address the following:

- Is the proposal complete – *i.e.*, does the utility's proposal address the top risks as identified by the utility?
- Does the utility's proposal meet the overall intents of the RAMP process?
- Are there any significant risks that have been missed in the proposal?
- Are there reasonable mitigation options that have not been examined?
- Are the proposed risk mitigations the most cost-effective methods for reducing the identified risks? That is, are there any proposed programs that are clearly less cost-effective than possible alternative programs?

- Do the proposed programs and alternatives represent a realistic set of options given the current condition of the installed assets, best practices for management of those types of assets, and the identified risks?
- Are the proposed risk mitigation programs in line with stakeholder preferences?

Regarding the issue of whether SED should have a witness to sponsor and testify about the staff report if hearings are held in the RAMP application, the Decision says:

> "That issue should be left to the RAMP proceeding to decide. In considering how the SED staff report is to be used, the due process rights of the parties should be preserved. Other parties will then be given the opportunity to comment on the utility's RAMP submission, and the SED staff report. This could then be followed by additional workshops to discuss all of these RAMP-related items. Since no decision is to be issued in connection with the RAMP filing, no evidentiary hearings will be held in the RAMP process."[32]

The Decision adds:

> "We conclude that today's decision, which describes and adopts the parameters of the S-MAP and RAMP processes, does not prevent the assigned ALJs in either the consolidated S-MAP applications, or in the RAMP proceedings, from taking any other

[32] D.14-12-025, p. 39.

action to adjudicate the S-MAP application or the RAMP application process."[33]

The Utilities Should Explain Their Approaches to Risk Assessment in RAMP Filings

For their RAMP filings, the utilities will make choices about how many risks to include and how to select those risks. The utilities should explain, in narrative form and with charts, how and why they made the choices that they did. For example, if a utility includes all items of level four or above on its 7x7 risk matrix in its RAMP filing, then the utility should explain why four is the optimal level. If the utility takes those risks of "consequence" level four or above but does not also include the "frequency" category, then the utility should explain in narrative why the result is optimized through that method and not through a different method. If the utility blends the "consequence" and "frequency" categories, with or without a greater weight on one or the other, then the utility should explain why it chose that approach. If the utility uses the result of its risk score algorithm to rank its top risks, then it should describe that choice.

The goal of the S-MAP proceeding is to make California safer by explicit identification and prioritization of the mitigations that can enhance safety. The utility should therefore show in its RAMP filing how it is accomplishing the goal of the S-MAP proceeding. The RAMP filing is an opportunity for the utilities to improve their methods for assessing and mitigating risk. It is also a way for the utilities to demonstrate new methods to better calculate and identify risk — and to mitigate risk more effectively. The utilities should use the RAMP filings as opportunities to clearly identify the most effective ways to achieve these goals and should communicate that understanding to all parties *so that others can adopt the best practices that result*.

[33] D.14-12-025, p. 43.

California's utilities have attempted to develop "risk-spend efficiency" calculations that can compare the costs and benefits of particular mitigations. These calculations have posed a challenge, and the utilities and other parties have not always agreed among themselves on what methods are most useful for calculating risk-spend efficiency. Nevertheless, understanding the costs of mitigations is an important part of the proceeding and an important step toward the General Rate Cases. The utilities should include risk-spend efficiency calculations in their RAMP filings, even if those calculations are imperfect. It may take iterations over multiple cycles to refine those calculations, but by starting now California can benefit in the future. This guidance is for S-MAP #1. By S-MAP #2 or S-MAP #3 these risk-spend efficiency calculations may arrive at the desired state. If a utility develops a different method to calculate and optimize its spending for mitigations, then the utility should describe that method in its RAMP filing for the Commission to understand and for other parties to see.

How the Utilities Can Show Progress toward Probabilistic Calculations

The Commission staff and the Parties to the S-MAP proceeding have had discussions on the goal of developing probabilistic calculations of risk. Currently, the utilities rank relative risks on a 7x7 matrix using a logarithmic scale. Ultimately, the utilities might instead carry out a more precise calculation. The utilities should describe their progress toward probabilistic calculations in their RAMP filings. If the utility has been able to do more precise calculations of risk for one of its lines of business, sub-lines of business, sub-sub-lines, or other portion of its operations, then the utility should indicate that success. It should also indicate whether that success can be used as a platform for carrying out more precise calculations of risk in the future for other portions of its business, stating which ones. The utility should indicate how many more

years of work it will need before the next portions of its business can benefit from probabilistic analysis.

For example, the Sempra utilities have made progress on calculating and analyzing risks related to wildfires — Sempra's #1 risk. While the utility does not have a similar depth of analysis for its other risks, it has made progress in a key area. The utility has also said that it is working on ways to more precisely calculate risks related to gas transmission and gas distribution. But in other areas, Sempra may lack data or otherwise lack the ability to improve its risk calculations.

Each utility should indicate those areas where it is most advanced in its progress toward probabilistic analysis; those areas that it expects to come next; and the areas of its business that are still quite far from using probabilistic risk assessment. It might be possible for the utilities to use a table format to show progress: the first column might show the most advanced areas, where the utility is within one to three years of achieving probabilistic analysis; the second column could show areas three to five years away from that point; and a third column could show areas of business that are five to seven years away.

For Sempra utilities, column one might have wildfires only; column two might have gas transmission, gas distribution, and other areas; column three would have areas of greater difficulty. For areas of the business that lack data for advanced calculations, the utility should indicate the steps that it is taking to develop that data over time and indicate a timeframe for how long it may take. For areas where the utility has succeeded in advancing its calculations, it should indicate whether and how those successes can inform its work to improve other risk calculations.

Inclusion of Safety Culture and Organizational Structure in RAMP Filings

The RAMP filings should show whether the utilities' Executive and Senior Management are sufficiently engaged in the risk assessment, prioritization, mitigation, and budgeting process -- and how they are engaged. RAMP filings should also inform the Commission of the utility Board's level of engagement and oversight over its safety performance and expenditures. The company's compensation policies related to safety should be included in the RAMP filing.

RAMP filings should also cover the company's organizational structure as it relates to safety. Each utility should analyze its successes and failures at improving its safety culture and describe its path forward toward a deep and pervasive safety culture.

Inclusion of Alternative Mitigations in RAMP Filings

D.14-12-025 directs the utilities to include, "For comparison purposes, at least two other alternative mitigation plans the utility considered and an explanation of why the utility views these plans as inferior to the proposal plan."[34] The utilities should present these two alternative scenarios in their RAMP filings. The utilities should justify why they chose the alternatives that they did, based on cost, reasonableness, current conditions, and other analyses.

In S-MAP workshops #3 and #4, parties discussed the alternative scenarios for the RAMP filings. Of note, Sempra said in workshop #3 that what the Decision asks for regarding alternatives is a more formal way of doing what Sempra has been doing for many years. As part of its normal process, it vets the best options and does the

[34] D.14-12-025, p.32.

alternatives analysis, considering efficiency, cost effectiveness, and other factors. Now Sempra will formalize those decisions and document those alternatives in its RAMP filings. The other utilities also said that they already produce a set of scenarios to analyze which risk mitigation choices are optimal.

Non-utility intervenors in the S-MAP workshops called for transparency regarding the utilities risk mitigation plans, including for affordability. Presentation of the utilities' alternatives analysis in the RAMP filings will add to transparency by showing other parties how costs and mitigations are chosen.

How RAMP Filings Progress to General Rate Cases

SED is considering a process to use to formally adopt each utility's RAMP filing and application prior to the GRC. This adoption will be informed by SED's evaluation of each RAMP filing. The adoption order will provide direction to the utility for incorporating changes to safety expenditures into its upcoming GRC filings. Following the adoption of the RAMP filing, SED will hand off the completed RAMP to the Commission's Energy Division and the Office of Ratepayer Advocates as they begin their work on the upcoming GRC. At that point, the utility will incorporate the safety steps into its upcoming GRC, testimony, and documents.

Responsibility for Rapid-Response Mitigations

The RAMP filings feed into the utilities' GRC filings in a *three-year cycle*. This can work well for ordinary procedures and procurement and as a forward-looking approach to mitigating risk. *However, some risks may be discovered that will require action on a much shorter time horizon*. The utilities carry full responsibility for acting on those shorter-term needs. The three-year cycle of RAMP and GRC does not in any way

absolve the utilities of the responsibility to respond to unexpected or urgent needs. The utilities must respond to shorter-term needs through processes other than the RAMP and GRC. If the utilities need action from the Commission to make rapid response more possible, then the utilities should communicate that to the Commission through appropriate channels.

Outlines for RAMP Filings

SED is considering proposed outlines and templates for the utilities' RAMP filings. Sempra utilities will be the first to make a RAMP filing, due in November 2016. Sempra has informally provided SED staff with a draft proposed outline for its upcoming filing, which is shown below.[35] This is an example for discussion only, not a final document:

1. Introduction/Summary
2. S-MAP Update
3. Risk Assessment Overview
4. Risk Mitigation Plan Overview
5. Risk #1 [**Repeated** for Risk #2, #3…]
    a. Risk Description
    b. Risk Scenarios
    c. Potential Drivers
    d. Risk Score
    e. Current Projects/Programs and Baseline Costs
    f. Proposed Projects/Programs and Forecasted Costs
    g. Alternatives Analysis
6. Summary/Conclusion

[35] SED staff met with Sempra staff on February 5, 2016, and Sempra presented slides entitled "Risk Assessment Mitigation Phase: Plan and Approach Overview, February 5, 2016."

This outline consists largely of a narrative format. SED also encourages inclusion of graphs, charts, and tables to illustrate the utilities' risk assessments, mitigations, and budgets. Some of the charts presented in the RAMP filings may be of use later in the GRC materials and also might be adapted for use in the two accountability reports.

In its informal discussions with CPUC Staff, Sempra indicated plans to include risks with an impact/consequence score of 4 or above on its 7x7 matrix in its category of "Health, Safety, and Environment." (PG&E and SCE use a category of "Safety" that does not include "Health" or "Environment.") Sempra's level 4 includes consequences with "few serious injuries or illnesses to public or employees; significant and short-term impacts to environment." Level 5 includes many serious injuries or illnesses and medium-term impacts to environment. Level 6 includes fatalities. Level 7 includes multiple fatalities and life threatening injuries and severe impacts to environment.

In total, Sempra expects to include 28 risks in its RAMP filing, of which eight are from its gas business, seven are from its electric business, and 13 are cross-cutting. Sempra's data is largely based on subject matter expertise. If Sempra were to include risks that score a 3 or higher on its 7x7 matrix — instead of a 4 as Sempra currently plans to do — then approximately 10 more risks would be included in the RAMP filing.

Sempra is preparing an analysis of the costs of its mitigations, as discussed above in this document as "spend efficiency," which is risk reduction per dollar calculated with a methodology currently being piloted. Sempra plans to use 2015 actuals for these calculations and to analyze five years of historical data if possible. It also plans to base its forecast costs off its 2015 actuals. Sempra is looking ahead to 2019 for its GRC and

will use range estimates because that is too far away to know precise costs. Sempra is also preparing analyses of two alternative mitigations, as required by D.14-12-025.

Timeline for the RAMP Filings

The timeline for the RAMP, as per D.14-12-025, is as follows:

- September 1 prior to the GRC filing date
  Utility sends letter to Executive Director (with a copy to the Chief ALJ) requesting that an OII be initiated for the utility's upcoming GRC filing, pursuant to this Decision.
- November 15 OII for the upcoming GRC initiated.
- November 30 Utility files RAMP submission in the OII.
- By December 15 PHC held.
- By December 15 Utility and SED hold workshop on utility's RAMP submission.
- February 28 SED files staff report on utility's RAMP submission.
- March 15 Staff hosts public workshop on SED report.
- April 10 Parties serve comments on RAMP submission and SED report.
- April/May If needed, additional workshops on RAMP-related items.
- May to August Utility incorporates RAMP results into its GRC filing.

Table 8

Ten Major Components of Ramp Filings Recommended by SED

Step	Description
Overall, the utility should show how it will use its expertise and budget to improve its safety record. To do so, <u>each utility should</u>:	**The goal of the S-MAP proceeding is to make California safer by identifying the mitigations that can optimize safety**
• **Identify its top risks**	SED currently foresees this including those risks ranked 4 or higher on the 7x7 matrices
• **Describe the controls or mitigations currently in place**	Creates a baseline for understanding how safety mitigation improves over time
• **Present its plan for improving the mitigation of each risk**	Includes analysis of execution feasibility, affordability, and any constraints
• **Present two alternative mitigation plans that it considered**	D.14-12-025 calls for the presentation of two alternative plans
• **Present an early stage "risk mitigated to cost ratio" or related optimization**	Pilot calculations are attempting to measure this item, although they are in an early stage
• **Identify lessons learned in the current round to apply in future rounds**	Lessons learned by one company will also inform the RAMP filings of the other companies
• **Move toward probabilistic calculations to the maximum extent possible**	While not all of a utility's lines of business may have the data needed, some areas can move toward these calculations in the short term
• **For those business areas with less data, improve the collection of data and provide a timeframe for improvement**	By beginning in S-MAP #1, the utilities can position themselves to make major improvements in risk assessment in S-MAP #2 and #3
• **Describe the company's safety culture, executive engagement, and compensation policies**	Should show how compensation is tied to safety performance, board and executive engagement in safety, and organizational structure related to safety
• **Respond to immediate or short-term crises outside of the RAMP and GRC process**	The RAMP and GRCs follow a three-year cycle and are not designed to address immediate needs; the utilities have responsibility for addressing safety regardless of the GRC cycle

Summary of Findings

Based on our review of the S-MAP applications, SED has made some substantive observations listed below concerning risk assessment models and risk-based decision-making frameworks presented in this proceeding. These observations are not meant to be exhaustive (nor indeed can they ever be). This list represents observations that we feel in our professional judgment are relevant and important in this first S-MAP proceeding.

In subsequent S-MAPs, SED will undoubtedly make other observations that we will feel should have been pointed out in this first S-MAP but which we did not do so in this evaluation. This could occur either because of oversight on our part or because of new insights gained through SED's own evolving understanding of risk assessment models and risk-based decision frameworks. With all this as a backdrop, SED is making the following observations with the goal of helping Commission decision-makers, intervenor parties, and utilities alike make informed decisions based on our impartial evaluation.

1. **Good progress has been made by all four utilities to develop a risk-based approach to manage their operations and assets and to inform rate case decisions.**
   To various degrees of maturity, all four utilities have embarked on a journey to adopt a risk-based approach to enhance safety and reliability. All four utilities have a risk-based decision framework that can be mapped to the Cycla 10-step process.
2. **The Rulemaking has provided extensive opportunity for the Commission and Parties to review and attempt to understand the Utilities' approaches.**
   One of the twin functions of the S-MAP proceedings is to allow parties a process "to understand the models the utilities propose to use to prioritize programs/projects

intended to mitigate risks."[36] This has been largely accomplished by the filed testimonies, the series of workshops where parties had ample opportunity to ask the utilities questions, associated workshop presentation materials, workshop summaries, and the parties' individual efforts to gain understanding of the models through their own data requests and direct informal meetings with the utilities.

3. **There is no specification of risk tolerance.**

Risk tolerance is not explicitly considered in any of the utility applicants' risk calculation models or risk-based decision frameworks. The utilities expressed in the workshops that their proposed programs/projects and proposed expenditures "**imply**" the individual utility's level of risk tolerance. There are two problems with this assertion.

By failing to provide an explicit specification of risk tolerance, the utilities are handicapping the ability of other stakeholders to make an informed decision as to whether the utilities' rate case proposals would have the desired risk reduction effect in relation to the desired level of risk tolerance. By failing to provide an explicit risk tolerance, the utilities would in effect be asking the stakeholders to accept in blind faith that the proposed programs and projects are necessary and sufficient (and no more than necessary or sufficient) to mitigate the risk down to a level that the utilities can tolerate, whatever that level is, which no stakeholder would be able to verify because the risk tolerance is not specified. This problem is compounded by the fact that, except in the case of PG&E's nuclear operation, their risk assessment models are a mixture of relative risk ranking models, where the scores produced by these models have no physical interpretation in the real world.

[36] Scoping Memo in A.15-05-002, P.3.

To some degree, this problem has been ameliorated by the utilities' use of performance metrics, benchmarks, industry best practices, and other performance measures in relation to industry peers in deciding their risk mitigation activities. However, measuring risk mitigation performance relative to metrics, benchmarks, industry best practices, and industry peers is not equivalent to providing an explicit risk tolerance since these measures still provide at best only an implied level of risk tolerance.

To illustrate the inadequacy of using these performance measures as a substitute for the utilities providing an explicit risk tolerance, consider an example of a program to improve safety performance in some key metric (such as reduction in third-party excavation damage) in order to drive performance from the bottom quartile to the top quartile relative to industry peers. Without consideration of an explicit risk tolerance, the utility and stakeholders would still be unable to determine whether the proposed risk mitigation activities are either sufficient (or excessive) relative to whatever risk tolerance the utility is striving for.

Demonstrating performance relative metrics, benchmarks, or peer industry groups is not a substitute for demonstrating performance relative to an explicit risk tolerance because it is entirely possible that the whole industry is performing poorly relative to some risk tolerance level. Improving performance from the bottom quartile to the top quartile when the whole industry is performing poorly would give the public little comfort if the performance still fell far short relative to the utility's risk tolerance.

Conversely, suppose the industry as a group is overspending relative to what is necessary to achieve the utility's risk tolerance. By trying to improve performance relative to this group and also failing to consider an explicit risk tolerance, the utility would run the risk of wasting precious ratepayer resources that could be spent elsewhere to reduce other risks.

The burden is on the utility applicant, and not on the other stakeholders, to demonstrate that the utilities' proposed risk mitigation activities are conducive to achieving its risk tolerance objectives. Simply providing a list of risk mitigation proposals and asserting that these proposals will result in risk reduction relative to an implied risk tolerance is not a substitute for such a demonstration.

Explicit consideration of risk tolerance is necessary to optimize the portfolio of risk mitigation activities to help determine the optimal mix of programs and projects and the optimal pace of execution in order to achieve either 1) the greatest aggregate risk reduction for all identified threats at a fixed level of aggregate expenditure or 2) the smallest amount of aggregate expenditure to achieve a desired level of aggregate risk reduction, or 3) some combinations of these two extremes. Without a precise specification of risk tolerance, any "optimization" that the utilities may claim they could do can only rightfully be described as prioritization rather than true optimization in a rigorous, mathematical sense.

Granted that the discussion of risk tolerance can be a policy question that should involve all stakeholders, until such a point has been reached a utility still has the burden to show what risk tolerance has been used in preparing its rate cases. Since the IOUs have asserted that their proposed revenue requirement is a reflection of

their risk tolerance, they have already decided what they are comfortable with. It is contradictory to assert on one hand that they DO have an implied risk tolerance, but on the other hand that they cannot disclose what that risk tolerance is when expected to do so.

4. **Utilities' risk assessment models are still predominantly indexing models where Subject Matter Experts (SMEs) assign integer logarithmic-scale scores to describe relative frequency and consequence rankings to produce risk scores.**
With the exception of PG&E's nuclear operations, utilities' risk evaluation models are based on a relative risk ranking approach. Despite the progress the utilities, particularly PG&E, have made over the last several years to improve their risk models, the risk score evaluation models presented by the utilities in this proceeding are still indexing models producing dimensionless risk ranking scores. There are many well-known limitations and drawbacks with indexing models. This finding should be interpreted as an observation rather than a criticism of the utilities since it has only been two years since the previous rate cases where this observation was made and in this short period of time we do not expect the utilities to have been able to make any significant improvements in their data collection to deviate from the relative risk ranking models.

The indexing approach based on a logarithmic scale of integer scores creates significant distortion in perception of the true magnitude of frequency and impact variables and the resulting risk scores. Human perception of numerical magnitude is innately based on a linear scale. A good demonstration of this human perception always thinking in linear-scale terms can be seen in PG&E's RIBA process. Despite the much trumpeted calibration sessions, PG&E's SMEs created an additional frequency score of 4.5 apparently because 4.5 is midway between 4 and 5 as if the

numbers were on the linear scale, even though the RIBA scores are explicitly on the log scale. In this instance, PG&E's SMEs simply fell back into the trap of thinking in linear-scale terms on what they intended to be a log scale because it is simply not in human nature to perceive the world in terms of the logarithmic scale. A score of 5 on the log scale is 10 times as frequent as a score of 4 on the same scale.

5. **The weights on impact dimensions were not chosen based on true equivalence and convertibility of different dimensions.**

   The utilities' risk models obtain the risk score for a threat and consequence scenario by summing (or weighting) the dimensionless contributions from different impact dimensions. (Summing the different impact dimension scores without applying weights is in fact equivalent to assigning equal weight to all the impact dimension scores.)

   The risk scores defined as such would lack physical interpretation. The weights establish equivalence relationships among the different impact dimensions. For example, if a utility's formula uses 30% weight on safety impact and 25% weight on reliability, it in effect establishes that 30 units of safety impact are to be treated as equal to 25 units of reliability impact.

   The current process makes about as much sense as evaluating a potentially unpleasant outcome by adding 2 rotten apples, 7 rotten oranges, and 2 missing dollars and then calling that weighted sum a risk score. Such a summation of different dimensions with different implied or explicit physical units is inherently nonsensical unless the disparate impact dimensions had weights that were objectively chosen based on detailed analysis to establish the conversion among the different impact dimensions. This, however, was not the case with the current

weights chosen by the utilities since their weights were subjectively chosen. The Commission could impose uniform conversion weights by regulatory fiat, but then the same criticism about the weights would still remain.

In order to establish the weights correctly, conversion relationships would first need to be established in some common unit of measurement, such as by expressing all impacts across different dimensions in dollar equivalents (possibly adjusted for inflation) for a large number of various past and anticipatory failure events. These dollar values on different dimensions could be based on subject matter expert opinions or historical data. Then the conversion relationships among different dimension pairs could be established based on the cumulative values of the dollar equivalents for all the various failure events. This process does not involve establishing the value of a statistical human live in dollar terms, although it is possible to incorporate the concept into this analysis.

The previous description is but one possible logical method to establish the relative weights. It is clearly not the only way. Whatever method a utility ultimately chooses to establish the weights should be based on sound reasoning and detailed analysis, and provided with a transparently auditable trail. In order to promote uniformity, the Commission could prescribe a uniform procedure to derive the weights, but each utility should derive its own set of weights to account for its uniqueness and different loss experience.

Alternatively, the Commission could dispense with the use of weights by dictating that all impact dimensions be expressed in terms of one common unit of measurement, such as inflation-adjusted dollars. Then the weights, which act as

conversion factors among impact dimensions, would be necessary. When a utility evaluates the risk score for a failure scenario, it would then have to evaluate each of the impact dimensions in inflation-adjusted dollar terms and the weights would not be used in the risk calculation equation. This is the same as setting all weights equal to 1, since a dollar in one impact dimension has the same value as a dollar in another impact dimension.

6. **Shareholder financial interests crept into enterprise and operational risk management focus.**

The utilities' risk assessment models and risk management frameworks as presented in this proceeding are based on enterprise and operational level risk management (EORM). With EORM, a utility manages risks at both the operational level and the enterprise level explicitly for the benefit respectively of the operation and of the enterprise. Implicit in EORM are the beneficiaries of the actions taken to reduce risks. When a utility practices risk management, it in effect acts as a fiduciary to mitigate risks for the benefit of the public at-large, utility workers, contractors to the utility, the environment, utility regulators, utility customers, intervenors in Commission proceedings, other stakeholders, and shareholders. The interests of these different beneficiary groups are reflected in the categories used by the utilities to characterize the potential consequence (or impact) and evaluate impact scores in the risk scoring formulas.

Although the interests of these diverse groups may largely overlap, they are not necessarily identical. When estimating impact scores a utility should be conscious of the potentially conflicting interests and asymmetric benefits conferred on shareholders and other groups. Prioritizing a portfolio of mitigation activities to benefit shareholders will almost certainly not result in an optimal portfolio from the

ratepayers' perspective. Impact categories that reflect shareholder interest have no direct impact on safety or reliability and should be redefined. For example, in PG&E's SB705 gas safety plan, financial performance is used to determine bonus. This directly contradicts the desire to promote safety since spending on safety negatively impacts financial performance. Likewise, in SDG&E's 7x7 matrix, one of the scoring attributes is "Financial." It is listed as "potential financial loss, including disallowance, legal actions, or fines, …" Disallowances and fines are impacts on shareholders and not on safety and should have no bearing on safety decisions funded by ratepayer money.

At a minimum, financial impact should be re-defined to remove shareholder financial impact and focus only on ratepayer financial impact. Since mitigation activities presented in rate cases are funded by ratepayers, the portfolio of activities should be prioritized (or optimized) to benefit ratepayers and not shareholders.

PG&E first ranks enterprise risks by the risk scores which includes reputation and financial, but these are omitted in the RIBA ranking process. Again, this conflates shareholder financial interests with safety impacts. (Use example of actual risks in a tertiary risk system to the suboptimal solution of having financial impact influence safety decisions).

7. **There is no optimization of portfolio of risk mitigation activities.**

   None of the utilities have a way to optimize their portfolio in a mathematically rigorous sense. There is no explicit consideration of optimization. Programs and projects are prioritized but not optimized. Prioritization is only an interim substitute for optimization but is not a replacement for it.

Inherent in risk management is the unavoidable fact of limited resources and other constraints. Without resource constraints, an operator could simply apply an infinite amount of an infinite number of risk mitigation activities and the risks would be driven to zero. Clearly this is reduction of the argument to an absurdity. Therefore, risk management always assumes recognition of some constraints (rate shock, availability of trained personnel, and limitation of resources). And, optimization is always tied to risk tolerance. These concepts are all tied together.

8. **Prioritizing based on cost effectiveness measures is not optimization.**
   Prioritizing a portfolio based on cost effectiveness measures, such as risk reduction per dollar spent, is not equivalent to optimizing a portfolio, and will probably produce a sub-optimal result from a total portfolio perspective. Although cost-effective measures such as risk spend efficiency or risk reduction per dollar spent give valuable information, their limitations should be recognized. Where information from risk reduction per dollar spent could be most useful is to provide a basis for weeding out grossly cost-ineffective mitigation activities.
9. **Risk evaluation models emphasizing high consequence events will not yield the same portfolio of risk mitigation activities compared to an approach using the traditional formula of risk = frequency x consequence.**
   PG&E's RET model emphasizes high consequence events and produces a relative risk score that is not based on a traditional risk = frequency x consequence on a linear scale. The emphasis on high consequence risks can create a risk prioritization that differs from one based on linear-scale risk scores. There could be valid societal reasons for emphasizing high consequence events, but distortion in risk rankings due to this emphasis should be recognized.

10. The risk scores are not comparable across utilities.

For the risk scores to be comparable across utilities, the Commission would have to impose a uniform RET formula, with uniform definitions of frequency ranges, uniform impact dimensions, and uniform definitions of impact. The Commission would also have to require that calibration sessions be held across the utilities.

Furthermore, in order for the risk scores to be comparable across utilities of unequal sizes, the frequency and consequence scores would need to be adjusted based on company size.

11. None of the models produce absolute risk scores.

The risk scores are either relative (PG&E model) or quasi-absolute (SCE and Sempra risk models). Relative risk scores distort perception of the magnitude of risk and are useful only for prioritization purposes but not optimization. The Commission could resolve this by imposing formulas that calculate linear-scale, absolute risk scores.

12. The models are marked by weak transparency and questionable repeatability.

To various degrees the utilities have made good progress in creating a structured risk management framework that can be described in terms of the Cycla 10-step process, but the decision-making process leading from risk evaluation to the eventual portfolio mix of proposed risk mitigation programs and projects is still only vaguely described. The most transparent and verifiable step seems to be the one offered by SCE: that SCE intends to prioritize their portfolio based on a risk spend efficiency scores.

One of the often repeated themes we heard from the utilities in this proceeding is almost identical to the one we found in PG&E's most recently filed gas safety plan:[37] to produce a risk management process that "provides a repeatable and consistent

[37] PG&E Gas Safety Plan and Compliance Statement filed December 29, 2015, in R.11-02-019.

method to identify, assess, rank, and mitigate risk." The heavy reliance on subject matter experts to estimate risks and the lack of explicit risk tolerance casts doubt on the accuracy of this statement. As an aspirational goal, this is indeed something the utilities should strive for, but as a practical matter, achieving this aspirational goal will likely take much longer.

13. **The risks models currently only take into account single risk drivers and do not consider interacting risk drivers (interacting threats) and synergy in mitigation across multiple risks.**

    The "Bowtie-diagram" approach used by SCE partially addresses this problem in a graphical way. Consideration of interacting risk drivers and the synergy in mitigation across multiple risks is a complex mathematical problem. The utilities should devote effort to develop quantitative methods to account for these interacting and synergy effects.

14. **Model granularity should be improved.**

    As we mentioned in the second S-MAP workshop, increasing granularity in the risk register is a double-edged sword. On the one hand, increasing granularity would help narrow down the threat and scenario identification and risk evaluation, and would thus enhance more targeted and more cost-effective risk mitigation strategies. On the other hand, increasing risk identification granularity would mean fewer data points for a specific failure scenario to support the risk evaluation and would thus increase the uncertainty surrounding the risk scores and increase overall uncertainty in the entire risk-informed resource allocation framework. The utilities could consider using parallel models, one with high granularity and another one with low granularity with each model giving a different view.

15. **Both the As Low As Reasonably Practical (ALARP) framework and the Joint Intervenors' proposed framework are valuable alternatives for consideration by the Commission.** ALARP is an overarching framework meant to be used in conjunction with whatever risk evaluation tool that a utility may use (including the Joint Intervenors' proposed approach). ALARP tends to be more useful in the longer horizon as the models mature and can incorporate more fully probabilistic approaches. However, the risk tolerance and gross disproportionality concepts in ALARP can be used even in the absence of fully probabilistic approaches. The downward-sloping risk tolerance limit lines in ALARP automatically emphasize avoiding high severity risks without needing to artificially boost the consequence term in the risk formula.

    The Joint Intervenors' alternative approach is intended to replace the utilities' existing risk evaluation tools. The Joint Intervenors' alternative approach tends to be more useful primarily in the immediate future as a bridge between the current non-probabilistic state and a more probabilistic state as the utilities' models mature.

16. **Individual models should be further refined to correct inconsistencies or improve clarity.**

    SCE's model uses the CP (consequence percentage) factor to denote the percentage of failure events that actually leads to safety related results. SCE's current model assumes that the CP stays the same both before and after mitigation. In reality, mitigation could, and probably would, reduce the consequence percentage of trigger events.

Recommendations

1. **The Commission should adopt explicit risk tolerance standards.**

   Consideration of risk tolerance is integral to risk management. The concept of risk tolerance is a sensitive subject in an atmosphere where the public has little tolerance for anything less than perfect safety. What the general public may not always be conscious of is the tradeoff between unrealistically high expectations of safety and utility rate affordability. The moment the Commission embarked on a risk-based approach to safety, it implicitly recognized that absolute safety rarely exists within any finite amount of safety budget. The Commission should therefore confront the issue by making an explicit recognition of this tradeoff by defining acceptable levels of risk tolerance.

   Consideration of risk tolerance could be part of the larger picture to consider whether an ALARP approach should be adopted. The Commission should consider addressing whether explicit risk tolerance standards should be set for the utilities in their rate cases. The failure to adopt explicit risk tolerance standards will hinder the utilities' ability to apply optimization techniques to their risk mitigation portfolios.

2. **It is premature to prescribe a common risk evaluation methodology in the first S-MAP.**

   For this first S-MAP, the Commission should continue to encourage increasing commonality among the utilities by giving explicit directions on what common approaches the Commission would like to see in the next S-MAP. Without formal orders from the Commission, it is unlikely that the utilities would adopt common risk management approaches at a pace and to the extent that the Commission and intervenors might desire.

We caution against imposing common approaches too quickly simply for the sake of imposing commonality without fully vetting the strengths and weaknesses in the risk evaluation models and the feasibility of imposing unique elements in those models across all utilities. Great strides have been made in this first S-MAP to understand the different models and risk-based approaches. However, to fully understand the strengths and weaknesses of the various model elements requires a much deeper level of familiarity that can only come from actually putting the various models through their paces, something that has not been done with SCE's and Sempra's nascent risk-based approaches. Instead of adopting common elements in this first S-MAP beyond what the utilities have identified in their Uniformity Report, we recommend that the most desirable features from the risk models be identified for possible adoption in the next S-MAP or perhaps in Phase 2 of the first S-MAP:

a) Risk evaluation formulas should produce linear-scale, absolute (or at least quasi-absolute) risk scores. The risk formulas should therefore follow the traditional aggregate risk formula (Risk = frequency x consequence) without any exponentials applied to the terms.
b) The consequence percentage term, CP, in SCE's formula gives the model a more realistic representation of trigger events and resulting consequences. The CP term will need to account for pre-mitigation vs. post mitigation. SCE's risk evaluation formula seems to be the most suitable formula for consideration as a common approach after correcting for the CP term to account for the effects of mitigation.

c) Emphasis on high consequence events should be replaced with decreasing risk tolerance for high risk events.

d) Risk scores should be comparable across utilities. This can only be accomplished if calibration sessions are held across utilities.

3. **All common elements identified in the "*Combined Utilities S-MAP Uniformity Report*" introduced in the S-MAP workshop on December 4, 2015, should be adopted in this S-MAP.**
4. **The Commission should prescribe uniform impact dimensions and a uniform methodology to derive the impact dimension weights. The Commission should <u>not</u> prescribe uniform weights.** Alternatively, the Commission could dispense with using weights by specifying that all impact dimension scores be expressed in one common equivalent unit of measurement, such as inflation-adjusted dollars. A uniform methodology to derive impact dimension weights would enhance inter-utility risk score comparability, but uniform weights that do not take into account the different cost structures and loss experience across utilities would paradoxically make the risk scores non-comparable.
5. **The utilities should continue to improve their risk management models and data collection efforts to support increasing use of fully probabilistic risk management models.**
6. **The utilities should develop methods to optimize their risk mitigation portfolios.** The current methods employed by the utilities entail prioritization, which is not the same as optimization.
7. **The utilities should consider having two parallel risk assessment models, with one having high granularity and another having low granularity to compare the results obtained from both methods.**

8. **The utilities should remove shareholders' financial interests from consideration in their risk models and decision frameworks used to support rate case expenditure proposals.**
9. **In the next S-MAP, the Commission should consider whether common risk evaluation formulas for ranking pipe segments be used in the gas distribution and gas transmission integrity management programs.**
10. **The Commission should continue to use the Cycla 10-Step Evaluation method as a common yardstick for evaluating the maturity of utility Risk Assessment and Mitigation models.** The method will gain in usefulness as utilities advance subsequent General Rate Cases that are subject to the full Risk-Based Framework adopted in D.14-12-025 and refined in this and future S-MAP cycles.
11. **The Commission should adopt SED's recommended Guidance for RAMP and the ten major components that should be included in RAMP filings.**

Attachment: SED Proposed Risk Lexicon

Risk Lexicon Proposed by SED	
Term	**Definition**
Risk	The potential for the occurrence of an event that would be desirable to avoid, often expressed in terms of a combination of risk drivers, a scenario in which risk drivers lead to various outcomes of an adverse event, and the associated probabilities of the outcomes. Different stakeholders may have varied perspectives on risk.
Inherent Risk	The level of risk that exists without risk controls or mitigations.
Event	An occurrence or change of a particular set of circumstances that may have potentially adverse consequences and may require action to address.
Frequency	Number of events generally defined per unit of time. (Frequency is often incorrectly treated as synonymous with probability or likelihood).
Likelihood	The expected value of possibility that an event will occur. Likelihoods are point values estimated by subject matter experts and are not derived from probability functions. Likelihood is quantified as a number between 0% and 100% (where 0% indicates impossibility and 100% indicates certainty). The higher the likelihood of an event, the more certain we are that the event will occur.
Probability	The relative possibility that an event will occur. Probability is quantified as a number between 0% and 100% (where 0% indicates impossibility and 100% indicates certainty). The higher the probability of an event, the more certain we are that the event will occur. (Often informally referred to as likelihood or chance. See Likelihood for distinction in usage between likelihood and probability).
Impact (or Consequence)	The effect or outcome of an event affecting objectives, which may be expressed, by terms including, although not limited to health, safety, reliability, economic and/or environmental damage.
Mitigation	Measure or activity proposed or in process designed to reduce the impact/consequences and/or likelihood/probability of an event.
Outcome	The final resolution or end result
Risk Driver	Factor(s) that could cause one or more risks to occur (Risk driver may also be commonly referred to as “threat”).
Risk Response Plan	Collection of mitigations
Control	Currently established measure that is modifying risk
Alternative Analysis	Evaluation of different alternatives available to mitigate risk
Residual Risk	Risk remaining after current controls.
Planned or Forecasted Residual Risk	Risk remaining after implementation of proposed mitigations.
Risk Score	Numerical representation of qualitative and/or quantitative risk assessment that is typically used to relatively rank risks and may change over time.
Risk Tolerance	Maximum amount of residual risk that an entity or its stakeholders are willing to accept after application of risk control or mitigation. Risk tolerance can be influenced by legal or regulatory requirements.