**Joint Utility Whitepaper on Methods to Incorporate Tail Risk into Utility Risk Modeling**
Risk Informed Decision-Making Proceeding (R.20-070-013)
December 6, 2023

## Introduction

On Oct. 13, 2023, the Assigned Commissioner issued a ruling in the Risk-Informed Decision-Making Proceeding (RDF, R20.07-013). The ruling authorized an additional workshop to extend the discussion regarding Tail Risk; the ruling indicated that the focus at the workshop should primarily be directed to discussing *non-wildfire*-related risks.

As noted in the scoping memo issued in the RDF proceeding, tail risk events are low-probability and high consequence events. Such events present a challenge to risk assessment and planning for a number of reasons. In many cases, these types of events are represented by only a few, if any, historical data points. This makes it difficult to discern any noticeable and reasonably reliable pattern. In other cases, historical data may over- or under- represent the probabilities and/or consequences of those risk events. This is especially true in complex systems, such as risks related to long-lived assets. In these cases, it may be prudent to utilize alternative approaches to help assess the reasonableness of mitigation activities.

Specifically, the Commission outlined the intent of this workshop is to address in detail the Phase 3 Scoping Memo issue (c)(2):

- Is additional Commission guidance needed regarding modeling of low probability, high consequence risk events more generally in the RDF and in utility Risk Assessment and Mitigation Phase (RAMP) filings?

## Joint Utility Proposal

In response to this question, SCE, SDG&E, and SoCalGas (the Joint Utilities) do believe that additional guidance is needed to address low-probability, high-risk events in the RDF and in utility Risk Assessment and Mitigation Phase (RAMP) filings. Accordingly, the Joint Utilities have drafted a whitepaper the includes specific examples of why additional guidance is needed. In this whitepaper, the Joint Utilities provide examples of how an appropriate tail risk metric for low-probability, high-consequence events can be derived in a practical manner, and why those metrics are more appropriate for establishing cost-benefit ratios than expected values.

In this proposal, The Joint Utilities respectfully request that the Commission modify the language in D.22-12-027 at Appendix A, A-14, row 24 to allow utilities to present an analysis of monetized pre-and post-mitigation [consequences of a risk event] CORE using a computation relevant to a tail risk value, rather than the expected value. Using two examples below, the joint utilities describe methods to derive tail risk values using generally-accepted risk management practices. We note that these methods recommend using tail risk value rather than expected value. Therefore, we believe the need to produce expected values may be irrelevant for certain low-probability, high-consequence risks.

## SCE Hydro Example

SCE operates a portfolio of 81 hydro dams which support 33 hydroelectric plants that provide a combined 1,153 MW of generating capacity. Most of these dams were constructed in the early 20th century, with the oldest dating to 1893 and the most recent dating to 1986. Changes in land use and climate have, and will likely continue, to alter the likelihood and consequence of potential hydro risk events through their remaining useful lives. SCE's Dam Safety Risk Assessment Program was initiated in 2008 and is modeled after "Risk Management – Best Practices and Risk Methodology," which was established by the United States Bureau of Reclamation (USBR) in the mid-1990s. This prescribed risk management approach is based on identifying the potential ways a specific dam could fail, known as Potential Failure Modes (PFMs), and then evaluating the likelihood of occurrence and the consequence of each PFM.[1] The hydro risk analysis presented in SCE's 2022 RAMP filing is based on this methodology.

The USBR guidelines are based on two interconnected concepts. First, that there is a level or risk deemed acceptable by society in order that some particular benefit can be obtained. This is known as "Tolerable Risk." Secondly, that the risk above this acceptable threshold should be mitigated until it is tolerable, or "As Low as Reasonably Practicable" (ALARP). These guidelines employ an f-N chart for establishing the baseline risk for individual dams, by plotting the annualized frequency of occurrence for each individual PFM(f) against the loss of life should that PFM occur (N).

The four "zones" on the f-N chart are used to demarcate different risk tolerance thresholds. The first zone is used to identify likelihood and/or consequences which are deemed broadly unacceptable except in extraordinary circumstances. This methodology can be used to develop appropriate thresholds to establish a tail risk metric for low probability, high consequence events for individual attributes (such as fatalities) or overall monetized risk. Note that uncertainty bands for each individual PFM can also be plotted on the f-N chart to better characterize the confidence in each PFM in the risk assessment.

For hydro asset failure, this zone is defined by a region where the average annual life loss is greater than one fatality per 1,000 years, as indicated by the region above the reference line "A" in Figure 1. The second region – between reference lines "A" and "B" – is where risks are intolerable – and that cost-effective mitigations should be employed to reduce the risk to as low as reasonably practicable. In this example, this zone is defined by the region where average annual life loss is less than one fatality per 100,000 years, indicated by region below the reference line "B" in Figure 1. Likelihoods and/or consequences below the ALARP line are generally tolerable, but practical mitigations should still be employed. Finally, in the special consideration zone, PFMS are extremely low-probability, but may result is extremely high consequences. In this example, this zone is defined as the region bounded by expected fatalities greater than 1,000, but annual probability less than 1 in 1,000,000, as indicated by reference line "C" in Figure 1.

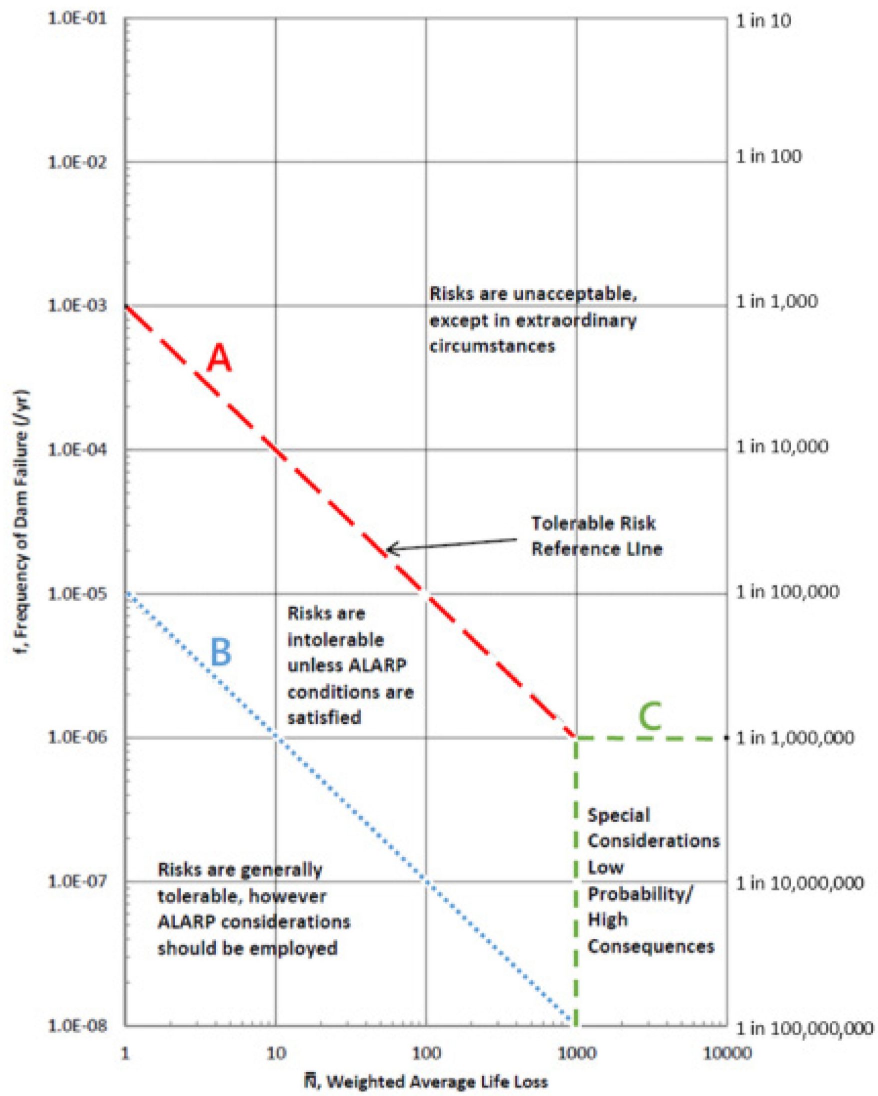
There are two types of risk analyses used to establish these f-N curves – Semi-Quantitative Risk Analyses and Quantitative Risk Analyses. Semi-Quantitative Risk Analysis (AQRA) is a heuristic method in which each PFM is classified into broad bins of likelihood and consequence by a group of subject matter experts (SMEs). The primary objective of SQRA is to determine which PFMs are of most concern for a particular dam or portfolio of dams that may require additional study and evaluation. Quantitative Risk Analyses (QRA) involve the use of field investigations, analyses, and studies to develop quantitative estimates of the probability of failure and the consequences of failure for the most critical PFM(s) for a given dam or portfolio of dams. The primary purpose of QRA is to inform decision-making around dam safety investments, and typically involves analyzing both the pre- and post-mitigated risk under existing conditions, as well as potentially under future conditions (e.g., changes in climate and/or downstream land use).

[1] The USBR framework has been updated, adopted, and modified by the USBR and other federal dam owners, such as the U.S. Army Corps of Engineers (USACE). It also forms the basis of the recently released Federal Emergency Management Agency (FEMA) Guidelines for Dam Safety Risk Management and the FERC guidelines for Risk Informed Decision Making (RIDM).

This framework outlines the following criteria to evaluate to what extent ALARP is satisfied in the ALARP region (e.g., between A and B, and below B). Cost-effectiveness tests to assess the relative benefit of incremental risk reduction measures can be used to assess the reasonableness of mitigation portfolios in relation to these risk tolerance reference lines (e.g., A and B). As a matter of best practice, there should not be a gross disproportionality of the proposed costs relative to the benefits of any mitigation activity in relation to these risk tolerance reference lines. In addition to cost effectiveness, mitigations should be assessed in relation to "Good Practice" such as compliance with FERC Engineering Guidelines or other industry-recognized standards, as well as other qualitative societal concerns. Other factors, including duration of the risk, availability of risk reduction options, potential for creation of new risks, adequacy of the mitigation to future conditions, as well as industry benchmarking, and operational feasibility of proposed mitigations should also be considered. Note that low-probability, high-consequence PFMs (below C) are generally deemed unacceptable, and measures are taken to mitigate these PFMs through practical engineering and/or prudent emergency planning.

In this example, the use of expected (or average value of A and B) serves little or no practical purpose. If one were to use the "expected value" (e.g. an average of the likelihoods and/or probabilities of all PFMs) rather than the tail risk metrics that demark the ALARP region - as denoted by reference lines A, B, or C – the resulting cost benefit assessment would result in the overvaluation of high-probability, low-consequence PFMs and an undervaluation of low probability, high consequence PFMs. We also note that the demarcation line used to establish tail risk values can also be used to assess the relative reasonableness of mitigation activities in comparison to other mitigations specifically designed to address low probability, high consequence risk events. The ALARP framework represents a general approach to balance mitigation costs, achievable benefits, and risk reduction. We note that this framework is predicated on establishing threshold values of tolerability in terms of both consequence and probability.

**Figure 1: f-N Chart from FERC Risk Informed Decision-Making Guidelines**



**SoCalGas and SDG&E Example**

SoCalGas and SDG&E are firmly committed to furthering the Commission's efforts, initiated twelve years ago, to guard against the occurrence of a catastrophic incident involving gas system infrastructure. At that time, the Commission stated:

> *The human suffering caused by these events is overwhelming. Families lost loved ones and an entire community endured widespread destruction. The depth of this tragedy is the source of our resolve to take all actions necessary to ensure it never happens again.*[2]

At that time, the Commission's stated goal was "to establish rules and policies that accord safety of gas utility operations the highest level of significance. We must ensure that our gas utilities recognize that mere compliance is not enough."[3] SoCalGas and SDG&E share this goal and an unwavering commitment to public safety. As such, SoCalGas and SDG&E seek authority to go beyond minimal compliance and continue to invest in the safety and reliability of their natural gas system. To enable those ongoing efforts, it is critical that the Commission refrain from adopting a risk-based decision-making framework (RDF) model in this proceeding that will inhibit the State's utilities from considering the potential consequences of tail risk events in their risk-based decision-making.

The SoCalGas gas system spans over 100,000 miles of pipeline (5.9 million meters) and serves 22 million customers across 24,000 square miles of territory. It is an intricate and complex system that includes intrastate pipelines and underground storage. The State of California imports over 90% of its natural gas supplies through intrastate, interstate, and international pipelines to continuously meet customer demand as far north as Visalia, south to Mexico, and from the Pacific coast to the Nevada/Arizona border. The SoCalGas transmission system is the primary feed to the SDG&E gas system and essential to meeting the electric generation needs of Southern California. Thus, the gas system is critical to meeting the current and future energy needs of California.

Given the size and diversity of the natural gas system that serves Southern California, the consideration of tail risk is a key element in the utilities risk-based decision-making process to account for low probability/high consequence events and ensure the continued safety and reliability of our customers and public in delivering natural gas.

As part of SoCalGas's and SDG&E's Integrity Management Programs, continuous improvement efforts are underway to mature the management of potential threats by transitioning to increasingly quantified methods in both the modeling of risk and the determination of remediation activities. As part of the Transmission Integrity Management Program (TIMP), assessment results from in-line inspections (ILI) have been used to perform corrosion reliability assessments that necessarily account for the tail behavior present in ILI data. Within the Distribution Integrity Management Program (DIMP), a transition from relative risk ranking to quantified risk ranking is underway, which recognizes distributions of risk that account for improbable events. In the Storage Integrity Management Program (SIMP), efforts to develop industry leading quantified models for downhole well integrity are underway, and tail risk is a fundamental component of accurately measuring the risk associated with various well mitigation activities. In this way, SoCalGas's and SDG&E's development of processes that recognize the full risk profile present on each asset type is a fundamental element of maturing into a comprehensive view of risk-informed decision-making.

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[2] R.11-02-019 at 1.

[3] *Id* at 10.

In 2017, the Western Electricity Coordinating Council (WECC) commissioned a study of the gas/electric interface in the Western Interconnection to identify potential threats to grid reliability at present and in the future. Specifically, the June 2018 Western Interconnection Gas - Electric Interface Study[4] found that limitations on Aliso Canyon had heightened region-wide reliability risks to the Western Interconnection (a wide area synchronous grid stretching from Western Canada south to Baja California in Mexico, reaching eastward over the Rockies to the Great Plains). The authors of this WECC Study (Wood Mackenzie) also presented in Rulemaking (R.) 20-01-007 (Order Instituting Rulemaking to Establish Policies, Processes, and Rules to Ensure Safe and Reliable Gas Systems in California and Perform Long-Term Gas System Planning), and highlighted that "the impact of an Aliso Canyon outage/retirement and its ripple effects into neighboring regions," including, for example, "significant unserved energy and unmet spinning reserves resulting in [approximately $1 billion] risked impact across Southwest / CA." [5]The authors of the study indicated that "[t]he actual event would effectively be around a 30-billion-dollar economic-impact event, so quite significant."[6] Consideration of the tail risk potential of such catastrophic reliability events is essential to address system reliability.

Going forward, if the Commission were to adopt a risk-based decision-making framework that considers "expected value" as a baseline position, then the results could potentially be catastrophic. An analysis that fails to allow utilities to properly account for and address the potential consequences of infrequent, yet catastrophic, events would fail to account for the true potential consequences and impacts to the system and society at large of such events and could potentially lead to the dangerous supposition that investments to prevent and mitigate the potential consequences of catastrophic natural gas risk events should be defunded. Instituting a "minimum" requirement of expected value and ignoring or undervaluing the potential consequences of tail events could arguably support the conclusion that all mitigations (outside of compliance) should be suspended whenever a system operates free of incident and should only be funded after an incident has occurred.

**Conclusion**

In this paper, the Joint Utilities have provided two practical examples that demonstrate why it is important to consider tail risk events. We also outlined generally-accepted approaches to establishing tail risk event metrics. In addition, we described, through these examples, why existing requirements to use expected values may not be aligned with underlying data that supports a given risk analysis, or with regulatory, judicial, or other applicable guidance.

We continue to stress the need to address critical topics, such as tail risk, within the broader context of risk scaling (attitude) and risk tolerance. Unless and until the Commission decides the issue of risk tolerance and clarifies *whose* risk attitude is actually reflected in these analyses, we continue to stress that continued flexibility is the most reasonable and appropriate approach. The utility with the burden of proof must be able to present its risk analysis and mitigation selection in the most effective, efficient, and accurate manner, consistent with how the utility assesses risks and runs its operations and business processes.

[4] https://www.wecc.org/Reliability/Western%20Interconnection%20Gas-Electric%20Interface%20Study%20Public%20Report.pdf

[5] R.20-01-007 Track 1B Workshop Presentation at Slide 13.

[6] *Id.*