

SoCalGas and SDG&E

Tail Risk Discussion in Advance of Technical Working Group #6

Risk Informed Decision-Making Proceeding (R.20-07-013)

November 22, 2023

## TABLE OF CONTENTS

I.	INTRODUCTION .....	1
II.	SUMMARY OF DISCUSSION .....	1
III.	THE COMPANIES’ BUSINESS DECISION-MAKING APPROACH, AND SOUND RISK MITIGATION PRINCIPLES, NECESSITATE CONSIDERATION OF TAIL RISKS.....	2
A.	The Companies operate in a “tail risk” industry, marked by the real risk of catastrophic losses of life, property, and ecosystems. ....	3
B.	If the Companies manage to “expected value” losses where tail risk exists, the worst-case outcomes remain unmitigated or under-mitigated. ....	4
C.	Not all aspects of the Companies operations are exposed to catastrophic risk, and we calibrate our mitigations accordingly. ....	5
D.	Other industries with comparable tail risk exposures orient their risk management around catastrophic events, and have well-defined, tail-risk mitigation frameworks. ....	6
i.	Oil and Gas E&P Industry .....	7
ii.	Nuclear Power Industry .....	8
iii.	Commercial Aviation Industry .....	9
iv.	Chemicals Industry .....	10
IV.	TAIL RISK MUST BE ADDRESSED IN CONCERT WITH RISK ATTITUDE AND RISK TOLERANCE .....	11
V.	CONCLUSION.....	11

## I. INTRODUCTION

San Diego Gas & Electric Company (SDG&E) and Southern California Gas Company (SoCalGas) (collectively, the Companies) appreciate the ongoing efforts of the Safety Policy Division (SPD) to advance the Risk-Based Decision-Making Framework (RDF) in the Safety Model Assessment Proceeding (S-MAP) Phase III.

A central characteristic of the utility industry the Companies operate in is the risk of catastrophic events. Unfortunately, our industry has experienced several events resulting in multiple fatalities, property losses, and expenses amounting in some cases to billions of dollars for a single event. Indeed, the RDF was established on the basis of such a catastrophic event in recognition of the ongoing and ever-present risk associated with operating utility infrastructure at scale.

As currently written, the Risk-Based Decision-Making Framework (RDF) provides for inclusion of catastrophic, or “tail” risk, in the formation of Benefit Cost Ratios (B/C Ratios) but does so as an “alternative” to an approach that relies on expected value.<sup>1</sup> In this paper, the Companies explain and support in detail how, for certain aspects of their operations, tail risk is the primary driver for risk mitigation decisions. For those aspects of the Companies’ operations for which tail risk events are a central driver – such as managing risks related to wildfire, medium-pressure and high-pressure gas operations, and electric infrastructure integrity – a framework oriented on expected value is inappropriate and could potentially lead to underinvestment in critical measures necessary for public safety and safe operations of our utility systems.

The Companies recognize that SPD held a Technical Working Group (TWG) on tail risk; however, that TWG focused on the modeling of wildfire tail risks and did not directly address the role of tail risk in the CBF. This paper addresses the importance of tail risk as both central to the Companies’ decision-making and necessary for understanding risk attitude, in advance of the upcoming December 6, 2023, TWG #6.

## II. SUMMARY OF DISCUSSION

As detailed in this paper, any final California Public Utilities Commission (Commission or CPUC) decision in this proceeding should account for the following considerations:

- Tail risk – specifically black swan event risk – is an unambiguous feature of certain risks from IOU operations, including catastrophic wildfires, medium-pressure and high-pressure gas incidents, cybersecurity risks, and perhaps others.
- Where tail risk exists, the RDF must continue to allow for recognition that the prevention of tail risks is the *primary lens* through which risk attitude and, ultimately, B/C ratios are developed.
- Where tail risk exists, the RDF must recognize that a decision-support approach in supplement to the CBF is necessary to accommodate critical mitigations that otherwise might not be considered “cost effective.”

---

<sup>1</sup> “Expected value” is a term that refers to the sum of all probability-weighted potential outcomes. Expected value does not correlate to any of the possible outcomes. Expected value is often cited in decision theory where a high number of iterations occur (such as gambling) but has less utility in one-time decisions (such as whether or not to make a risk mitigation investment).

- Not all of the Companies risk exposures are of a catastrophic/tail risk magnitude. For such risks, the Companies calibrate their mitigation investments accordingly in order to allocate limited resources to priority risks and to safeguard affordability balanced with safety and reliability of the system.
- The established risk frameworks of industries that bear similar risk profiles to that of the Companies are instructive to understanding tail-risk oriented risk attitude and risk management.
- Sound application of risk tolerance dictates that it is reasonable and prudent to manage risk in defense of tail risk outcomes, not expected value outcomes.
- For those areas of the Companies’ operations exposed to tail risk events, pre-emptive investments in targeted mitigations are preferable to, and less costly than, reactive respond and restore expenditures.

### **III. THE COMPANIES’ BUSINESS DECISION-MAKING APPROACH, AND SOUND RISK MITIGATION PRINCIPLES, NECESSITATE CONSIDERATION OF TAIL RISKS**

Before delving into the importance of “tail risk” in the Companies’ risk-based decision-making, it is first useful to distinguish two definitions of the term “tail risk.” Within the domain of statistics, “tail risk” typically refers to the tail of a probability distribution as derived from a data set (*e.g.*, the 95th or 99th percentile outcome). We will refer to this first definition as “parametric tail risk.” “Tail risk” can also refer to the potential for a singular catastrophic event (or very few events) whose consequences dwarf all other events. Such events are often referred to as “quantum events,” or “black swan events” because they would appear to be impossible on the basis of the statistical (parametric) risk distribution, yet they happen nonetheless. We will refer to this second definition as “black swan event risk.” In the body of this paper, the reference to “tail risk” is primarily focused on the latter definition.

The potential for catastrophic events has shaped the Companies’ mitigation strategies over the last two decades.<sup>2</sup> Indeed, SDG&E was lauded by the Commission for its leadership in wildfire mitigation.<sup>3</sup> Likewise, SDG&E was awarded the “2023 Chartwell Best Practices Award” for developing and using the Wildfire Next Generation System, or WiNGS, to help protect communities it serves from regional wildfire risk.

As described and supported in detail herein, while expected value can (and does) provide appropriate guidance for some aspects of our operations, there are aspects that are definitively characterized by tail risk, among them wildfire prevention, medium- and high-pressure gas integrity management, and electric and gas system safety/integrity management. For these aspects of our operations, our decision-making is oriented around tail risk exposure as is consistent with sound risk mitigation principles observed both in our industry and in industries with similar risk profiles.

---

<sup>2</sup> CPUC Workshop for Rulemaking (R.) 20-07-013: Phase 3 Workshop #2 on Tail Risk: Consequence Modeling (July 26, 2023) at 51:50, *available at* <https://youtu.be/LyxpIliMTi4>.

<sup>3</sup> R.18-10-007, CPUC Public Meeting on Utility Safety Practices (August 25, 2021). Commissioner Shiroma commended the “tremendous efforts” SDG&E has made as well as SDG&E’s “deserved reputation for spearheading many of the safety efforts, particularly with wildfire mitigation, even some years before other utilities.”

**A. The Companies operate in a “tail risk” industry, marked by the real risk of catastrophic losses of life, property, and ecosystems.**

The initiating event for the RDF was a catastrophic event – the 2010 San Bruno pipeline rupture – and the priority of the RDF has since been the prevention of events of such magnitude. As MGRA pointed out in its tail risk White Paper presented in the July 26, 2023 TWG, losses and damages are dominated by “tail risk” (catastrophic) events.<sup>4</sup> As shown in Figure 1 below, counter to the notion that catastrophic events are exceedingly rare, our industry has seen numerous catastrophic events in the past 15 years in California and elsewhere:

**Figure 1. Non-Exhaustive List of Utility Industry Catastrophic Events Since 2007**

Event	Year	Fatalities	Reported Losses (\$Millions)
Winter Storm Uri (TX) <sup>5</sup>	2021	210	\$80,000
Camp Fire (CA) <sup>6</sup>	2018	85	\$10,750 – \$16,500
North Bay Fires (CA) <sup>7</sup>	2017	44	\$9,400
Thomas Fire (CA)	2017	2	\$2,470
San Bruno Pipeline Explosion (CA) <sup>8</sup>	2010	8	\$2,200
Witch Fire (CA)	2007	2	\$2,080
Merrimack Valley Gas Explosion (MA) <sup>9</sup>	2018	1	\$1,685
Dixie Fire (CA) <sup>10</sup>	2021	1	\$1,150

<sup>4</sup> Specific to wildfires in SDG&E’s territory, Dr. Mitchell’s identifies that “the three largest historical wildfires in San Diego County...caused more loss of life and property than all the other San Diego fires combined.” (Mitchell White Paper at 16-17). See R.20-07-013, Tail Risk and Event Statistics for Utility Planning (August 1, 2023) at 16-17.

<sup>5</sup> Comptroller.Texas.Gov, Winter Storm Uri 2021 – The Economic Impact of the Storm (October 2021), available at <https://comptroller.texas.gov/economy/fiscal-notes/2021/oct/winter-storm-impact.php#:~:text=The%20storm%20contributed%20to%20at,%2480%20billion%20to%20%24130%20billion.>

<sup>6</sup> Insurance Information Institute, Facts + Statistics: Wildfires, available at [https://www.iii.org/fact-statistic/facts-statistics-wildfires#Top%2010%20Costliest%20Wildland%20Fires%20In%20The%20United%20States%20\(1\)](https://www.iii.org/fact-statistic/facts-statistics-wildfires#Top%2010%20Costliest%20Wildland%20Fires%20In%20The%20United%20States%20(1);); see also, California’s Camp Fire was the Costliest Global Disaster Last Year, Insurance Report Shows (January 11, 2019), available at <https://www.latimes.com/local/lanow/la-me-ln-camp-fire-insured-losses-20190111-story.html>.

<sup>7</sup> California Department of Insurance, October Wildfire Claims Top \$9.4 Billion Statewide (December 6, 2017), available at <https://www.insurance.ca.gov/0400-news/0100-press-releases/archives/release135-17.cfm>.

<sup>8</sup> Courthouse News Service, PG&E Settles Shareholder Suit for \$90 Million (July 19, 2017), available at <https://www.courthousenews.com/pge-settles-shareholder-suit-90-million/>.

<sup>9</sup> U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Pipeline Incident 20 Year Trends, available at <https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-incident-20-year-trends>.

<sup>10</sup> Washington Post, PG&E Faces Federal Probe in Dixie Fire, Estimates \$1.15 Billion in Losses from the Blaze (November 2, 2021), available at <https://www.washingtonpost.com/nation/2021/11/02/pge-dixie-fire-inquiry-california/>.

Event	Year	Fatalities	Reported Losses (\$Millions)
East Harlem Gas Explosion (NY) <sup>11</sup>	2014	8	\$153
Hennipen Gas Explosion (MN) <sup>12</sup>	2017	2	\$52
Dan River Coal Ash Spill (NC) <sup>13</sup>	2014	0	\$1,100 – \$9,000

Indeed, the five costliest, electric-infrastructure-related wildfires in the U.S. on record – all of which occurred in California – resulted in 116 fatalities, nearly 28,000 lost properties, and more than \$30 billion in losses.<sup>14</sup> For comparison, the U.S. commercial nuclear power industry, which orients its risk management around the mitigation of catastrophic events (as discussed below), has recorded no fatalities or property losses on record.<sup>11</sup>

SDG&E is proud of its wildfire mitigation efforts in the past 15 years and recognizes the continuing threat and the need to remain vigilant. For example, FEMA just announced that San Diego County remains the *highest wildfire threat county in the U.S.*<sup>15</sup> The Companies also note that in 2016, in the wake of then unprecedented wildfires, the CPUC moved toward a “reasonable worst case” approach, only to have the magnitude of those fires eclipsed by the 2018 fires. Given that past wildfires have led to thousands of acres of damage, lost property, and fatalities it would be difficult to conceive of a scenario that is worse than some of the wildfires previously experienced in that region of the state.”<sup>16</sup>

**B. If the Companies manage to “expected value” losses where tail risk exists, the worst-case outcomes remain unmitigated or under-mitigated.**

Given the potential for catastrophic loss of life, property and ecosystems evidenced above, if we orient our risk management around “average” losses, and consequently fail to take prudent actions to prevent the next catastrophe, we will have failed our customers and the citizens of California, and the RDF will stand as a policy failure. The Companies are concerned that the CBF is drifting in a direction that does not adequately account for tail risk, and more generally is becoming geared toward expected value (as discussed below). As Dr. Mitchell states in MGRA’s Tail Risk White Paper, a framework that considers only “average” or “expected value” consequences runs the risk of “underestim[ing] the value of mitigation[, which] may lead to underinvestment in mitigation, and consequently the loss of life and

<sup>11</sup> Reuters, Con Edison Reaches \$153 Million Settlement Over Fatal 2014 Harlem blast (February 16, 2017), *available at* <https://www.reuters.com/article/us-new-york-conedison/con-edison-reaches-153-million-settlement-over-fatal-2014-harlem-blast-idUSKBN15V2Q8/>.

<sup>12</sup> U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, *available at* <https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-incident-20-year-trends>.

<sup>13</sup> WFAE 90.7, Duke Energy Customers Won’t Be Charged \$1.1B for Coal-Ash Cleanup After NC Settlement (January 25, 2021), *available at* <https://www.wfae.org/energy-environment/2021-01-25/duke-energy-nc-officials-announce-coal-ash-expense-deal>.

<sup>14</sup> Insurance Information Institute, Facts + Statistics: Wildfires, Top 10 Costliest Wildland Fires in the United States, *available at* <https://www.iii.org/fact-statistic/facts-statistics-wildfires>.

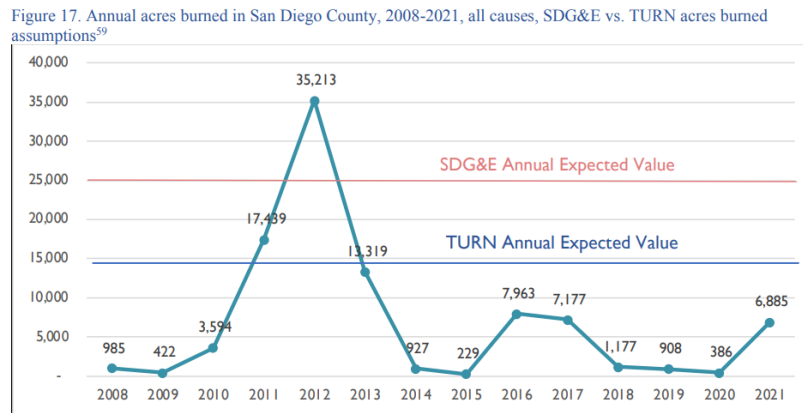
<sup>15</sup> Federal Emergency Management Agency (FEMA) National Risk Index, Wildfire, *available at* <https://hazards.fema.gov/nri/wildfire>.

<sup>16</sup> I.16-10-016/-015, Administrative Law Judge’s Ruling Including Safety and Enforcement Division Report into Record and Scheduling Comments (March 9, 2017) at Attachment A, p. 63.

property.”<sup>17</sup> Likewise, SPD’s advisor in Phase II, Level4, recognized the deficiency in expected values in quantitative risk analysis generally, and in addressing risk aversion specifically.<sup>18</sup>

TURN’s testimony in the Companies’ TY 2024 GRC illustrates the error of applying an expected value framework where tail risk exists. In the below excerpt from that testimony,<sup>19</sup> TURN recommends managing wildfire risk to the “expected,” or average, acres burned from the past 15 years. (TURN notably truncates its data set at 2008, which excludes the catastrophic 2007 Witch, Rice and Guejito Fires.) Such an approach, if adopted, would omit the most damaging events (*i.e.*, those outcomes above the expected value line).

**Figure 2. Excerpt from TURN-08 testimony in SDG&E and SoCalGas 2024 GRC**



TURN’s promotion of mitigating all but the most damaging events is analogous to insuring only a portion of a home’s value. Moreover, by prudently investing to protect against catastrophic events, the Companies also mitigate all other, lesser events arising from the same risk drivers. Where tail risk exists such as those identified in Figure 1 above, the response and recovery costs well exceed the cost of mitigations to prevent such occurrences. If applied on the basis of tail risk (where tail risk exists), the CBF can be informative.

**C. Not all aspects of the Companies operations are exposed to catastrophic risk, and we calibrate our mitigations accordingly.**

In meeting their duties and responsibilities to safely serve the public and protect customers and employees, the Companies look at mitigating risk balanced with resource availability and affordability. As a matter of practice, variation in the level of resource intensity, as well as variation in the degree of risk aversion, neutrality, or acceptance are embedded in our day-to-day decision-making and operations. The Companies do this because, although we do not compromise on preventing high-impact events, we recognize the need to efficiently allocate our limited resources and to safeguard our commitment to affordability. For example, we prioritize our resources when repairing gas leaks based on their severity,

<sup>17</sup> MGRA White Paper at 11.

<sup>18</sup> Assessment of Joint Intervenors’ Multi-Attribute Approach Douglas W. Hubbard and Sam L. Savage (October 21, 2016) at 4-6.

<sup>19</sup> Application (A.) 22-05-016, Prepared Testimony of Eric Borden, Addressing San Diego Gas & Electric’s Test Year 2024 Wildfire Mitigation Hardening Measures and Related Wildfire Risk Modeling Issues (March 27, 2023, Revised June 23, 2023) (Exhibit TURN-08-E) at 31.

recognizing a level 3 leak in a high-consequence area (HCA) requires greater resource intensity and risk aversion than a level 1, non-HCA leak.

The law and Commission policy and precedent support a utility’s prioritization of funding in real time to “[r]espond to immediate or short-term crises outside of the RAMP and GRC process.”<sup>20</sup> As the Commission has stated: “RAMP and GRCs...are not designed to address immediate needs; the utilities have responsibility for addressing safety regardless of the GRC cycle.”<sup>21</sup> Further, the “Commission has always acknowledged that utilities may need to reprioritize spending between GRCs” and has recognized that a modern utility needs to more often change course to respond to “rapidly unfolding events such as the catastrophic wildfires in 2007, 2017, 2018, and now, 2019,” that require a utility to “quickly re-direct[] Commission-authorized GRC funding from its originally-intended purpose to a wholly different purpose.”<sup>22</sup>

**D. Other industries with comparable tail risk exposures orient their risk management around catastrophic events, and have well-defined, tail-risk mitigation frameworks.**

It is instructive to look to the risk frameworks of other industries that face comparable tail risks, as Mr. Schneider explained at the October 4, 2023 TWG on Risk Scaling.<sup>23</sup> In this section, the Companies discuss risk frameworks from the following industries: oil and gas exploration and production (E&P), nuclear power, commercial aviation, and chemicals. Similar to the IOUs, these industries’ operations are characterized by massive, physical infrastructure, handle highly dangerous substances, and for which failures of components or personnel can result in catastrophic losses of life, property and ecosystems. To illustrate, Figure 3 below lists a sampling of catastrophic events that have occurred in these industries since 2000:

**Figure 3. Sampling of Catastrophic Events in Industries Comparable to SDG&E and SoCalGas (since 2000)**

Example Catastrophic Events				
Industry	Description	Year	Fatalities	Reported Losses (\$M)
Oil & Gas	Texas City Refinery Explosion <sup>24</sup>	2005	15	\$1,500
	Deepwater Horizon Oil Spill <sup>25</sup>	2010	11	\$40,000
Nuclear	Fukushima Nuclear Disaster <sup>26</sup>	2011	2000	\$800,000

<sup>20</sup> D.18-04-016 at 6 (citing D.16-08-018 at 151-152).

<sup>21</sup> D.16-08-018 at 152.

<sup>22</sup> D.20-01-002 at 35.

<sup>23</sup> CPUC Workshop on Phase 3 Workshop #4: Risk Scaling (October 4, 2023), *available at* <https://www.youtube.com/watch?v=Wz0Q-uSeF5E> at 2:49:32.

<sup>24</sup> The New York Times, Company Deficiencies Blamed in 2005 Texas Explosion (March 21, 2007), *available at* <https://www.nytimes.com/2007/03/21/us/21explode.html>.

<sup>25</sup> Britannica, Deepwater Horizon Oil Spill, *available at* <https://www.britannica.com/event/Deepwater-Horizon-oil-spill>.

<sup>26</sup> Clean Technica, Fukushima’s Final Costs Will Approach a Trillion Dollars Just for Nuclear Disaster (April 16, 2019), *available at* <https://cleantechnica.com/2019/04/16/fukushimas-final-costs-will-approach-one-trillion-dollars-just-for-nuclear-disaster/>.



Example Catastrophic Events				
Industry	Description	Year	Fatalities	Reported Losses (\$M)
Aviation	China Eastern Airlines Flight 5735 crash <sup>27</sup>	2022	132	\$2,100
	Ethiopian Airlines Flight 302	2019	157	Combined Losses: \$20,000 <sup>28</sup>
	Sriwijaya Air Flight 182	2021	62	
Chemical	LaPorte Chemical Plant Explosion <sup>29</sup>	2014	4	\$16
	Tianjin Explosion <sup>30</sup>	2015	801	\$6000

### i. Oil and Gas E&P Industry

Among its risk practices, the oil and gas industry apply conditional value-at-risk (CvaR)<sup>31</sup> and Layer-of-Protection Analysis (LOPA)<sup>32</sup> risk-management frameworks, both of which are oriented around worst-case scenarios. As illustrated in Figure 4 below, the CVaR framework is notable in that it focuses on only the “worst case” potential outcomes, the prevention of which is imperative for the industry.

<sup>27</sup> Al Jazeera, China Eastern Faces Losses, Regulatory Scrutiny After Fatal Crash (March 23, 2022), available at <https://www.aljazeera.com/economy/2022/3/23/china-eastern-faces-losses-regulatory-scrutiny-after-fatal-crash>.

<sup>28</sup> Reuters, Ethiopian Airlines flies 737 MAX with Passengers for First Time since Deadly Crash (February 2, 2022), available at <https://www.reuters.com/business/aerospace-defense/ethiopian-airlines-fly-737-max-with-passengers-first-time-since-deadly-crash-2022-02-01/#:~:text=The%20accidents%20exposed%20a%20problem,shortcomings%20with%20the%20certification%20process>.

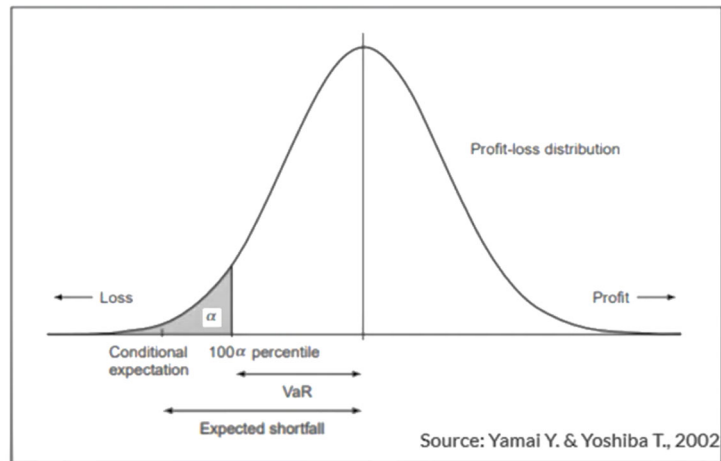
<sup>29</sup> Houston Public Media, DuPont Ordered to Pay \$16 Million for Deadly 2014 LaPorte Plant Chemical Leak (April 25, 2023), available at <https://www.houstonpublicmedia.org/articles/news/energy-environment/2023/04/25/449993/dupont-ordered-to-pay-16-million-for-deadly-2014-laporte-plant-chemical-leak/>.

<sup>30</sup> Offshore Energy, IUMI: Tianjin Disaster a Wake-Up Call to Cargo Insurers (September 15, 2015), available at <https://www.offshore-energy.biz/iumi-tianjin-disaster-a-wake-up-call-to-cargo-insurers/>.

<sup>31</sup> Tutorials Operations Research INFORMS 2008, Value-at-Risk vs. Conditional Value-at-Risk in Risk Management & Optimization, available at [https://www.ise.ufl.edu/uryasev/files/2011/11/VaR\\_vs\\_CVaR\\_INFORMS.pdf](https://www.ise.ufl.edu/uryasev/files/2011/11/VaR_vs_CVaR_INFORMS.pdf).

<sup>32</sup> Science Direct, Layer of Protection Analysis (Handbook of Fire and Explosion Protection Engineering Principles for Oil, Gas, Chemical, and Related Facilities (2019), available at <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/layer-of-protection-analysis>.

**Figure 4. Illustration of CVAR Risk Framework applied in the Oil and Gas Industry.**



**ii. Nuclear Power Industry**

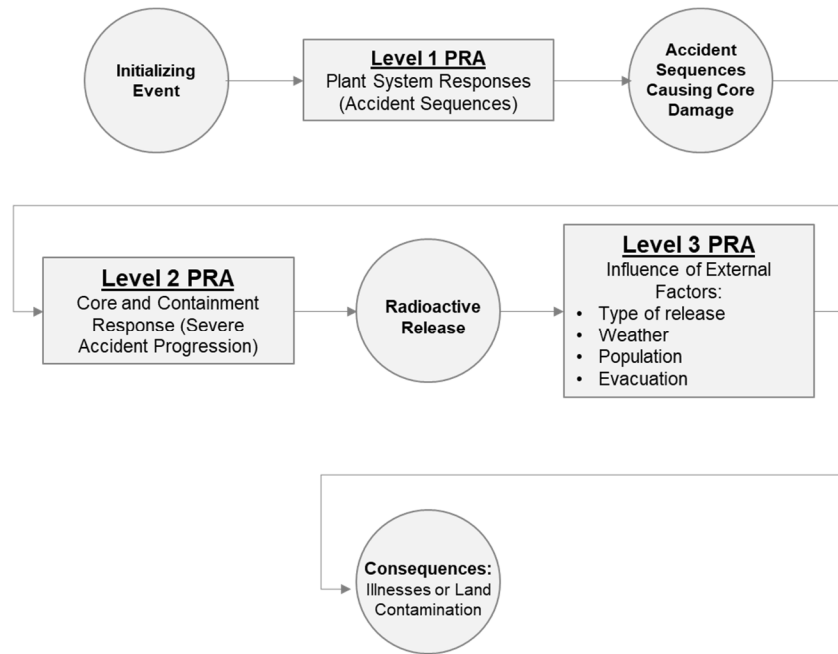
The necessity of preventing catastrophic events, namely uncontained radiation releases, goes without saying for the nuclear power industry. As such, the orientation of risk management in that industry is squarely focused on preventing high-impact events. The Companies note that, despite having no fatalities or property losses on record, the U.S. commercial nuclear industry has made \$3.6 billion in combined safety investments in response to the Fukushima nuclear accident in 2011.<sup>33</sup>

Among its layered risk and safety management frameworks, nuclear plant operators are required by the Nuclear Regulatory Commission (NRC) to apply an event-tree/fault-tree approach that emphasizes degrees of consequences within a probabilistic risk assessment (PRA) framework.<sup>34</sup> As shown in Figure 5 below, the PRA fault-tree framework anchors the catastrophic, Level 3 outcomes as the ultimate, to-be-prevented events:

<sup>33</sup> S&P Global Commodity Insights, US Nuclear Plant Operators Estimate \$3.6 bil in Post-Fukushima costs (June 6, 2013), available at <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/electric-power/060613-us-nuclear-plant-operators-estimate-36-bil-in-post-fukushima-costs>.

<sup>34</sup> United States Nuclear Regulatory Commission, Probabilistic Risk Assessment (PRA), available at <https://www.nrc.gov/about-nrc/regulatory/risk-informed/pr.html>.

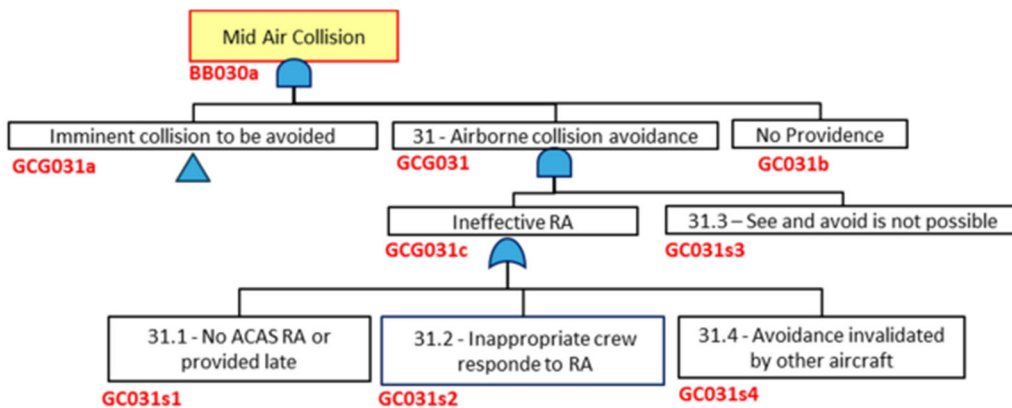
**Figure 5. Nuclear Power Industry 3-Level PRA Fault-Tree Risk Framework Schematic**



**iii. Commercial Aviation Industry**

Another industry for which prevention of catastrophic events is the obvious risk management priority is commercial aviation. The central goal of both the U.S. Federal Aviation Administration’s (FAA) “3P” (Perceive, Process, Perform) framework, and the European Union (EU)’s multi-faceted causal/fault tree analysis<sup>35</sup> framework (partial schematic shown in Figure 6 below) is the prevention of catastrophic collisions.

**Figure 6. Partial Schematic of European Union Sky Safety Multi-Faceted Causal/Fault Tree Risk Framework**



<sup>35</sup> European Commission, Integrated Risk Assessment Framework, available at [https://www.futuresky-safety.eu/wp-content/uploads/2019/07/FSS\\_P4\\_CEEA\\_D4.7\\_v2.0.pdf](https://www.futuresky-safety.eu/wp-content/uploads/2019/07/FSS_P4_CEEA_D4.7_v2.0.pdf).

Importantly, these aviation risk management frameworks are not affixed to “expected value” or other academic measures of average consequences; they are definitively anchored to understanding and preventing the cascading events that can result in catastrophic outcomes.

**iv. Chemicals Industry**

The chemicals industry deploys yet another tail risk-oriented risk management approach, the Safety Integrity Level (SIL)<sup>36</sup> index framework. The SIL framework, which is also deployed in other high-risk industries (including E&P), dictates that controls perform at ultra-low risk of failure, specifically for the purpose of preventing catastrophic events. As illustrated in Figure 7 below, the SIL index requires components to perform at between 10<sup>-5</sup> (99.999%) and 10<sup>-9</sup> (99.999999%) confidence level.

**Figure 7. Safety Integrity Level Component Failure Criteria**

High Demand (or Continuous) Mode of Operation	
Safety Integrity Level (SIL)	Probability of Failure on Demand (PFD/h)
1	10 <sup>-5</sup> -10 <sup>-6</sup>
2	10 <sup>-6</sup> -10 <sup>-7</sup>
3	10 <sup>-7</sup> -10 <sup>-8</sup>
4	10 <sup>-8</sup> -10 <sup>-9</sup>

Nothing in the SIL risk management design can be construed as being concerned with expected value consequences.

The chemicals industry (as well as tailing dams<sup>37</sup> and other industries) also commonly adopts the concept of As Low As Reasonably Practical (ALARP).<sup>38</sup> ALARP is a well-accepted *risk tolerance* framework that recognizes that i) certain outcomes must be prevented, ii) certain outcomes are acceptable, and iii) outcomes lying between i) and ii) should be mitigated to the greatest extent practical. Of note, the ALARP framework provides that the intolerable/prevent-at-all-cost region is specifically relevant to catastrophic events.

<sup>36</sup> Cross Company, Determining Safety Integrity Levels for your Process Application, *available at* <https://www.crossco.com/resources/articles/determining-safety-integrity-levels-for-your-process-application/>.

<sup>37</sup> A Case Study on ALARP Optimization Cesar Oboni, Franco Oboni, *available at* <https://www.riskope.com/wp-content/uploads/2022/07/A-Case-Study-on-ALARP-Optimization-2022-07-08.pdf>.

<sup>38</sup> Science Direct, Using the ALARP Principle for Safety Management in the Energy Production Sector of Chemical Industry, Volume 169 (January 2018), *available at* <https://www.sciencedirect.com/science/article/abs/pii/S0951832017300960>.

#### IV. TAIL RISK MUST BE ADDRESSED IN CONCERT WITH RISK ATTITUDE AND RISK TOLERANCE

Scott Pearson, SDG&E's Director of Risk and Compliance, and Greg Flores, SoCalGas's Director of Risk and Compliance, stated during the October 4, 2023 Risk Scaling TWG, the foundation of risk attitude within the Companies' decision-making process is our exposure.<sup>39</sup> As pertains to those tail-risk aspects of our operations, the Companies recommend that the Commission recognize the prevention of tail risks as the primary lens through which risk attitude and, ultimately, benefit-cost ratios are developed. Additionally, where there is the potential for catastrophic losses of an intolerable nature, a supplemental decision-support framework, such as As Low as Reasonably Practical (ALARP), is needed to accommodate critical mitigations that otherwise might not be considered "cost effective." Doing so would align the CBF with the way business decisions are and should be made in the face of tail risk exposures.

As indicated in the Companies' November 6, 2023 Opening Comments on TWG #4, our position is that the Companies' risk attitude should be reflected in the CBF.<sup>40</sup> Moreover, the Companies' predominately risk averse attitude is consistent with societal norms. No evidence has been provided supporting the view that ratepayers, or any population for that matter, are risk neutral. To the contrary, a recent study by Northwestern Mutual<sup>41</sup> indicates that the majority of the population is consistently risk averse along multiple dimensions of life. Likewise, a 2020 Columbia University study confirmed the 1979 findings of Kahneman and Tversky<sup>42</sup> that the motivational strength of losses is twice that of gains when people are faced with uncertainty.<sup>43</sup>

#### V. CONCLUSION

With this discussion, the Companies intend to provide additional insight into SoCalGas's and SDG&E's risk management approaches, with an emphasis on the criticality of tail risk in utility and non-utility industry risk-informed decision-making frameworks. We provided counterpoints to reliance on expected values as baseline measures for assessing risk and mitigation effectiveness and examples of how mitigations should be calibrated based on data and operational concerns. This discussion demonstrates that tail risk is inextricably linked to broader discussions including risk scaling and tolerance and that continued flexibility is the most reasonable approach for future modifications to the RDF.

---

<sup>39</sup> CPUC Workshop on Phase 3 Workshop #4: Risk Scaling (October 4, 2023), *available at* <https://www.youtube.com/watch?v=WzoQ-uSeF5E> at 2:08:44.

<sup>40</sup> *See generally*, R.20-07-013, Joint Comments of Southern California Gas Company and San Diego Gas & Electric Company to Administrative Law Judge's Ruling Providing Workshop #4 Questions for Party Comment (November 6, 2023).

<sup>41</sup> Northwestern Mutual, Planning & Progress Study 2019, *available at* <https://news.northwesternmutual.com/planning-and-progress-2019>.

<sup>42</sup> D. Kahneman and A. Tversky, Prospect Theory: An Analysis of Decision Under Risk, *Econometrica*, Vol. 47, No. 2 (March 1979), *available at* <https://courses.washington.edu/pbafhall/514/514%20Readings/ProspectTheory.pdf>.

<sup>43</sup> Ruggeri, K., Ali, S., Berge, M.L. *et al.* Replicating patterns of prospect theory for decision under risk. *Nature Hum Behavior* 4, 622–633 (May 18, 2020), *available at* <https://www.nature.com/articles/s41562-020-0886-x>.