Joint Utilities Uniform & Probabilistic Risk Assessment Methodology

Presented at the California Public Utilities Commission

February 15, 2017

DRAFT

Agenda

February 15th

- Welcome and Expectations for Workshop
- Overview of CPUC Objectives and Directives
- Overview of the Joint Utilities' Approach (JUA) – Uniform and Probabilistic
- Safety Focus: Application of the JUA to the Safety Attribute
- Comparison to CPUC Objectives and Directives
- Roadmap and Timeline

Why are we here?

"Our efforts must improve protection for the public, for utility workers and CPUC employees, …"

Pipeline Incidents

Wildfires

Cyber Attacks

"I think we're safer," Michael Picker, the new president of the California Public Utilities Commission, told KQED News in an interview. "I don't think we're safe enough to satisfy me."

Workplace Violence

Decision 16-08-018 Order

	Orders for The Utilities	Status
1	Vet the Joint Intervenor Multi-Attribute Approach foundational requirements and how it operates in real-world scenarios.	Vetting will be done once test-drive is complete
2	Test drive the Joint Intervenor Multi-Attribute Approach.	In progress
3	Review utility pilots.	On-going
4	Provide a showing of pilots demonstrating the use of probabilistic models. (e.g. probabilistic risk analysis, calibrated subject matter expertise, and risk reduction benefit per dollar)	Will be presented today Update progress in future workshops
5	Show how utilities strategies align with and/or differ from JIA using the same or similar problems.	To be completed once the JIA and JUA complete test-drives and assess pros and cons of both methodologies

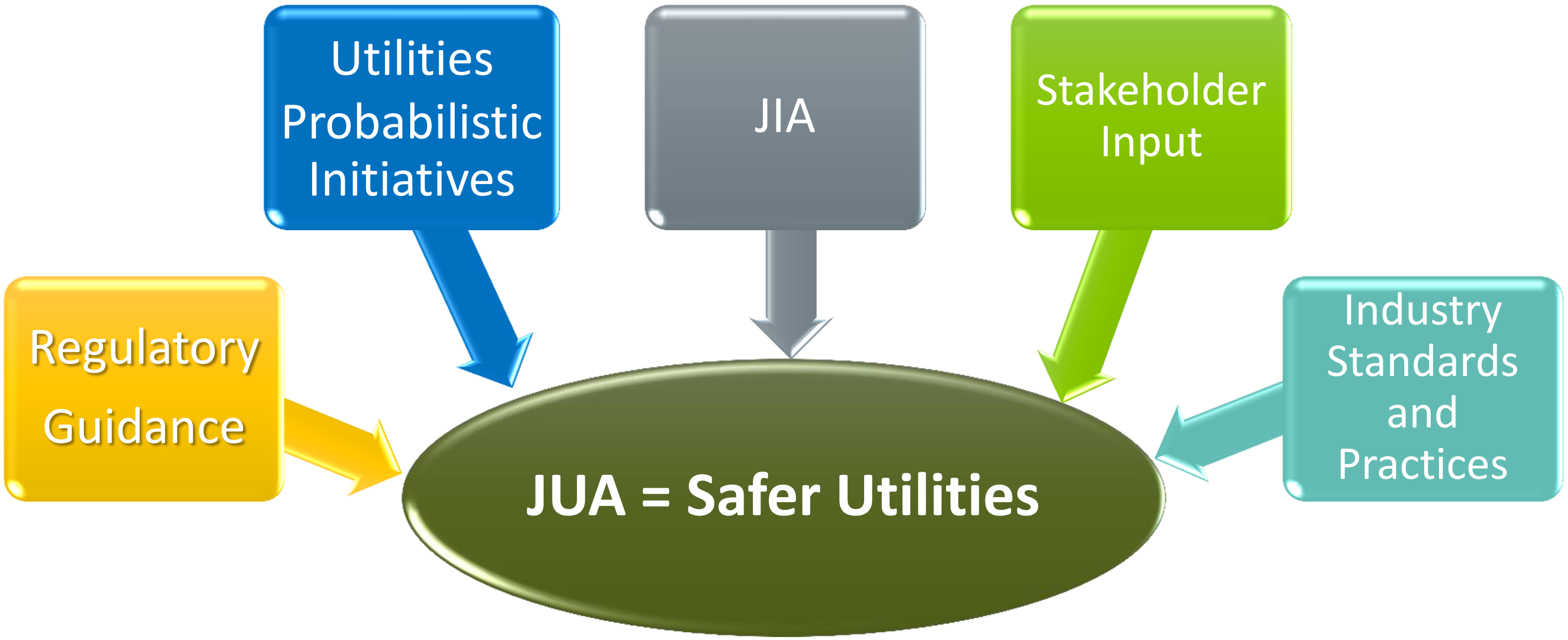
Utilities' Risk Management Uniformity Principles

- The Utilities focus on a number of uniform principles including:
  - ISO 31000
  - COSO
  - ISO 55000 tenets
  - API Recommended Practice 1173 Public Safety tenets
  - Cycla model
  - Risk lexicon
  - Impact categories
  - Likelihood category criteria
  - Safety category criteria

The JUA builds on these principles.

Expectations for the Workshop

- Introduce the Joint Utilities' Approach – Bow Tie Analysis, Probabilistic Quantification, Safety Focus, and Roadmap
- Demonstrate the application to the Safety Attribute of the JUA using utility risk examples
- Provide a roadmap for next steps



CPUC Requirements

CPUC Docs

Safety Policy Statement (July 10, 2014), Safety Action Plan and Regulatory Strategy (February 12, 2015), Policy and Planning Division and Safety Enforcement Division – Quantifying Risk: Building Resiliency into Utility Planning (January 23, 2014), Cycla Report (May 16, 2013), Liberty Consulting Report (May 6, 2013), Safety and Enforcement Division Risk Assessment section Staff Report on SoCalGas and SDG&E's 2016-2018 GRC (March 27, 2015), Safety and Enforcement Division Risk Assessment section Staff Report on PG&E's 2017-2019 GRC (March 7, 2016), Safety Enforcement Division Evaluation Report on the Risk Evaluation Models and Risked-based Decision Frameworks in A.15-05-002, et al (March 21, 2016), S-MAP Decision D.16-08-18 (August 18, 2016), S-MAP Scoping Memo and Ruling of Assigned Commissioner in A15-05-002 (December 13, 2016), and SED Report on SCE's 2018-2020 GRC A.16-09-001 (January 31, 2017)

- Probabilistic
- Safety–focused
- Simple / clear / transparent (understandable by non-experts)
- Uniform
- Comparable across risks and utilities
- Cost-effective modeling

Acceptance Criteria

Probabilistic

- CPUC Interim Decision* includes:
  - "… requires utilities to provide a 'showing' of 'pilots' demonstrating the use of probabilistic models (e.g., probabilistic risk analysis, calibrated subject matter expertise, and risk reduction benefit per dollar) …"
  - "… calibrated subject matter expertise is an essential component of developing the distributions used in risk analysis."

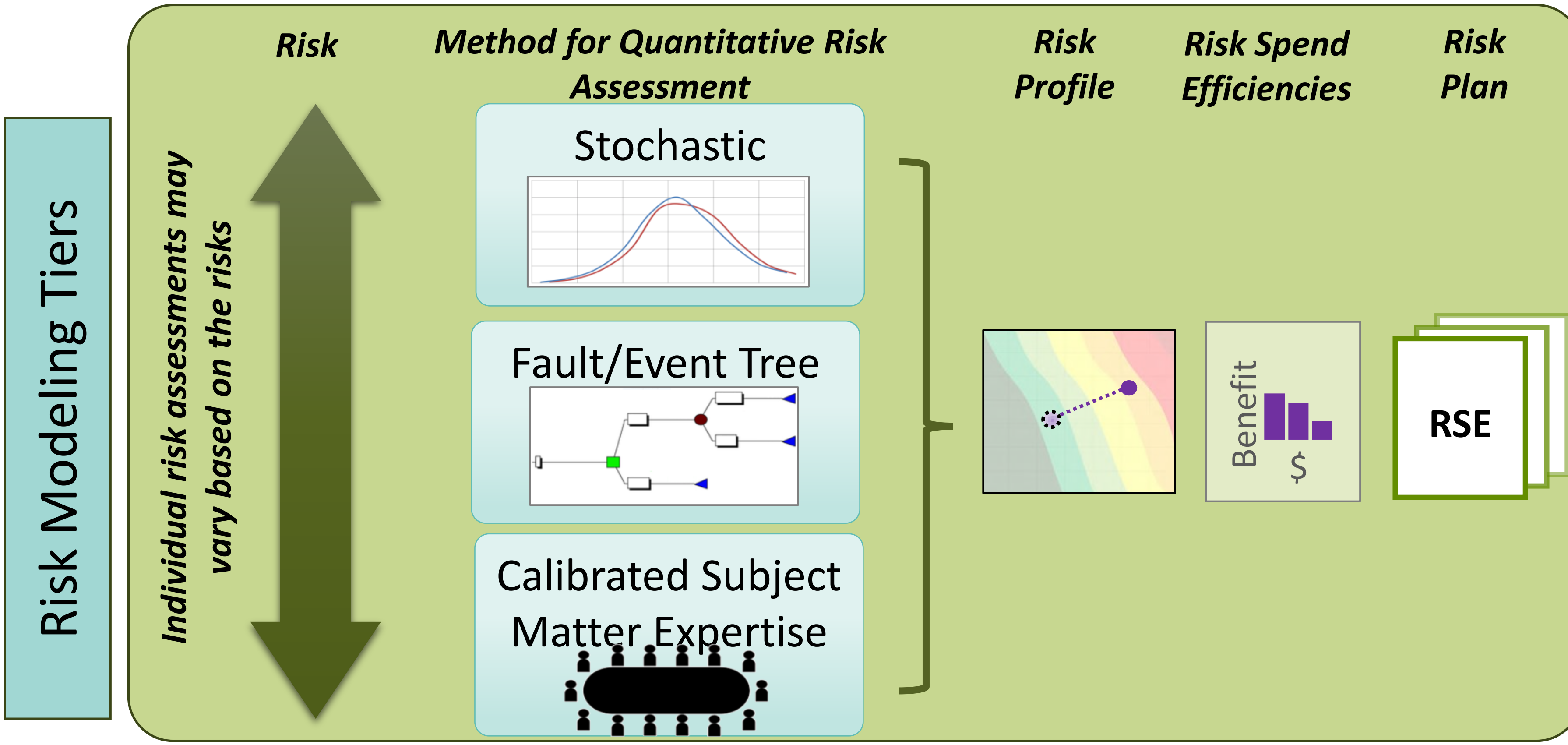
The JUA incorporates probabilistic risk analysis, uses calibrated subject matter expertise and results in comparable risk spend efficiency for risks and mitigations.

Demonstrated use of probabilistic models in first S-MAP filings (FiRM, TIMP, Electric T&D)
Started new pilots which will be illustrated today

**Decision 16-08-018 August 18, 2016 pg 191-192 and pg 73*

Probabilistic Modeling and Risk Modeling Tiers

Different risks warrant different levels of modeling sophistication based on various factors such as the significance of the risk, the cost effectiveness of modeling, data availability and feasibility.



Uniform

- CPUC Interim Decision* includes:
  - "… take steps toward a more uniform risk management framework."
  - "The utilities should take steps toward a more uniform approach towards calculation of risk reduction in a second phase of this proceeding"

The JUA proposes a uniform approach to safety risk assessment and risk spend efficiency determination.

Utilities have taken steps towards more uniformity in their process and frameworks (e.g. Cycla's model, bowties, etc.) JUA is a next step towards evaluation of risks and mitigations

**Decision 16-08-018 August 18, 2016 pg 1 and pg 190*

Comparability

- CPUC Interim Decision* includes:
  - "Develop comparable risk scores across utilities"
  - "The utilities need improvement in order to calculate risk reduction in a way that is comparable across utilities."

The JUA proposes a uniform approach that allows for comparisons across safety risks, controls, mitigations and utilities.

**Decision 16-08-018 August 18, 2016 pg 179 and pg 181*

Simple/Transparent

- CPUC Interim Decision* includes:
  - “Criteria to determine any priorities should be fulfillment of Commission goals, ability to impact short-term change, **transparency**, reasonableness, accuracy of results and **ease of preparation and implementation**, among other things.” (emphasis added)

The JUA provides a transparent, simple to use and easy to understand approach to comparing risks and mitigations within and across utilities.

**Decision 16-08-018 August 18, 2016 pg 173*

Safety Risks

- The CPUC Guiding Principles* include:
  - "Ultimately we are striving to achieve a goal of zero accidents and injuries across all the utilities and businesses we regulate within our own workplace."
  - "Continually assess and reduce the safety risk posed by the companies we regulate."
  - "Hold companies (and their extended contractors) accountable for safety of their facilities and practices"

- **The JUA begins by focusing on the safety attribute of Safety Risks**
- **The JUA approach is flexible and can accommodate additional attributes beyond safety**

** Safety Policy Statement of the California Public Utilities Commission July 10, 2014 pg. 1*

Cost Effective

- CPUC Interim Decision* includes:
  - "Adopting a common framework will ultimately streamline proceedings and minimize the mount of resources and time devoted to understanding the literacies of various models and provide useful comparisons."

The JUA is a common framework that allows for comparability of probabilistic safety risk assessment models

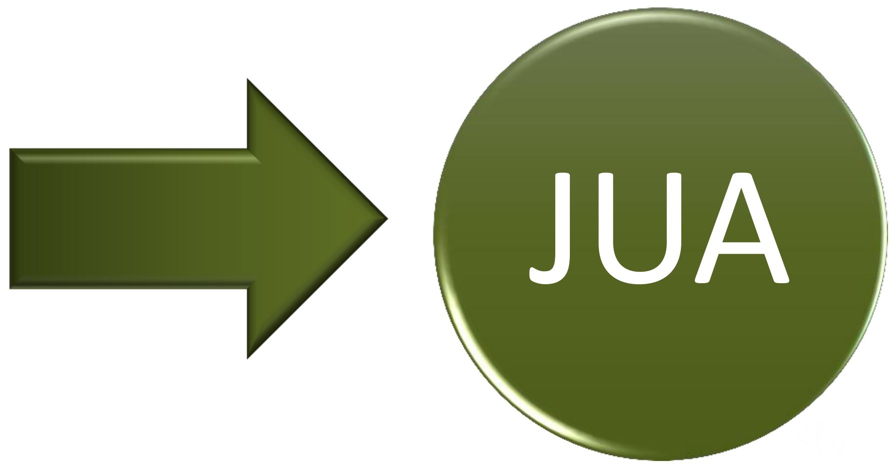
JUA acknowledges and provides for a varying degree of modeling maturity (tiers)

**Decision 16-08-018 August 18, 2016 pg 180 and pg 190*

The Joint Utilities' Approach
Model Overview

Developing the JUA

- Created a compendium of CPUC objectives and requirements.
- Built on each utility's ongoing risk management initiatives.
- Incorporated external experts' knowledge.
- Incorporated knowledge from initial JIA workshops.



Acceptance Criteria

Success = **Meets the CPUC Requirements**

- Per the CPUC's requirements, the model should be:
  - Safety-focused
  - Simple / transparent / understandable by non-experts
  - Uniform
  - Probabilistic
  - Comparable across risks and utilities
  - Cost-effective

JUA Methodology

The analytical framework that has been developed can be used to test the risk spend efficiency and effectiveness of mitigations

Common Lexicon

- Understand the risks in a common way, differentiating between risk events and drivers to the events
- Understand what potential exposure would entail

Risk Bow-Tie

- Perform a Bow Tie analysis to identify the drivers of the risk
- Determine event frequencies associated with each driver
- Align, as appropriate, on consequence categories and common currencies for each category with CPUC guidance

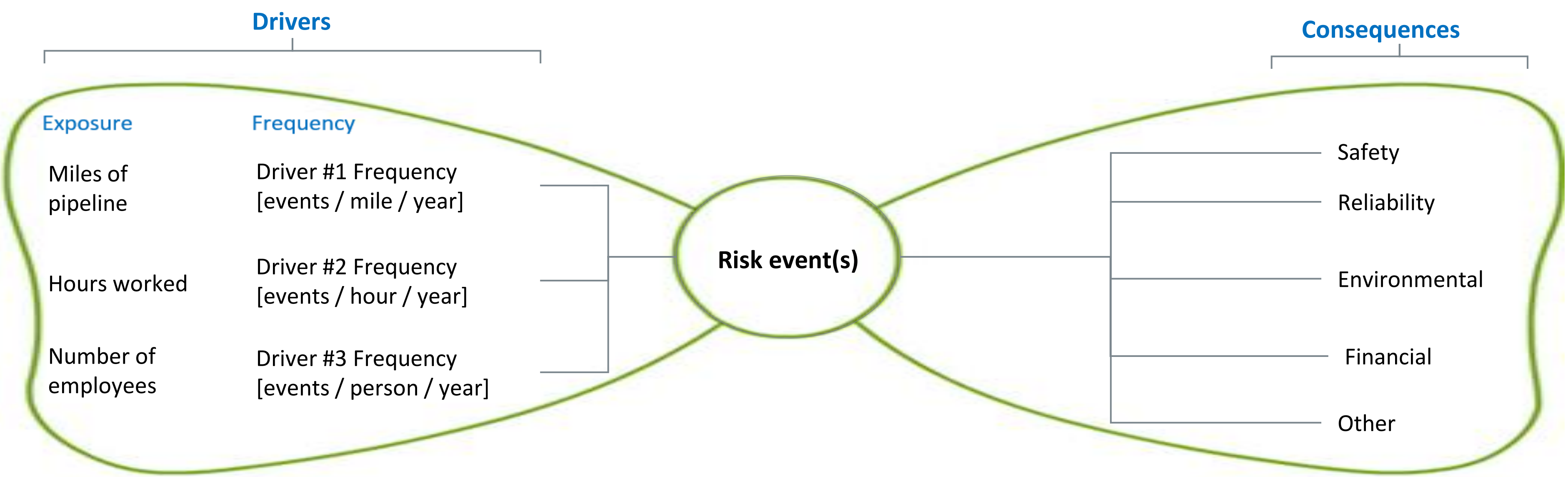
Actions

- Assess whether there are effective mitigations impacting critical risk drivers
- Understand spending needs over rate case period
- Calculate safety RSE as an input into decision-making

Determine the data needed to clarify and inform the risk event at each stage

JUA Methodology: Model Overview

Bow Tie provides transparent view of exposure, data-driven frequencies of risk drivers, and a consistent approach to developing consequence attributes



Quantitative Risk Assessment

Attribute methods and processes informed by JIA and the CPUC's input

- ✓ **Uniform methods and approaches**
- ✓ **Quantitative, multi-attribute scales and values will be utility-specific**
- ✓ **Transparent New weightings developed will help ensure Safety focus**

JUA Methodology: Model Components

Exposure	Frequency	Consequences	Mitigations
…what is the asset or non-asset measure that fundamentally affects the risk?	…what is the frequency of event drivers per exposure?	…if an event happens, what are the consequences?	…which programs alter the frequency or consequences of risk events? By how much?
People	**# / year / person**	**Safety** Other attributes	**Security programs, workforce training, etc.**
Example: **25,050** employees **8,700** contractors **33,750** total workforce	**Example:** **204 events**/ **1** year / all employees	**Example:** **22** injuries / event **14** fatalities / event	**Example:** **Location access control** among facilities and key personnel

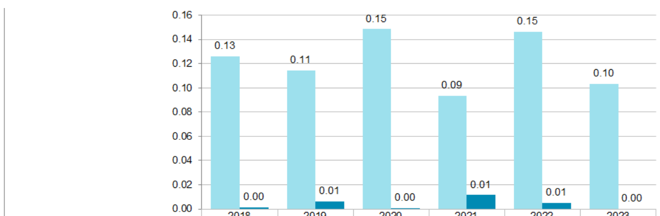
JUA Methodology: Model Outputs

Illustrative

Simulation and modeling allows for creation of different reports.

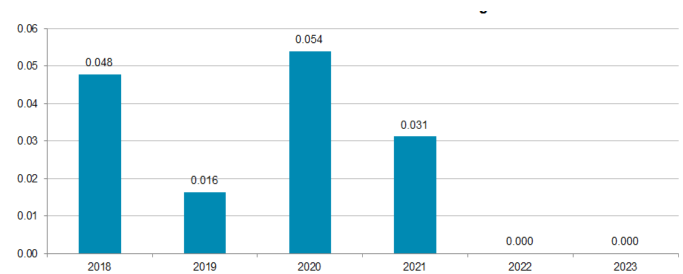
INPUT | **CALCULATIONS** | **RESULTS**

Report 1: Consequence Results over Time (Unmitigated vs. Mitigated)

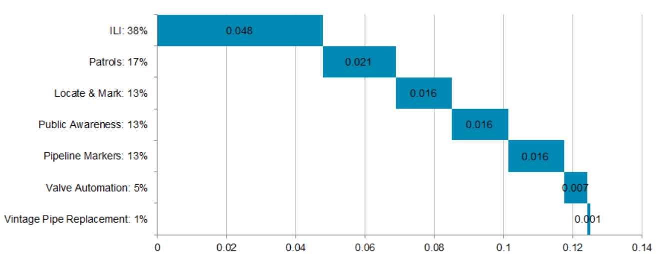


	2018	2019	2020	2021	2022	2023
GAS_Safety1_Fatality - Unmitigated	0.13	0.11	0.15	0.09	0.15	0.10
GAS_Safety1_Fatality - Mitigated	0.00	0.01	0.00	0.01	0.01	0.00
Delta	0.12	0.11	0.15	0.08	0.14	0.10

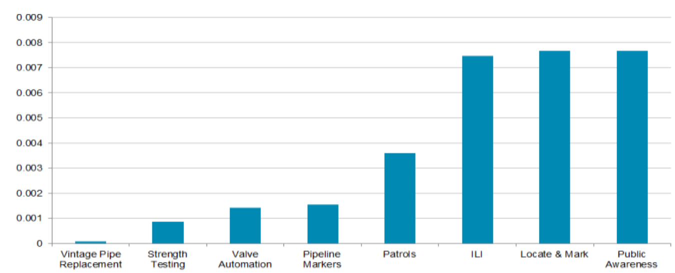
Report 3: Absolute Mitigation Effectiveness over time



Report 2: Mitigation Effectiveness per consequence



Report 4: Risk Spend Efficiency Reduction in consequence per dollar spent



Near-Term Application: The Safety Attribute of the JUA Model

Safety Attribute: A Good First Step

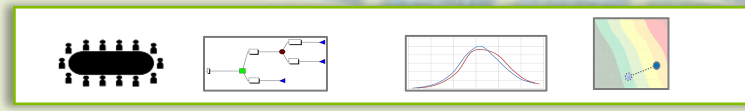
- JUA:
  - Focuses on safety
  - Allows for uniform, probabilistic comparison across risks, mitigations, utilities
  - Enables the use of various levels of modeling sophistication
  - Translates various types of modeling outputs into a common model that the utilities can use to prioritize and mitigate safety risks
  - Evaluates the effectiveness of mitigations in the context of the risks in the utilities' risk registers such as:
    - Safety risk reduction from wildfire risk
    - Safety risk reduction from pipeline failure risk
  - Flexible to be used in numerous ways
    - Risk Tolerances, Risk Spend Efficiency

JUA Overview

Illustrative

Internal Utility Analysis

- Developed internally
- Proportionate model detail
- Appropriate Data
- May include company-specific concerns



Outputs from various modeling approaches are translated into a

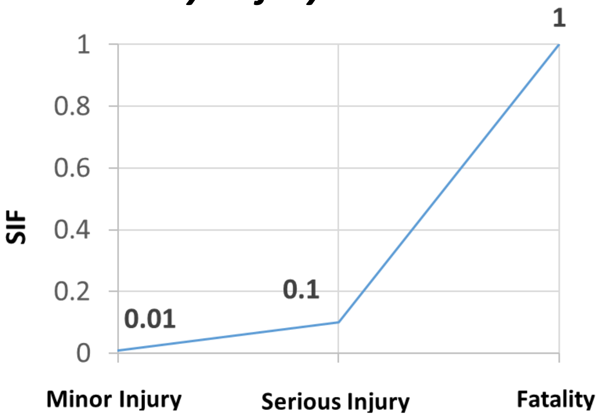
Uniform Safety Risk Matrix

Safety Impact	Extreme (2.5 – 12.5 SIFs*)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)
Likelihood**	0.05	0.10	0.33

* SIF = Serious Injury and/or Fatality.

** Values in table are annual likelihoods of occurrence, accumulated by any trigger in the risk category.

Preliminary Safety Attribute Curve



Note: This is a preliminary concept that helps translate various modeling approaches into common safety assessments. The safety metric and its associated impact categories are still under development and will incorporate lessons learned from JIA.

JUA Potential Applications

Potential application to be determined in collaboration with commission and interested parties

Application	Description	Value
Safety Reporting	*Transparently communicate safety exposure for each risk in a common language*	*Enables commission and parties to understand and compare utilities' safety risk exposure*
Safety Risk Scoring	*Develop common safety risk scores using natural units*	*Enables commission and parties to understand and compare utilities' safety risk profiles*
Safety Risk Spend Efficiency	*Calculate common safety risk spend efficiencies for mitigations*	*Enables commission and parties to understand and compare utilities' efficiency of safety mitigations*

Notes:

- RSE is useful because it cultivates the utilities' safety culture and provides valuable inputs that inform investment decisions in a transparent safety-focused way
- Other attributes, factors and constraints are important to consider when making final decisions

JUA Risk Scoring

Illustrative

Risk XYZ

Safety Impact	Extreme (2.5 – 12.5 SIFs)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)
Likelihood	0.05	0.10	0.33

Safety risk score calculation

Use midpoints of each impact level to do math:

$$\boldsymbol{Risk\ Score = \sum Impact \times Likelihood}$$

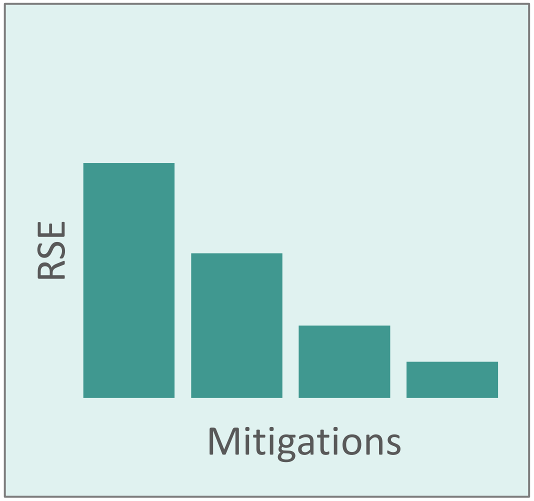
Safety Risk Score: (7.5 * 0.05) + (1.5 * 0.10) + (0.3 * .33) = **0.624**

Interpretation in Natural Units: On average, ~0.6 SIFs are expected to occur each year.

JUA Risk Spend Efficiency

If desirable, mitigations can be ranked based on safety risk reduction per dollar

	Safety Risk Score Before *(SIFs/yr)*	**Safety Risk Score After** *(SIFs/yr)*	**Cost** *($)*	**RSE** *Safety Risk Score Reduction/$*
Mitigation 1				
Mitigation 2				
.				
.				
Mitigation n				



JUA Potential Outputs

- Safety-based risk ranking for each company using a common framework
- Individual risk assessment summaries including:
  - Risk description
  - Utility-specific modeling approach (inputs, model, outputs)
  - Evaluation of current safety risk level
  - Alternatives analysis and mitigation ranking using a safety-based RSE

JUA Demo

Illustrative Examples

SDG&E Examples

Illustrative Examples

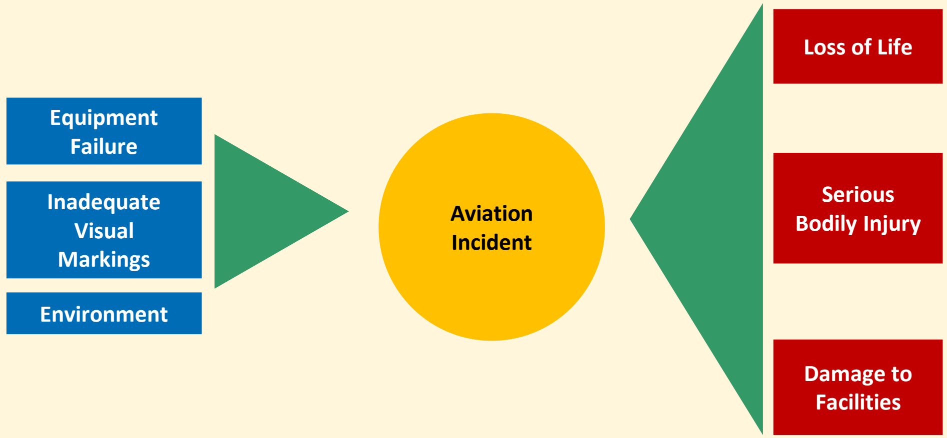
Aviation – Stochastic

Fail to Black Start – Event Tree

Stochastic Example: SDG&E Aviation

Illustrative

Probabilistic Model



Stochastic Example: SDG&E Aviation

Illustrative

- **Risk:** *Aviation risk from helicopters incurring safety events during operations*

Likelihood of Event

Gamma distribution
(14.658, 0.80717)

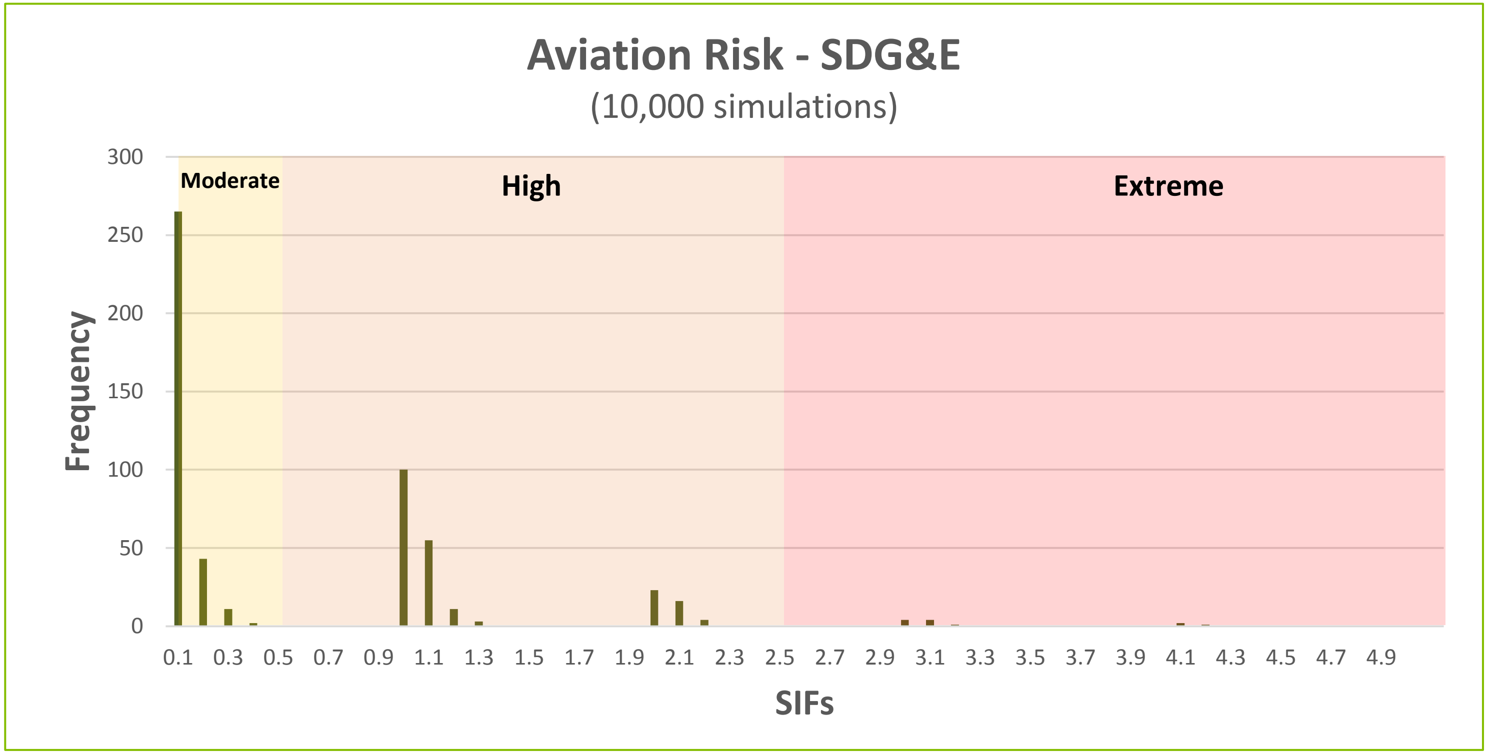
Consequence of Event

Geometric distribution
Fatality (0.77834)
Serious Injury (0.82717)
Minor Injury (0.72194)

Run	Fatality	Serious injury	Minor injury	SIF
A	1	0	0	1
B	0	0	0	0
C	0	2	1	0.21
D	2	1	0	2.1

Stochastic Example: SDG&E Aviation

Illustrative

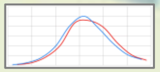


	Impact			
	Extreme	High	Moderate	Not Shown
SIFS	2.5-12.5	0.5-2.5	0.1-0.5	0-0.1
Occurrences	12	212	56	9720
Likelihood	.0012	.0212	.0056	.972

Stochastic Example: SDG&E Aviation

Illustrative

	Impact			
	Extreme	High	Moderate	Not Shown
SIFs	2.5-12.5	0.5-2.5	0.1-0.5	0-0.1
Occurrences	12	212	56	9720
Likelihood	.0012	.0212	.0056	.972



Uniform Safety Risk Matrix

Safety Impact	Extreme (2.5 – 12.5 SIFs)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)
Likelihood	0.0012	0.0212	0.0056

Stochastic Example: SDG&E Aviation

Illustrative

Aviation Risk – Pre-Mitigation (Operating single-engine helicopters)

Safety Impact	Extreme (2.5 – 12.5 SIFs)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)	Safety Risk Score (Expected SIFs/yr)
Likelihood	0.0012	0.0212	0.0056	0.0424

Aviation Risk – Post-Mitigation (Operating twin-engine helicopters)

Safety Impact	Extreme (2.5 – 12.5 SIFs)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)	Safety Risk Score (Expected SIFs/yr)
Likelihood	0.0003	0.0104	0.0006	0.0180

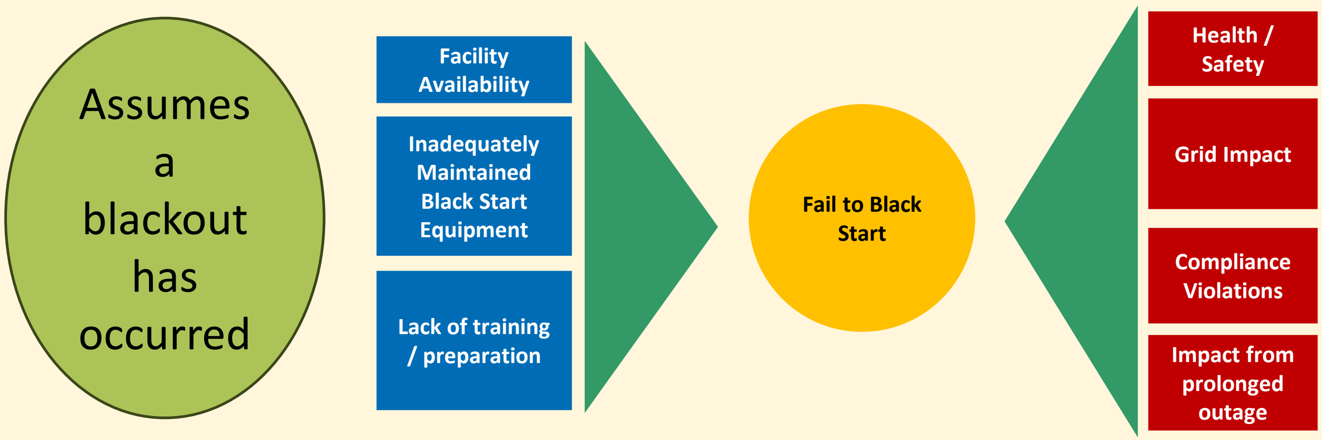
Risk Spend Efficiency

Mitigation	Safety Risk Score Before	Safety Risk Score After	Cost	Safety Risk Score Reduced/$1M
Replacing single engine with twin-engine	0.0424	0.0180	$3M	0.00815

Fault/Event Tree Example: SDG&E Fail To Black Start

Illustrative

Event Tree Model



Fault/Event Tree Example: SDG&E Fail To Black Start

Illustrative

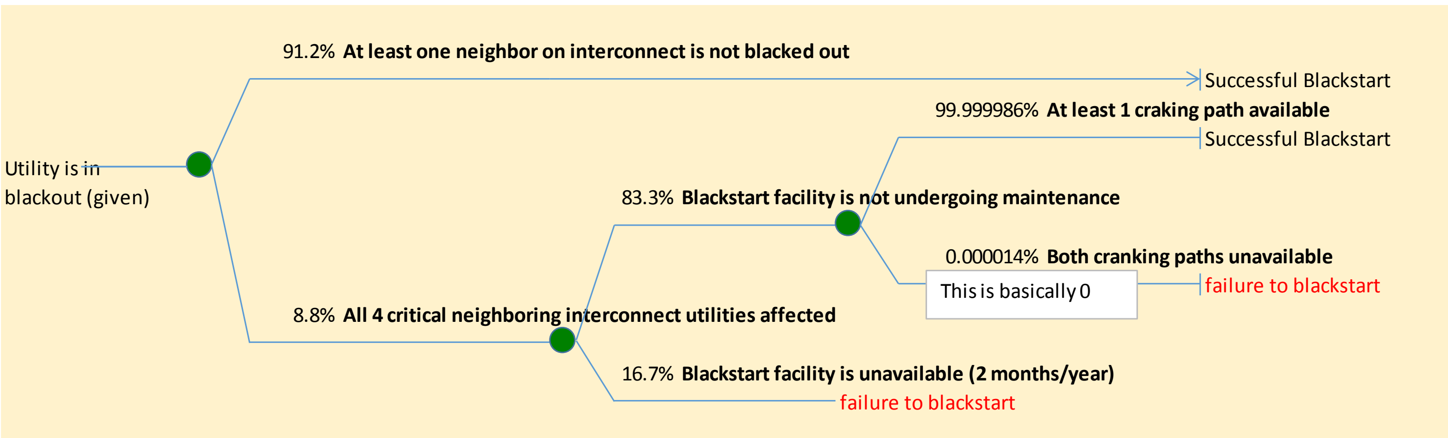
Pre-Mitigation

Current State

Current likelihood 1.8%

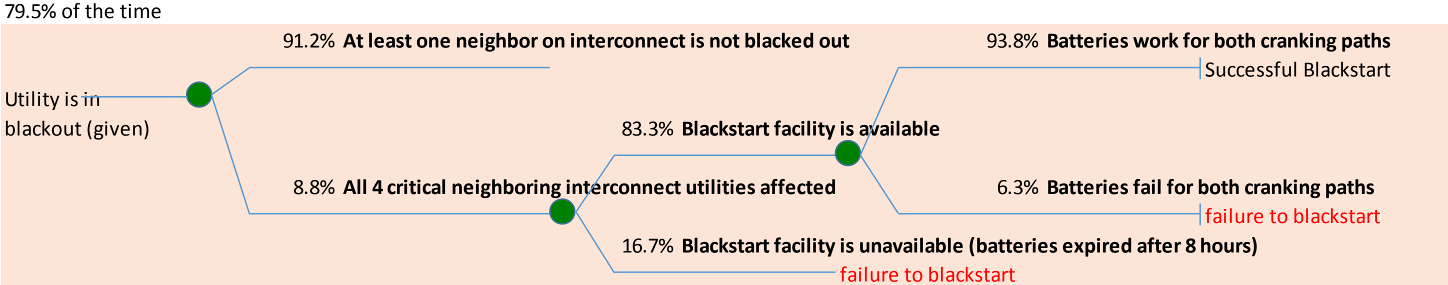
Blackout less than 8 hours: **0.3%**

20.5% of the time



Blackout greater than 8 hours: **1.5%**

79.5% of the time



PG&E SDGE A Sempra Energy utility SoCalGas A Sempra Energy utility SOUTHERN CALIFORNIA EDISON An EDISON INTERNATIONAL Company

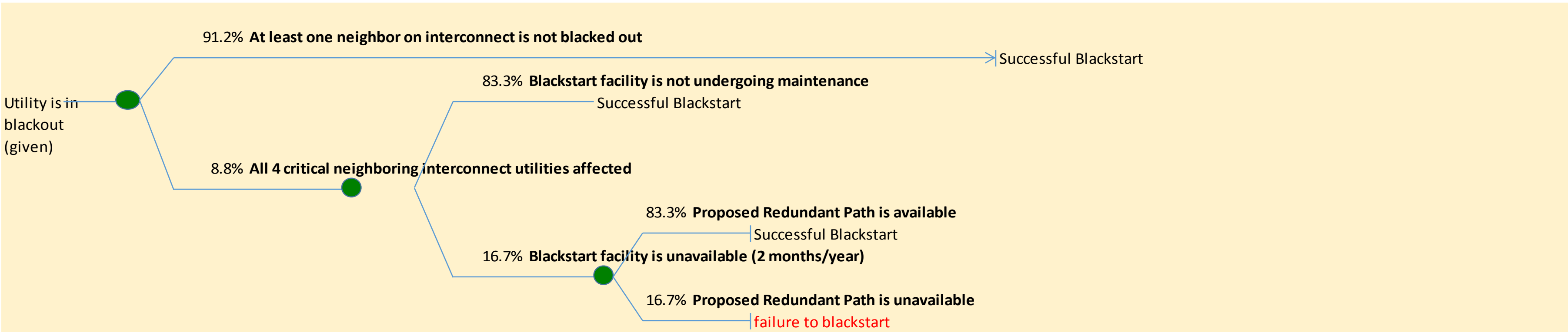
Example Methodology: SDG&E Fail to Black Start

Illustrative

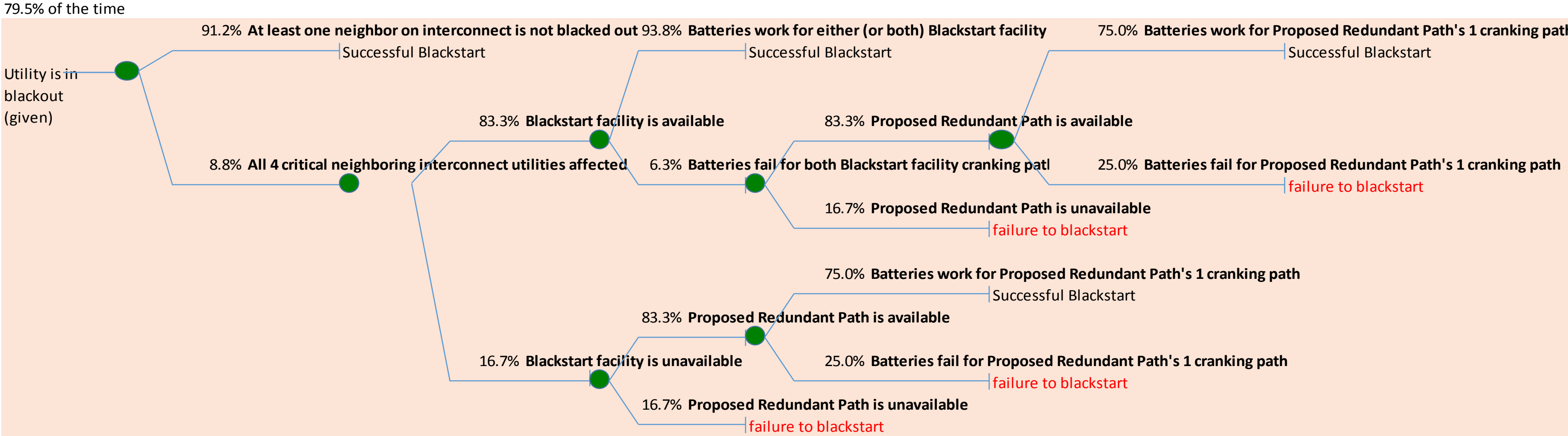
Post-Mitigation

Proposed Redundant Path (P1)	
New P1 Likelihood	0.62%

Blackout less than 8 hours: **0.05%**
20.5% of the time



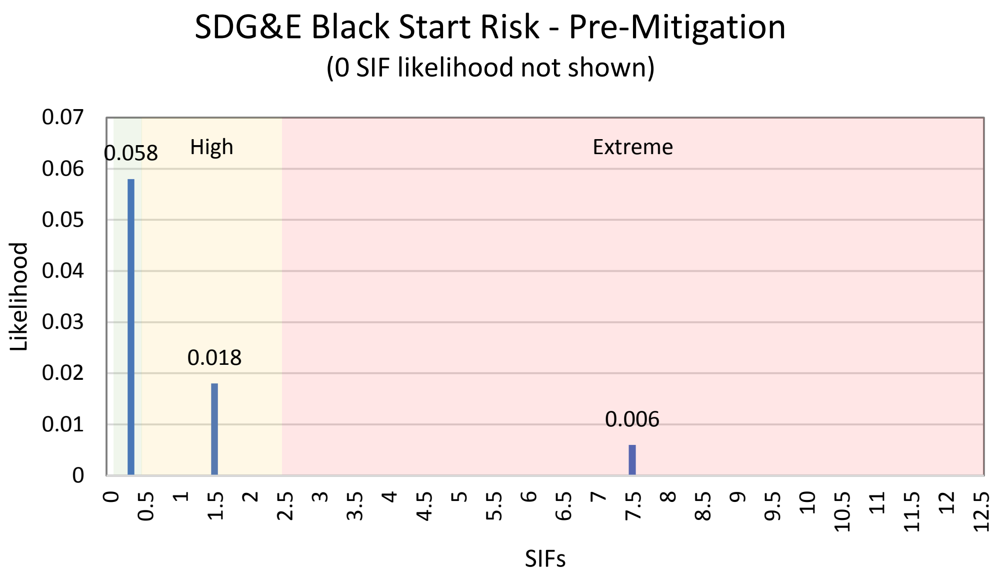
Blackout greater than 8 hours: **0.57%**
79.5% of the time



PG&E SDGE A Sempra Energy utility SoCalGas A Sempra Energy utility SOUTHERN CALIFORNIA EDISON An EDISON INTERNATIONAL Company

Fault/Event Tree Example: SDG&E Fail To Black Start

Illustrative



	Impact			
	Extreme	High	Moderate	<Moderate
SIFs	2.5-12.5	0.5-2.5	0.1-0.5	0-0.1
Likelihood	0.006	0.018	0.058	0.918
Multiplier	7.5	1.5	0.3	0

PG&E — SDGE A Sempra Energy utility — SoCalGas A Sempra Energy utility — Southern California Edison An Edison International Company

Fault/Event Tree Example: SDG&E Fail To Black Start

Illustrative

Fail to Black Start Risk – Pre-Mitigation

Safety Impact	Extreme (2.5 – 12.5 SIFs)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)	Safety Risk Score (Expected SIFs/yr)
Likelihood	0.006	0.018	0.058	0.0894

Fail to Black Start Risk – Post-Mitigation (South Grid Black Start Project: adds additional redundant cranking path. Likelihood reduced by 65.9%)

Safety Impact	Extreme (2.5 – 12.5 SIFs)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)	Safety Risk Score (Expected SIFs/yr)
Likelihood	0.002	0.006	0.018	0.0294

Risk Spend Efficiency

Mitigation	Safety Risk Score Before	Safety Risk Score After	Cost	Safety Risk Score Reduced/$1M
Black Start Redundancy	0.0894	0.0294	$1.2M	0.05

SCG Example

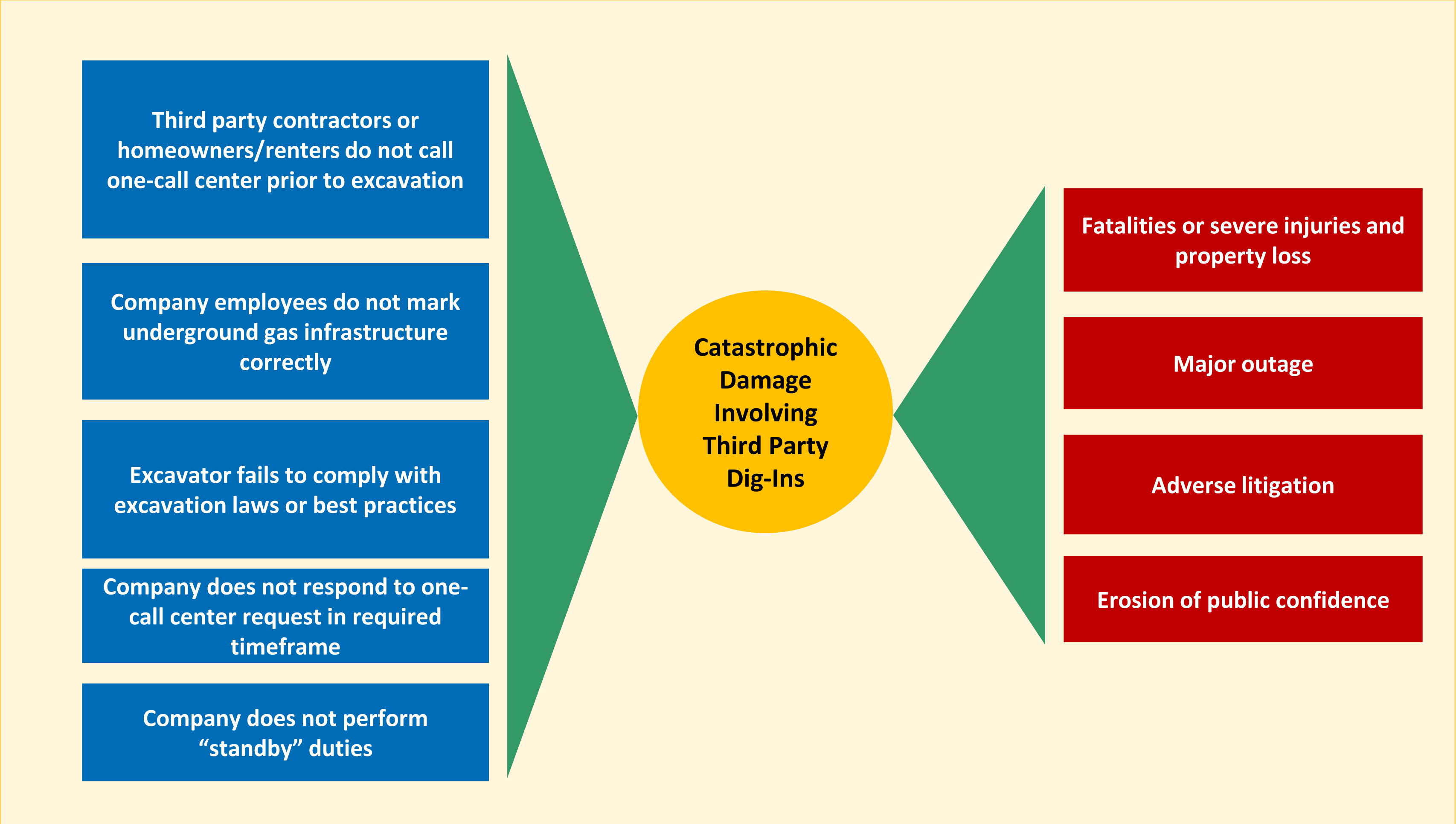
Illustrative Example

Third Party Dig-Ins

Third Party Dig-Ins Bow Tie Diagram

Illustrative

- The risk of a dig-in, caused by third party activities, which results in catastrophic consequences.

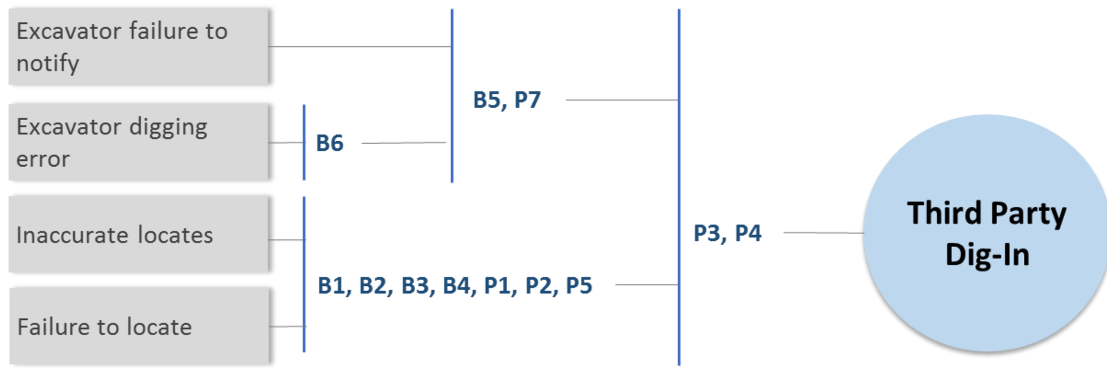


Event Tree Example – SCG – Dig-ins

Illustrative

- Started with dig-in data collected by "damage cause" according to event tree
- Identified causes and triggers affected by each mitigation
- Calibrated likelihood and mitigation improvements with engineering

Triggers



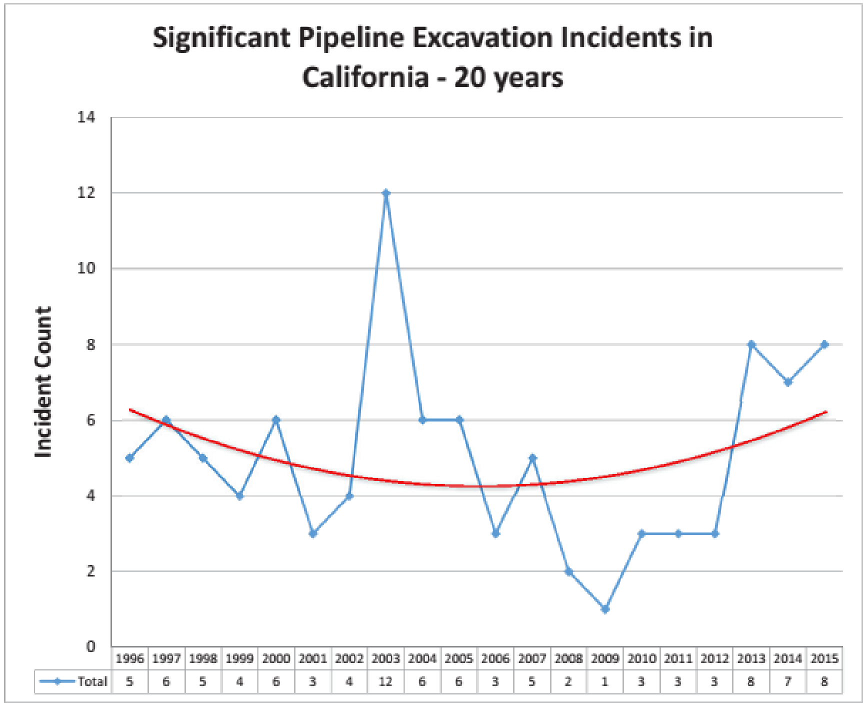
Mitigations

B1	Locate & Mark Training	P1	Standardize & Upgrade Equipment
B2	Locate & Mark Operator Qualification	P2	Issue Smart Phones
B3	Staff Support	P3	Upgrade reporting systems
B4	Locate & Mark	P4	Incremental support staff
B5	Damage Prevention Public Awareness	P5	Incremental locate & mark resources
B6	Pipeline Observation (standby)	P7	Public awareness

- Admin-side analysis
- In-field dig-in prevention and improvements
- Public awareness

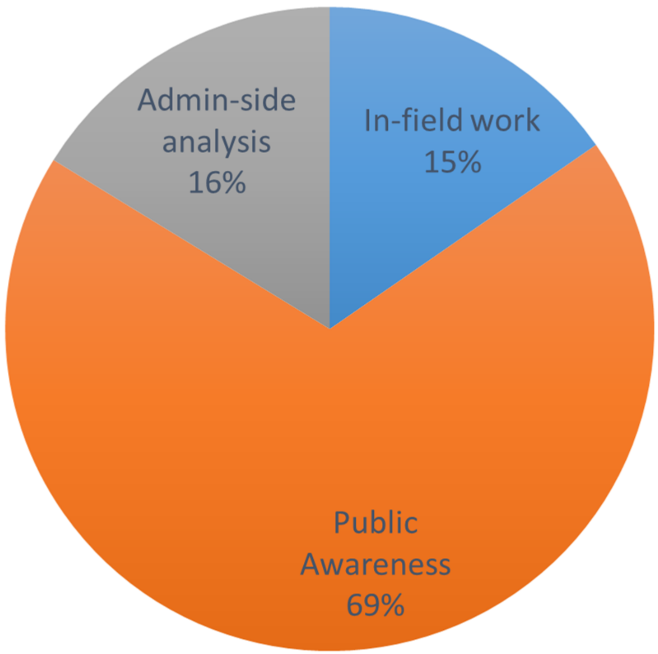
Event Tree Example – SCG – Dig-ins

- Used event tree to apply each mitigation improvement to post-mitigation likelihood data



Source: SoCalGas RAMP Chapter SCG-1. SoCalGas - I16-10-016 - RISK ASSESSMENT AND MITIGATION PHASE REPORT OF SAN DIEGO GAS & ELECTRIC COMPANY AND SOUTHERN CALIFORNIA GAS COMPANY

Share of dig-ins by mitigation category



- Next, calibrate with industry research and industry data

Event Tree Example – SCG – Dig-ins

Illustrative

Third Party Dig-Ins Risk – Pre-Mitigation

Safety Impact	Extreme (2.5 – 12.5 SIFs)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)	Safety Risk Score (Expected SIFs/yr)
Likelihood	0.0183	0.33	0.4	0.76

Third Party Dig-Ins Risk – Post-Mitigation (Increase public awareness)

Safety Impact	Extreme (2.5 – 12.5 SIFs)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)	Safety Risk Score (Expected SIFs/yr)
Likelihood	0.018	0.3283	0.394	0.75

Risk Spend Efficiency

Mitigation	Safety Risk Score Before	Safety Risk Score After	Cost	Safety Risk Score Reduced/$1M
Increased Public Awareness	0.76	0.75	$200K	0.05

PG&E Example

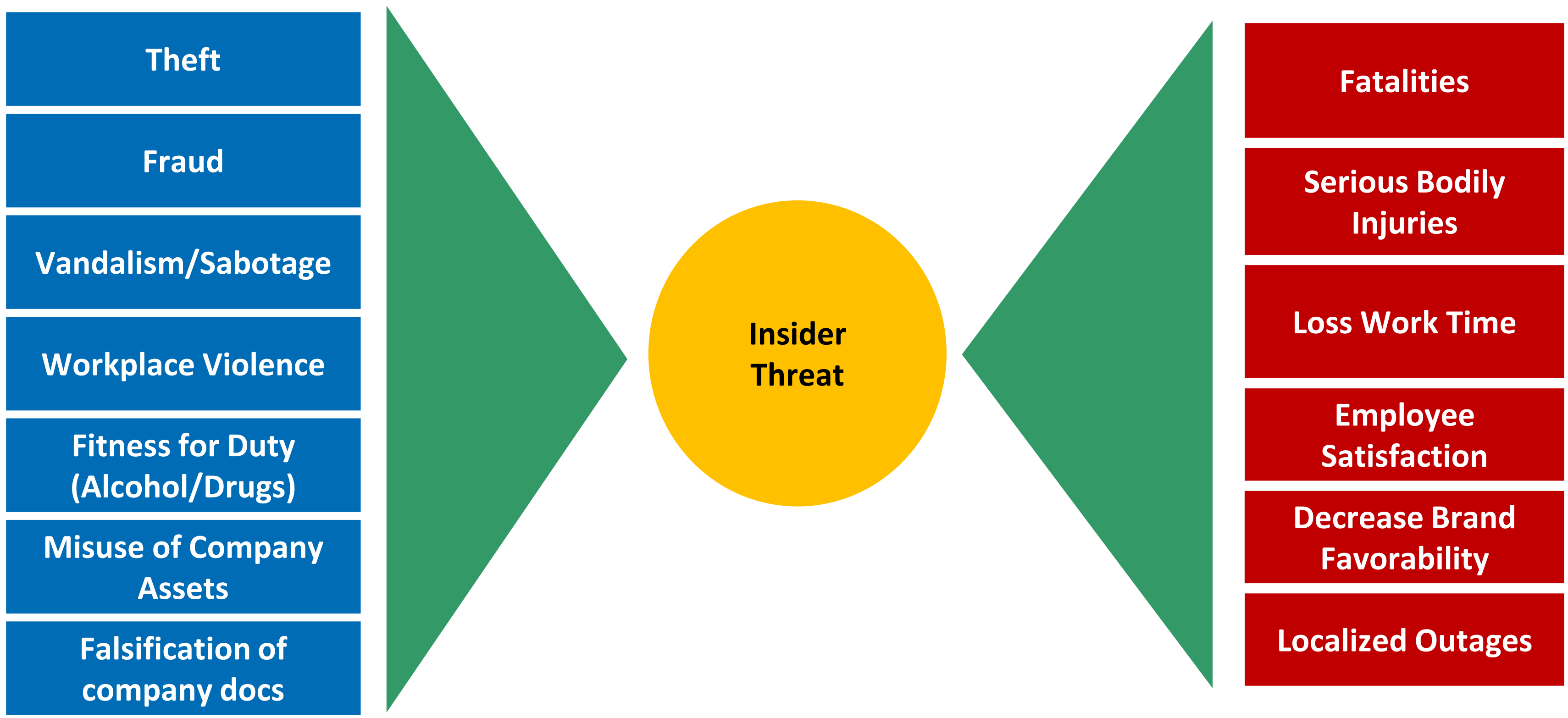
Illustrative Example

Insider Threat

Insider Threat Bow Tie Diagram

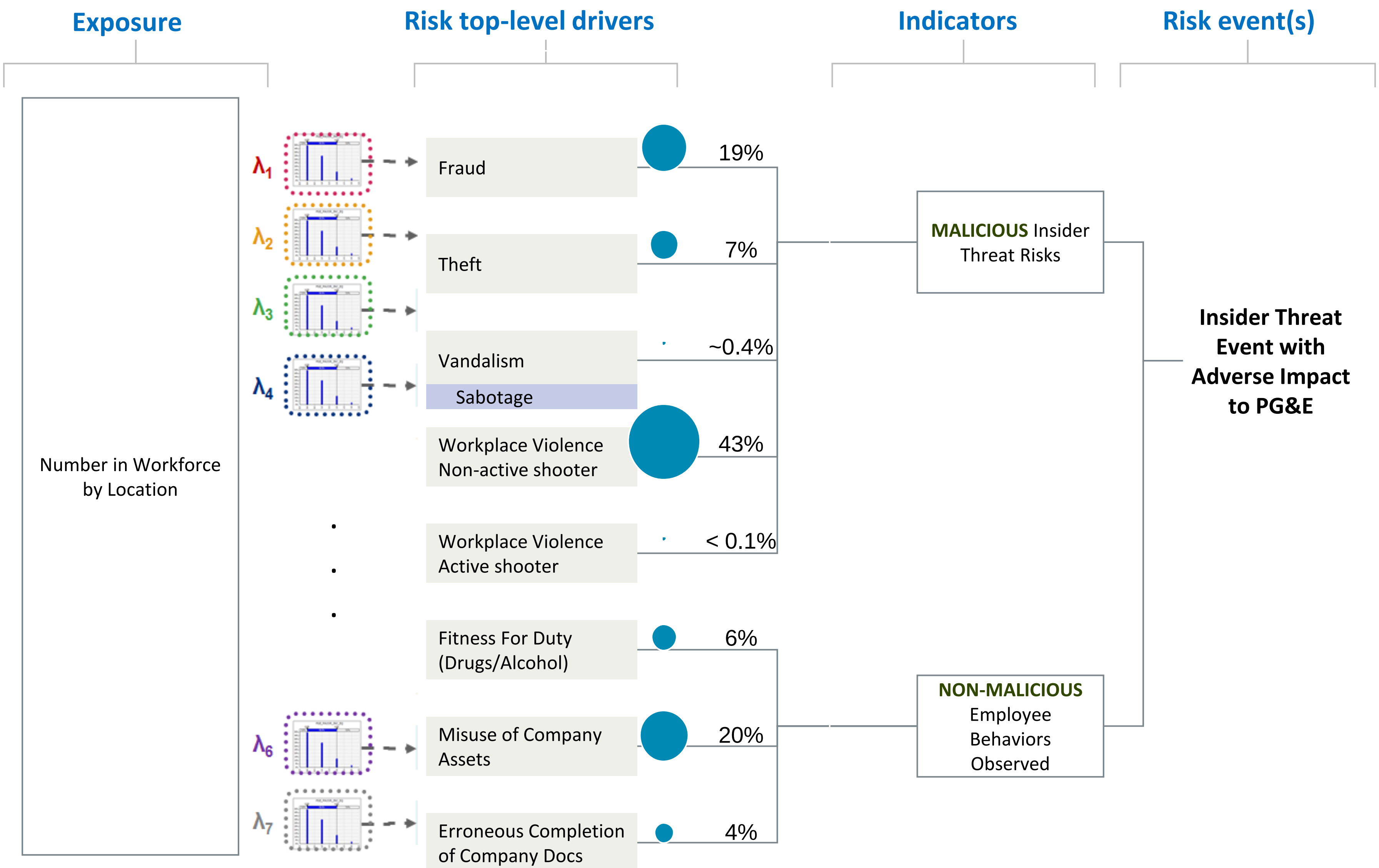
Illustrative

- "A **current** or **former employee** or **contractor** uses their company issued PG&E access and company knowledge **to harm the company** through **theft, fraud, sabotage, or workplace violence**. Such activities may **cause loss of assets or information, financial liability, damage to facilities or systems, or harm to individuals, company assets, or reputation**."



Insider Threat Bow Tie Diagram-Left Side

Illustrative



Mitigation matrices

Illustrative

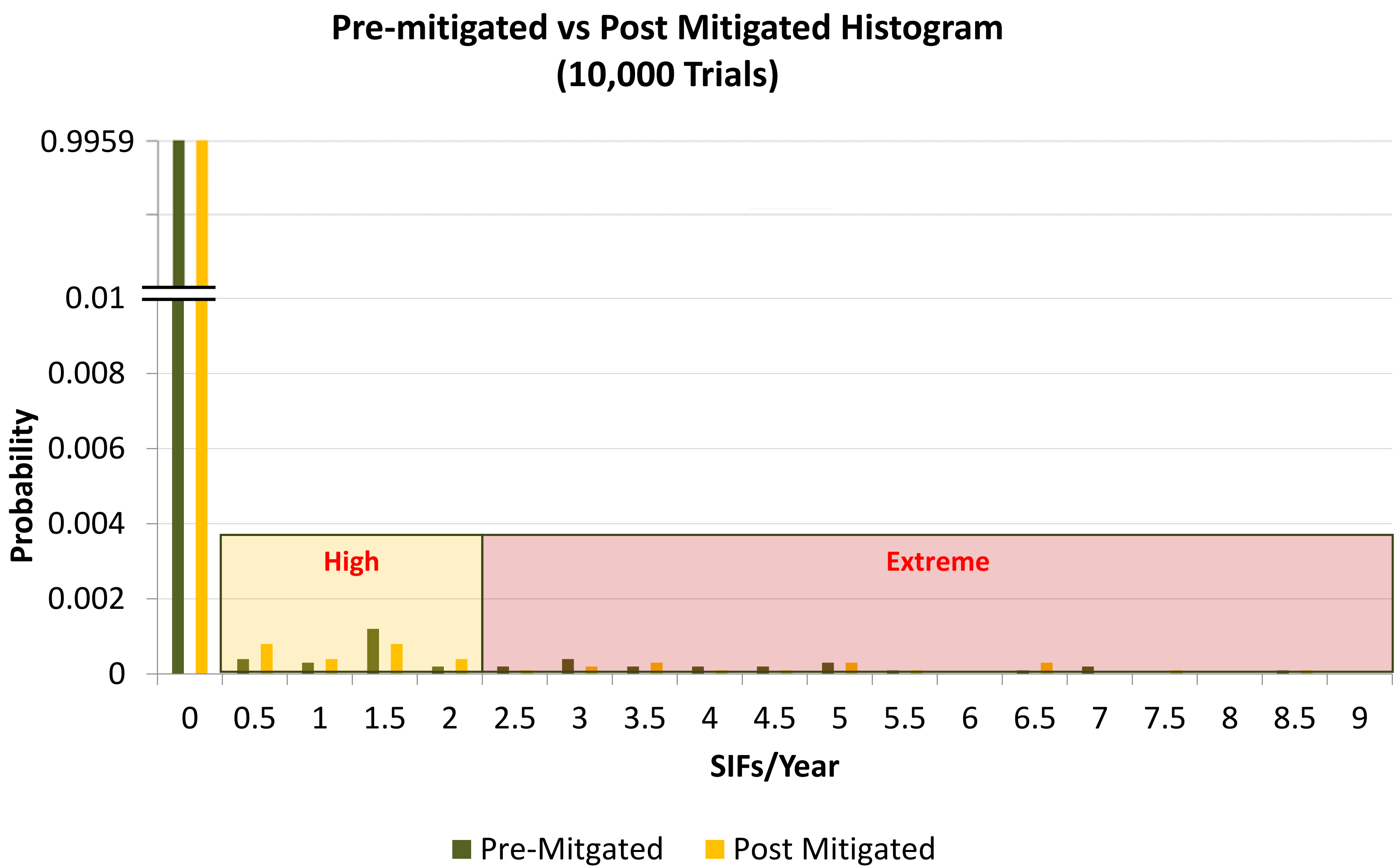
The relationship between mitigations and drivers / consequences governs the structure of the risk model

		Mitigation 1	Mitigation 2
Frequency	Theft		
	Fraud	30%	
	Vandalism/Sabotage	5%	
	Workplace Violence	10%	
	Fitness For Duty/(Drugs Alcohol)		
	Misuse of Company Assets	10%	
	Falsification of Company Documents	10%	
Consequence	Safety	10%	
	Reliability	10%	
	Trust		
	Environmental		
	Compliance		
	Financial		
Costs/Year of Expense	Capital		
	O&M	$3 M	
	Start Year	2018	
	End Year	2018	

(Mitigations: Mitigation 1, Mitigation 2)

Results - SIF Distribution

Illustrative



Stochastic Example: PG&E Insider Threat

Illustrative

Insider Threat Risk – Pre-Mitigation

Safety Impact	Extreme (2.5 – 12.5 SIFs)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)	Safety Risk Score (Expected SIFs/yr)
Likelihood	0.0020	0.0021	0.0005	0.0183

Insider Threat Risk – Post-Mitigation

Safety Impact	Extreme (2.5 – 12.5 SIFs)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)	Safety Risk Score (Expected SIFs/yr)
Likelihood	0.0017	0.0024	0.0004	0.0165

Risk Spend Efficiency

Mitigation	Safety Risk Score Before	Safety Risk Score After	Cost	Safety Risk Score Reduced/$1M
Insider Threat Mitigation	0.0183	0.0165	$3M	0.0006

SCE Example

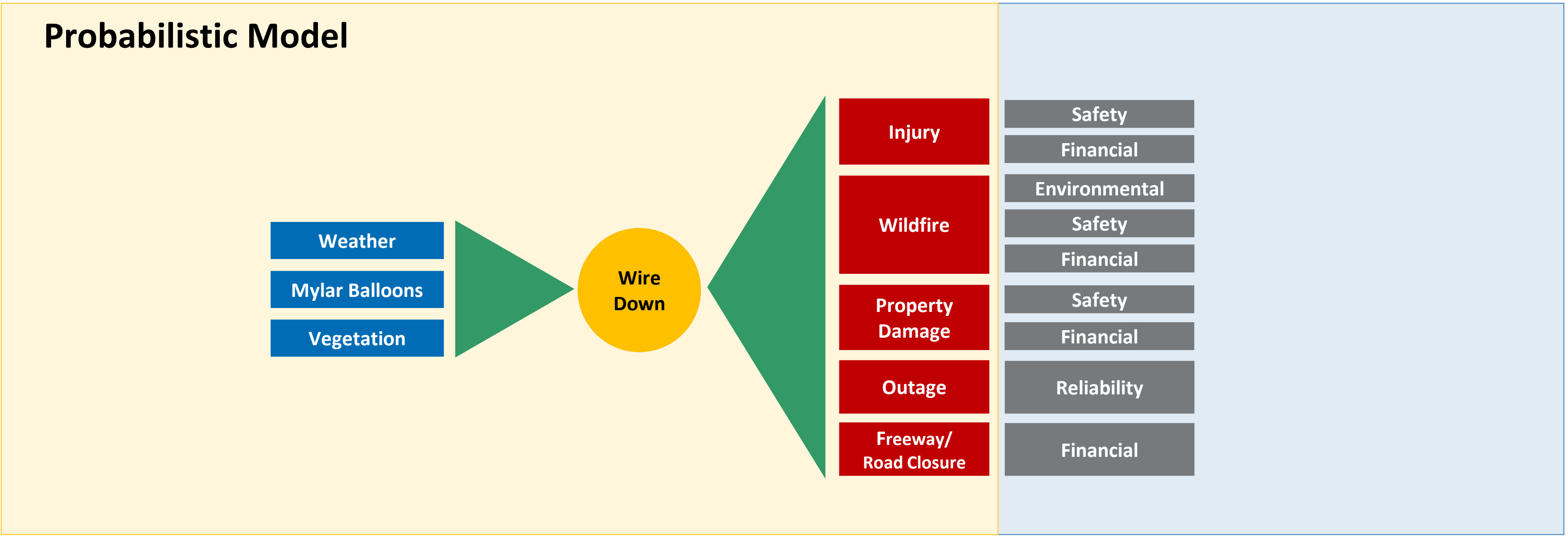
Illustrative Example

Wire Down

Wire Down Bow Tie Diagram

Illustrative

- The example shown focuses entirely on the safety consequence of the injury outcome
- A complete evaluation would score each consequence of every outcome



Modeling Approach

Illustrative

Step 1

- Assume wire downs are a Poisson process with a mean calculated from historical data.

Step 2

- Simulate 10,000 trials by sampling TEF values from the distribution.

Step 3

- For each simulation, draw the number of outcomes from a binomial distribution with a number of trials equal to the simulated TEF and a probability of success based on recorded safety incidents.

Step 4

- For each positive outcome, randomly choose the number of SIFs from the distribution of historical SIFs caused by wire down events.

Step 5

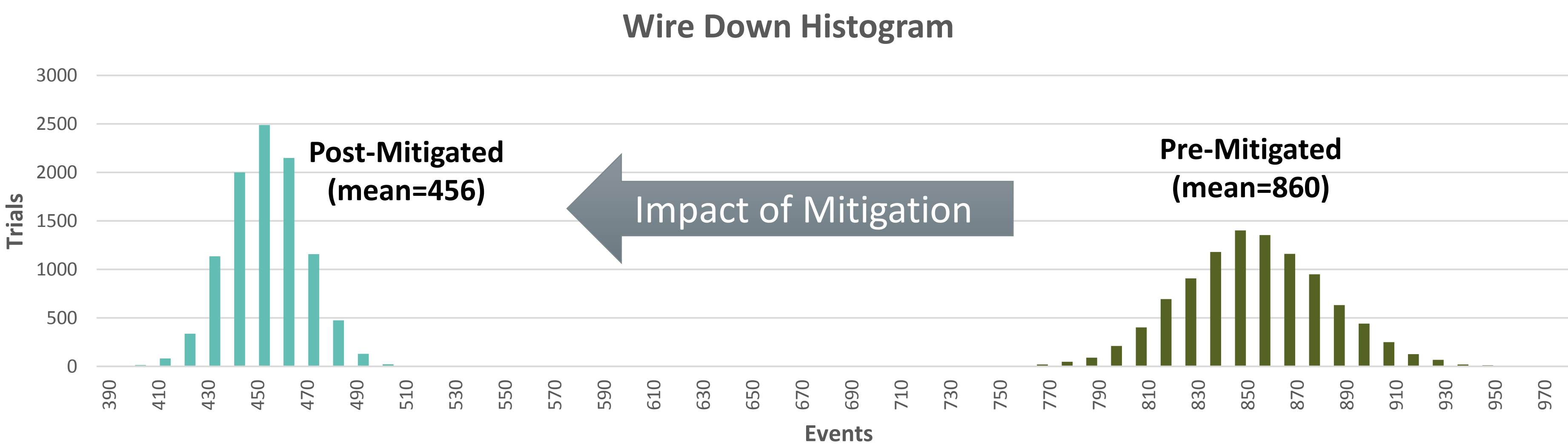
- Sum the SIFs for each scenarios.

The modeling approach, assumptions, and results are illustrative.

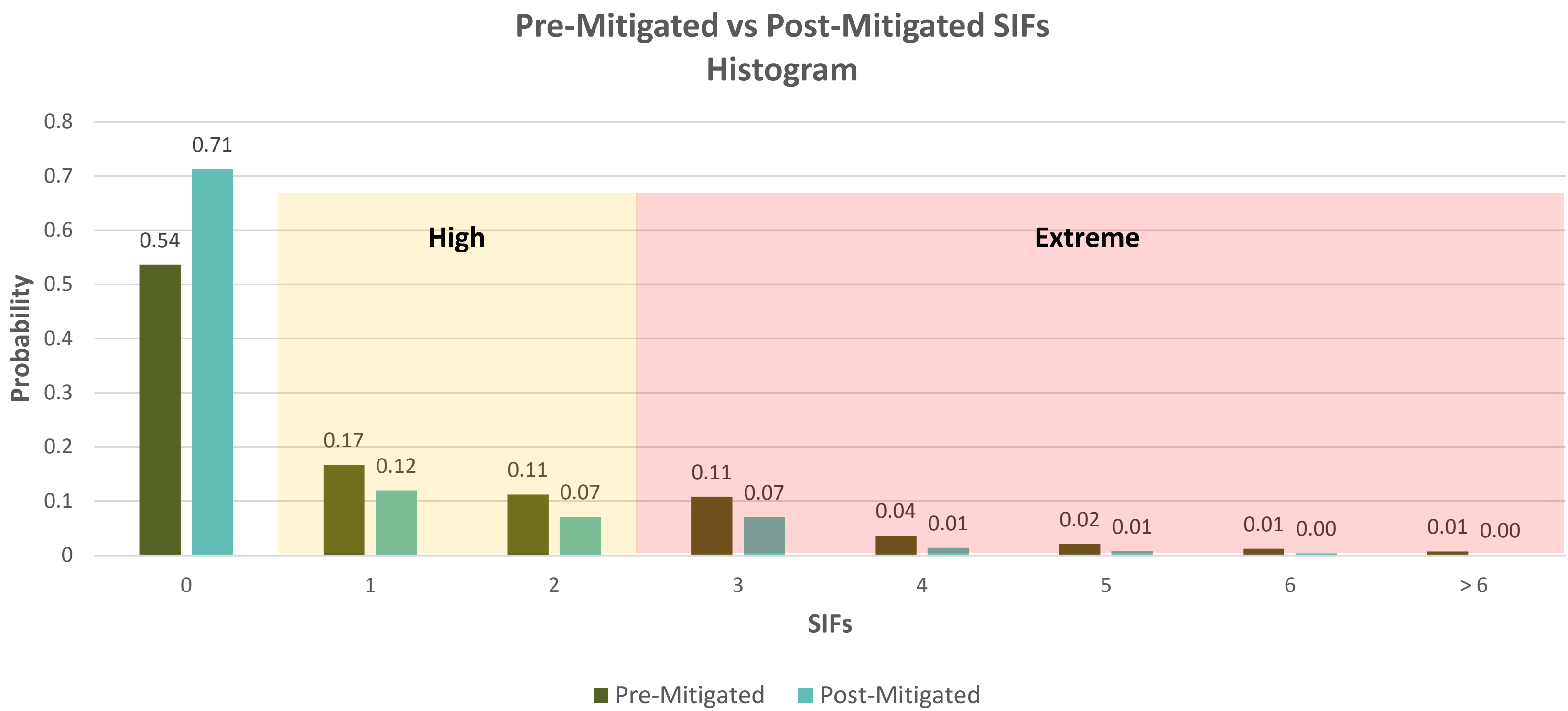
Results - TEF Distribution

- Pre-Mitigated Scenario
  - Assumptions
    - Wire downs are a Poisson process
    - Historical TEF used as mean for Poisson distribution

- Post-Mitigated Scenario
  - Assumptions
    - Reconductor mitigation applied to all distribution circuits
    - Reconductor effectively reduces TEF by 47%



Results - SIF Distribution



	Impact			
	Extreme	High	Moderate	Not Shown
SIFS	2.5-12.5	0.5-2.5	0.1-0.5	0-0.1
Occurrences	1848	2791	0	5361
Likelihood	0.185	0.279	0.000	0.536

Probabilistic Example: SCE Wire Down Risk

Illustrative

Wire Down Risk – Pre-Mitigation

Safety Impact	Extreme (2.5 – 12.5 SIFs)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)	Safety Risk Score (Expected SIFs/yr)
Likelihood	0.18	0.28	0.00	1.80

Wire Down Risk – Post-Mitigation

Safety Impact	Extreme (2.5 – 12.5 SIFs)	High (0.5 – 2.5 SIFs)	Moderate (0.1 – 0.5 SIFs)	Safety Risk Score (Expected SIFs/yr)
Likelihood	0.10	0.19	0.00	1.01

Risk Spend Efficiency

Mitigation	Safety Risk Score Before	Safety Risk Score After	Cost	Safety Risk Score Reduced/$1M
Wire Down mitigation	1.80	1.01	$5.6B	0.00014

Comparability

Comparability

Illustrative

Utilities maintain their appropriately unique modeling approaches with the ability to translate results into a common safety risk language that allows for comparability across the utilities

	PG&E	SDG&E		SCE	SCG
Risk	*Insider threat*	*Aviation incident*	*Fail to black start*	*Wire down incident*	*Third-party dig-ins*
Modeling Approach	*Stochastic*	*Stochastic*	*Fault/Event Tree Analysis*	*Stochastic*	*Fault/Event Tree Analysis*
Pre-Mitigation Safety Risk Score (Expected SIFs/yr)	*0.0183*	*0.0424*	*0.0894*	*1.8450*	*0.7600*
Post-Mitigation Safety Risk Score (Expected SIFs/yr)	*0.0165*	*0.0180*	*0.0294*	*0.9600*	*0.7500*
Cost ($)	*$3.0M*	*$3.0M*	*$1.2M*	*$5.6B*	*$200K*
RSE (Safety Risk Score Reduced/$1M)	*0.00060*	*0.00815*	*0.05000*	*0.00014*	*0.05000*

Next Steps

- Develop roadmap for Safety attribute evolution, which includes:
  1. For all IOUs: Decide on the numerical safety scales (e.g. SIF, injuries, etc)
  2. For each IOU separately: Produce a risk distribution for the Safety attribute using the numerical scales from #1
  3. For all IOUs: Decide how many categories to use (i.e. Extreme, High, Moderate, etc)
  4. For all IOUs: Decide on the numerical safety scales for the categories from #3
  5. For all IOUs: Decide on the safety multipliers for all categories from #3
  6. For each IOU separately: Calculate the new risk score

- Future potential expansion to other attributes:
  - Incorporate other attributes in the future
  - Development of risk tolerances / ALARP
  - Heat map

Success Criteria Evaluation

Safety-Focused	✓	*Safety-based risk ranking and mitigation*
Simple	✓	*Easy to communicate and understand*
Uniform	✓	*Can be uniformly applied by all utilities*
Probabilistic	✓	*Enables probabilistic modeling*
Comparable	✓	*Enables comparison of safety risks across utilities*
Cost-Effective	✓	*Is not costly to implement*

Roadmap

2017 Actions	2018 Actions	2019 Actions
▪ Continue to participate in JIA test drives. ▪ Meet and confer with parties. ▪ Determine how to conduct test drives for JUA. ▪ Begin test drives for JUA platform. ▪ Continue the use of the tiered modeling approach. ▪ Finalize JIA test drive.	▪ Finalize JUA test drive. ▪ Consider other attributes for JUA. ▪ Begin SME calibration and common risk profiles among the IOUs. ▪ Utilities file second S-MAP applications. ▪ Begin discussion on incorporation of risk tolerance. ▪ Develop a common risk taxonomy.	▪ Continued evolution risk methodologies. ▪ Workshops associated with the second S-MAP. ▪ Incorporate CPUC decisions into RAMP filings.

Questions?