SMAP Workshop

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SCE's Risk-Informed Planning Approach is Evolving

- SCE began developing explicit risk-informed planning and prioritizing methodologies and processes in 2014.
- SCE has undertaken a phased implementation approach to facilitate thoughtful and sustainable change; initial pilot includes specific T&D activities.
- SCE's risk assessment and prioritization approaches will evolve in coming planning cycles.
- Data, modeling, and analysis capabilities will need continuous focus.
- Internal and regulatory decision-making processes have to be flexible and practical to promote continuous improvement, effectiveness, and efficiency.

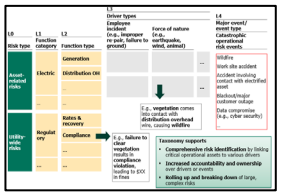
Risk-Informed Planning Approach and Tools

Approach

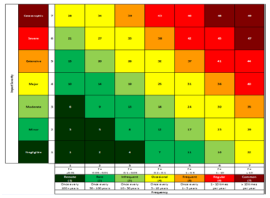
1	2	3	4	5
Identify Risks	**Evaluate Risks**	**Identify Mitigations**	**Evaluate Mitigations**	**Prioritize Spend**

Tools

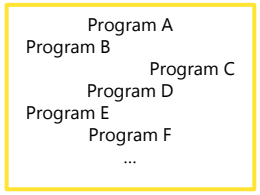
Risk Taxonomy Risk Statement



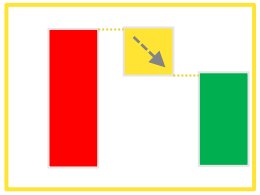
Risk Evaluation Tool (RET) Risk Scoring



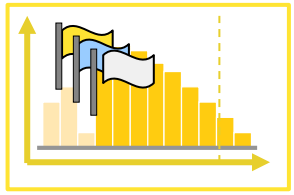
Driver Analysis



Risk Evaluation Tool Risk Scoring and Flags



Prioritization Methodology Risk Spend Efficiency



Objectives

- Single approach to defining and categorizing risks
- Helps in identification and aggregation of risks

- Company-wide tool to measure risks
- Assessments can be based on data and/or professional judgment where data is limited
- Enables comparison of risks across the company

- Development of risk mitigation solutions

- Consistent approach to measuring benefits of mitigation programs
- Enables comparison of different programs across the company

- Multi-year planning prioritizing spend on most effective mitigations
- Effectiveness of mitigation program measured by risk spend efficiency
- Also take into account non-risk considerations

Risk Evaluation Tool is Foundational to Risk-Informed Planning

A Impact dimensions: Capture different types of consequences

- **Safety**
- **Reliability**
- **Environmental**
- **Compliance**
- **Financial**

B Impact levels & calibration: Each impact dimension broken into 1-7 levels, calibrated across dimensions

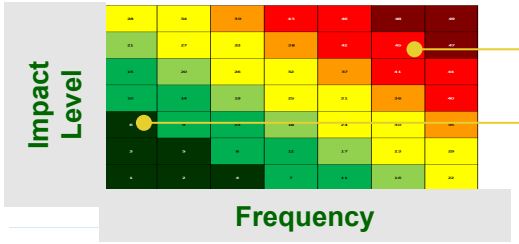
Score	Example impact
7	Safety: Many fatalities
6	Reliability: Outage resulting in at least 2 million total customer hours of interruption
5	Safety: Serious injuries or illnesses to many employees, public members or contractors resulting in hospitalization, disability or loss of work
4	Reliability: Outage resulting in at least 20,000 total customer hours of interruption
3	Financial: $300k - $3M in costs
2	Safety: Minor injury or illness
1	Reliability: Outage resulting in less than 200 total customer hours of interruption

C Frequency levels: Frequency defined as number of events per year

Score	Frequency
7	>10x / year
6	1-10x / year
5	1x every 1-3 years
4	1x every 3-5 years
3	1x every 10-30 years
2	1x every 30-100 years
1	1x every 100+ yrs.

D Risk score equation which measures risk scores by adding the scores for each of the relevant impact dimensions

- Impact & frequency produce a risk score for each dimension
- Add risk scores for each dimension to get aggregate risk score
- Risk score is a metric that can be used to compare risks of different types



Risk Evaluation Tool: Impact Dimensions

SAFETY	The potential impact of a risk event on public or worker safety
RELIABILITY	The potential impact of a risk event on service or grid reliability
ENVIRONMENTAL	The potential impact of a risk event on natural resources such as air, soil, water, plant or animal life
COMPLIANCE	The potential impact of a risk event resulting in non-compliance with federal, state, local, industrial, or operational standards or requirements
FINANCIAL	The potential of a risk event resulting in a financial costs to customers, shareholders and/or third parties measured in incremental dollar impact

Prioritization of Each Project, Program or Activity Is Informed By Its Risk Reduction Benefit and Cost

RISK SCORE	$RS = TEF * CP * 10^{CI}$, where: RS = Risk Score of a risk statement TEF = Triggered Event Frequency - Number of times a risk event occurs per year CP = Consequence Percentage - Conditional probability that an outcome occurs given the risk event has occurred CI = Consequence Impact - Expected severity level of the impact for the risk
RISK REDUCTION	Mitigated Risk Score = $RS_{\text{pre-mitigation}} - RS_{\text{post-mitigation}}$
PRIORITIZATION METRIC	Risk Spend Efficiency = Mitigated Risk Score / Program Cost ($M)
OTHER NON-RISK CONSIDERATIONS	• Funding • Resources • Operational constraints • Compliance requirements • In-flight projects

Risk Identification:
Systematically Identifying, Categorizing, and Documenting Risks

TOOLS / MODELS	• Risk statement format • Risk taxonomy
PROCESS	• Analysis of SCE and industry events • Survey and workshops with subject matter experts and leaders
ILLUSTRATIVE EXAMPLE Pole Failure	**Asset** related **event-outcome-impact** combinations Pole fails in service • potentially leading to human contact with overhead conductors, which could have safety and financial impacts; • potentially leading to a wildfire, which could have environmental and financial impacts; • potentially leading to property damage, which could have financial impacts; and • potentially leading to an outage, which could have reliability impacts.

Risk Evaluation:
Consistently Scoring Risks Based on Probability and Consequence

TOOL / MODELS	• Risk Evaluation Tool • Risk Scoring Formula • Asset condition models • Failure analysis models • Impact analysis tools • Asset reliability models
PROCESS	• Technical analysis of utility historical or industry data to forecast probability and impact • Subject matter expert input for validation or when data is limited
ILLUSTRATIVE EXAMPLE Pole Failure	• Asset condition analysis– estimate pole condition based on latest inspection • Failure analysis (TEF)– forecast probability of pole failure based on pole condition and other drivers of pole failure • Outcome and Impact Analysis (CP / CI) – forecast worst reasonable direct impact of pole failure for human contact, wildfire, property damage, or outage • Calculate risk score for each risk statement based on probability of risk event, probability of outcome, and impact of outcome

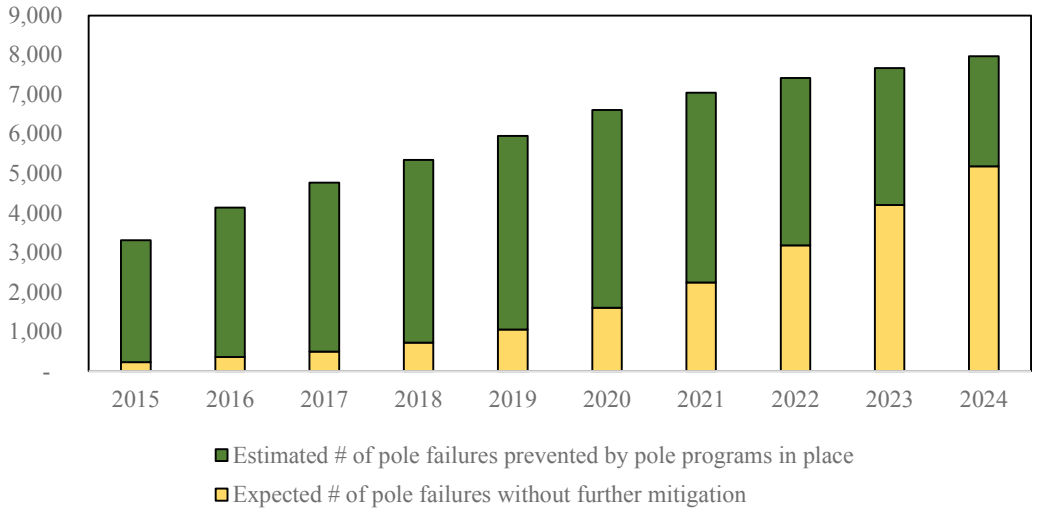
Risk Evaluation
– Illustrative Example Estimating Probability of Pole Failure

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

TRIGGERED EVENT FREQUENCY (TEF)

Forecast based on probabilistic model which is a function of:

- Presence and extent of pole deterioration
  - latest inspection results on pole deterioration and
  - estimated increase in deterioration since last inspection based on age
- Initial safety factor of the pole as designed
- Likelihood of critical load based on deterioration and safety factor



Risk Evaluation
– Illustrative Example Estimating Consequence of Pole Failure

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

CONSEQUENCE PERCENTAGE (CP)

AND

CONSEQUENCE IMPACT (CI)

Impact Analysis:

- Human contact and Property Damage – Historical CPUC reportable incidents and emergency pole replacement data
- Wildfire –
    - percentage of poles in high fire areas
    - historical rate of downed wire remaining energized
    - assumptions on potential impact for illustrative purposes
- Outages – historical outage data

Worst Reasonable Direct Impact (WRDI):

- Estimate probability of outcome for each impact level
- Calculate risk score for each impact level
- CP / CI combination with highest risk score for each event-outcome combination

Risk Evaluation
– Illustrative Example of Risk Scoring Pole Failure Risks

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

RISK SCORING FOR POLE FAILING IN SERVICE BY POTENTIAL OUTCOME IN 2015							
Risk Statement				Current Residual			
	No.	Outcome	Impact Dimension	TEF	WRDI CP	WRDI CI	Risk Score
a	1	Injury	Safety	230	0.012%	6	28,497
b			Financial	230	0.012%	4	285
c			Environmental	230	0.063%	5	14,375
d	2	Wildfire	Safety	230	0.031%	6	71,875
e			Financial	230	0.063%	6	143,750
f	3	Property Damage	Financial	230	0.012%	3	28
g	4	Outage	Reliability	230	24.014%	3	55,231
			Total				314,042

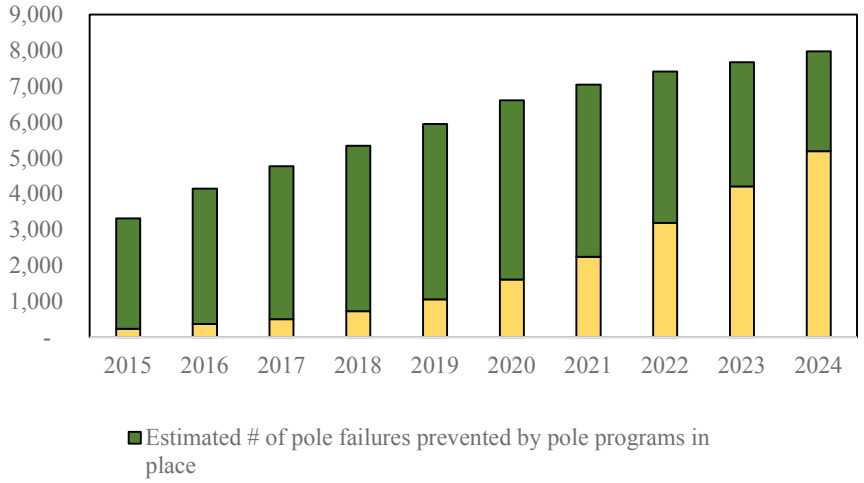
SUMMARY OF RISK SCORES FOR POLE FAILING IN SERVICE BY IMPACT DIMENSION		
	Impact Dimension	Currrent Residual Risk Score
a+d	Safety	100,372
g	Reliability	55,231
c	Environmental	14,375
b+e+f	Financial	144,063
	Compliance	0
	Total	314,042

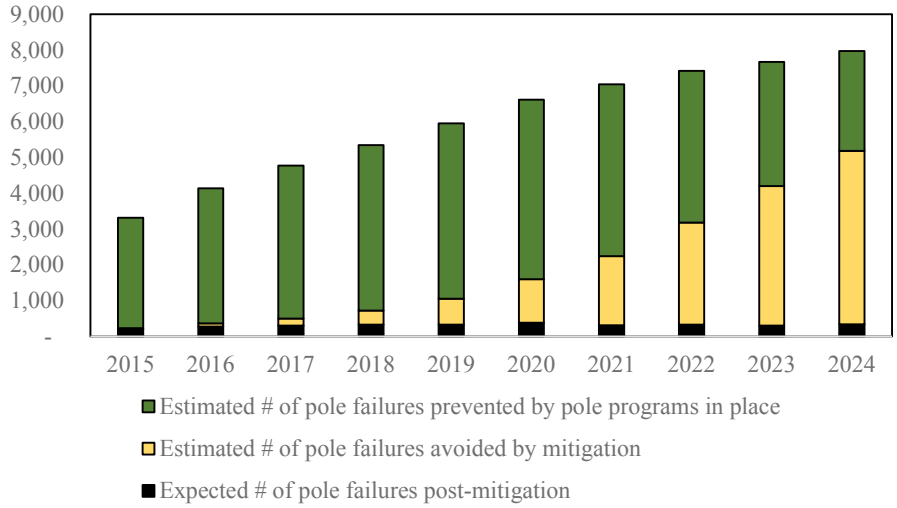
Mitigation Identification:
Systematically Identifying Ways of Reducing TEF, CP, or CI

TOOL / MODELS	• Root Cause Analysis • Fish Bone Diagrams • Driver Analysis • Asset Criticality Database • Mitigation Alternative Development
PROCESS	• Analysis of utility historical data or industry intelligence • Subject matter experts input – engineering and field employees
ILLUSTRATIVE EXAMPLE Pole Failure	• Driver analysis – identify all factors that impact the frequency or impact of pole failure – Deterioration of pole, pole loading, pole material and manufacturing method, pole location – high wind or high fire, residential, metro, etc. • Asset Criticality Database – asset level data to quantify or qualify drivers • Mitigation Alternative Development – Identify remediation that specifically targets the risk drivers in each stratum or tranche – Pole design standards , Tailored pole inspection programs , Pole repair or strengthening, Pole replacement , Undergrounding, Vegetation management and brush control

Mitigation Evaluation:
Comparing Mitigations Options Identified Consistently

TOOL / MODELS	• Risk Evaluation Tool • Risk Scoring Formula • Failure analysis models • Impact analysis tools • Bundling or unbundling of work
PROCESS	• Technical analysis of utility historical or industry data to forecast probability and impact of risk • Subject matter expert input for validation or when data is limited
ILLUSTRATIVE EXAMPLE Pole Failure	• Pole replacements based on 10-year levelized intrusive inspection cycle • Two tranches – high fire and non-high fire areas





Mitigation Evaluation – Illustrative Example Estimating Post-Mitigation Risk Scores for Pole Failure Risks

RISK SCORING FOR POLE FAILING IN HIGH-FIRE AREA BY POTENTIAL OUTCOME IN 2015										
ASSUMING 1100 POLE REPLACEMENTS										
Risk Statement			Current Residual				Planned Residual			
No.	Outcome	Impact Dimension	TEF	WRDI CP	WRDI CI	Risk Score	TEF	WRDI CP	WRDI CI	Risk Score
1	Injury	Safety	37	0.004%	6	1,303	27	0.004%	6	951
		Financial	37	0.004%	4	13	27	0.004%	4	10
		Environmental	37	0.389%	5	14,375	27	0.389%	5	10,490
2	Wildfire	Safety	37	0.194%	6	71,875	27	0.194%	6	52,449
		Financial	37	0.389%	6	143,750	27	0.389%	6	104,899
3	Property Damage	Financial	37	0.012%	3	5	27	0.012%	3	3
4	Outage	Reliability	37	24.014%	3	8,885	27	24.01%	3	6,484
			Total			240,206				175,285

RISK SCORING FOR POLE FAILING IN NON-HIGH-FIRE AREA BY POTENTIAL OUTCOME IN 2015										
ASSUMING 4000 POLE REPLACEMENTS										
Risk Statement			Current Residual				Planned Residual			
No.	Outcome	Impact Dimension	TEF	WRDI CP	WRDI CI	Risk Score	TEF	WRDI CP	WRDI CI	Risk Score
1	Injury	Safety	193	0.014%	6	27,194	174	0.014%	6	24,517
		Financial	193	0.014%	4	272	174	0.014%	4	245
		Environmental	193				174			
2	Wildfire	Safety	193				174			
		Financial	193				174			
3	Property Damage	Financial	193	0.012%	3	24	174	0.012%	3	22
4	Outage	Reliability	193	24.014%	3	46,346	174	24.014%	3	41,784
			Total			73,836				66,567

Prioritization:
Ranking Type and Scope of Mitigation

TOOL / MODELS	• Risk Score Efficiency Metric (RSE) • Other considerations for funding, resources, operational constraints, and schedule
PROCESS	• Analysis and comparison of RSE among mitigation alternatives by risk, by asset, and across portfolio • Management and subject matter expert input to overlay business and operational judgment
ILLUSTRATIVE EXAMPLE Pole Failure	• RSE (includes estimated costs and risk reduction) • Resource requirements (crews, planners, etc.) • Operational considerations (permitting, bundling with other work on the same circuits, etc.) • Compliance considerations (GO 165 and GO 95)

Mitigation Tranche	Work Volume A	Unit Cost B	Total Cost ($M) C=A*B	Current Residual Risk Score D	Planned Residual Risk Score E	Risk Reduction F=D-E	Risk Spend Efficiency G=F/C
Pole Repl in HF areas	1,100 poles	$14,000	$15.40	240,206	175,285	64,921	4,216
Pole Repl in NHF areas	4,000 poles	$14,000	$56.00	73,836	66,567	7,269	130

Challenges and Opportunities

DATA	• Comprehensive data on incidents and asset (attributes, condition, performance) is not always available, or is not compiled in a manner that facilitates analysis • Need continued focus on **building data capabilities** prioritized by current risk evaluation • **Industry data** can be leveraged until utility specific data capability is developed • **Informed judgment** has to be applied and documented to continue progress towards risk-informed planning until such data capabilities are mature
MODELS & METHODS	• Analysis to better isolate **risk drivers** by asset class needed • Models to **forecast asset condition and asset failures** need continued refinement • **Risk evaluation, mitigation evaluation, and prioritization** methodologies will continue to evolve
PROCESS	• Processes within **SCE** to perform **risk-informed planning and provide appropriate governance** is evolving as our capabilities mature • Will need to align these with **regulatory processes** as they reach steady state
ALIGNMENT ON OBJECTIVES	• Currently **various regulatory proceedings** and requirements incorporate risk in different ways • SCE **internal planning** also incorporates risk in various planning activities, but sometime through different lenses • Need **to align objectives for consistency and efficiency** in planning functions and decision making