UTILITY RISK MANAGEMENT

Intervenor Perspective:

Energy Producers and Users Coalition
Indicated Shippers
The Utility Reform Network

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Goals of a Risk Management Methodology

- Prioritizes Safety
- Promotes Cost-Effective and Optimized Risk Management
- Is Transparent, Easy-to-Use, and Understandable
- Can Be Implemented by All Utilities

THE BUILDING BLOCKS OF AN EFFECTIVE RISK MANAGEMENT METHODOLOGY

A Fundamental Requirement

- **Risk reduction <u>must</u> be quantifiable to permit assessment of the cost-effectiveness of the risk mitigation strategies**
  - **If risk reduction is not measured, then it is impossible to determine the cost-effectiveness of risk management strategies**
  - **Without measurement of risk reduction, there are no benchmarks to compare alternatives**
- **The approach recommended by Intervenors allows utilities to measure risk reduction**

Approach

- Use ASME B31.8s definition of Risk
  - Risk = Likelihood of Failure (LoF) X Consequence of Failure (CoF)
  - Risk Reduction=$(\text{LoF X CoF})_{\text{Before}}$- $(\text{LoF X CoF})_{\text{After}}$

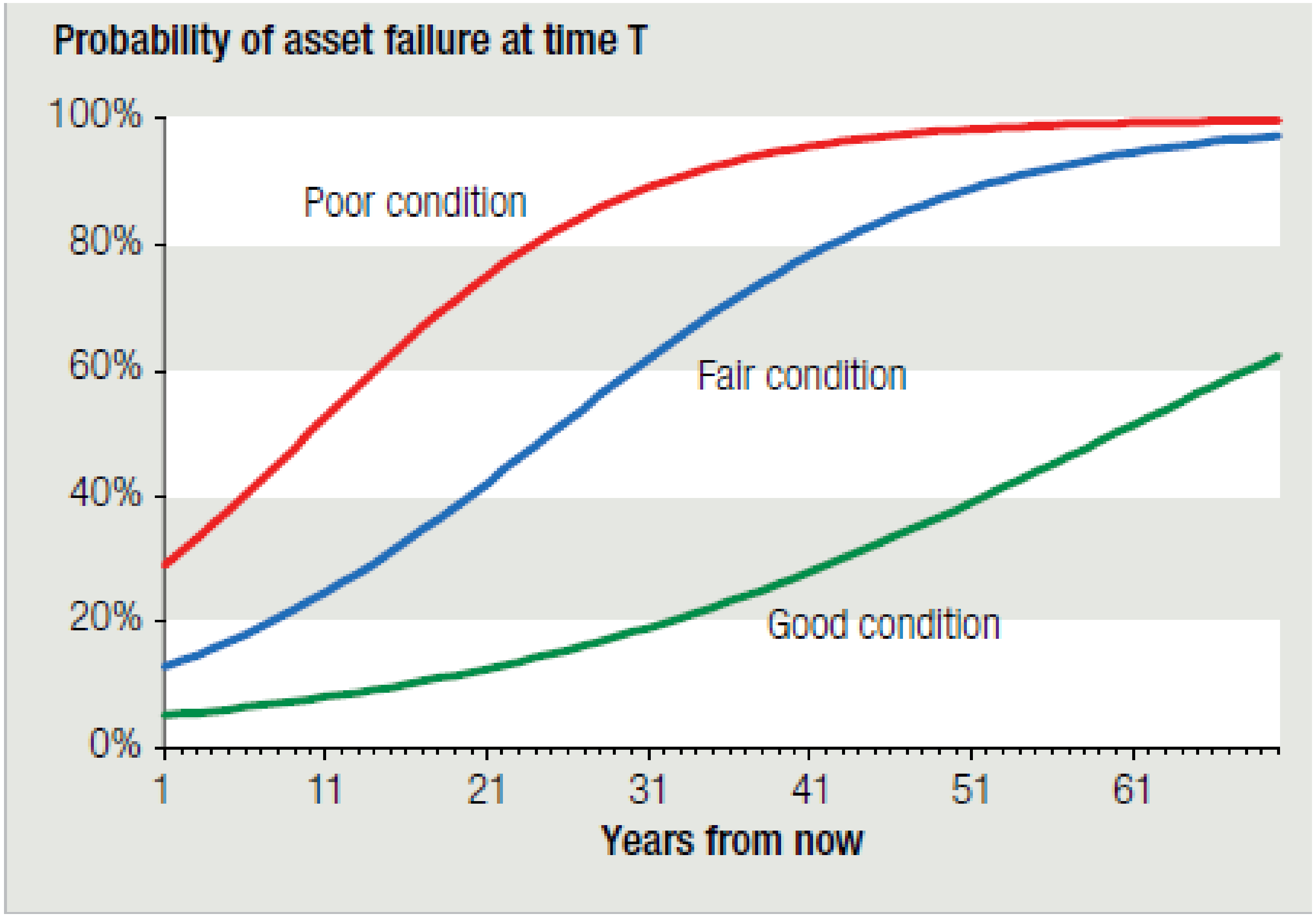
- Utilities' discrete, non-additive, "order-of-magnitude" 1 to 7 LoF and CoF scales do not allow the computation of risk reduction

- Intervenor approach uses additive LoF and CoF scales
  - Easier to understand and implement
  - Enables computation of risk reduction

Measuring LoF

- Express LoF values as mathematical probabilities, between 0% and 100%
- LoF is determined by ***hazard rate***, i.e. the probability that an asset will fail over time; typically, annual time frame
- *Condition Dependent Hazard Rate*: probability that the asset will fail based on the condition of the asset
  - Examples: gas transmission pipe based on presence of manufacturing defects or corrosion; wooden electric distribution poles with insect and wind damage.
- LoF also depends on, e.g.:
  - Outside events: earthquakes, wildfires, terrorism
  - Operator Error: Failure to operate equipment properly

Condition-dependent hazard rates



Outside events (e.g., earthquake, fire, will shift these hazard rates upwards (recognizing they can never be greater than 100%)

Probability of Failure, Not Frequency of Failure

- Instead of 1-7 scale values, express LoF values as mathematical probabilities, between 0% and 100%
- Frequency, e.g., once every 10 years, is different from probability, e.g., 10% likelihood that a failure will occur in the next year.

Establishing Condition-dependent Hazard Rates

- SMEs define what it means for assets to have different condition (e.g., good, fair, poor) and develop hazard rates for equipment in that condition
- SMEs provide information about the types of outside events that can lead to asset failure and the likelihood of those outside events
- SMEs provide “multipliers” that are used to shift the hazard rate curves to account for the outside events. For example, in Figure 2, a magnitude 6.0 earthquake might shift the “good” condition hazard rate curve up by 10%, the “fair” condition rate curve by 20%, and the “poor” condition curve by 50%

Approach to Measuring LoF Supports S-MAP Goals

- Supports public and employee safety, by measuring risk of failure events as accurately as possible
- Supports cost-effectiveness by allowing computation of risk reduction
- Supports understandability by using mathematical probabilities
- Supports transparency by using a rigorous process to develop likelihood of risky events that can be reviewed by all stakeholders

Measuring CoF

- Proposed methodology uses a *multi-attribute utility function* approach
- CoF is defined as a weighted sum of values of different attribute levels (e.g., safety, reliability, financial impact, environmental, etc.)

$$\mathrm{CoF}(X) = w_{\mathrm{SAFETY}}\mathrm{SafetyScore}(X) + w_{\mathrm{RELIABILITY}}\mathrm{ReliabilityScore}(X) + w_{\mathrm{FINANCIAL}}\mathrm{FinancialScore}(X) + w_{\mathrm{ENVIRONMENT}}\mathrm{EnvironmentalScore}(X)$$

$$\text{where: } w_{\mathrm{SAFETY}} + w_{\mathrm{RELIABILITY}} + w_{\mathrm{FINANCIAL}} + w_{\mathrm{ENVIRONMENT}} = 100\%$$

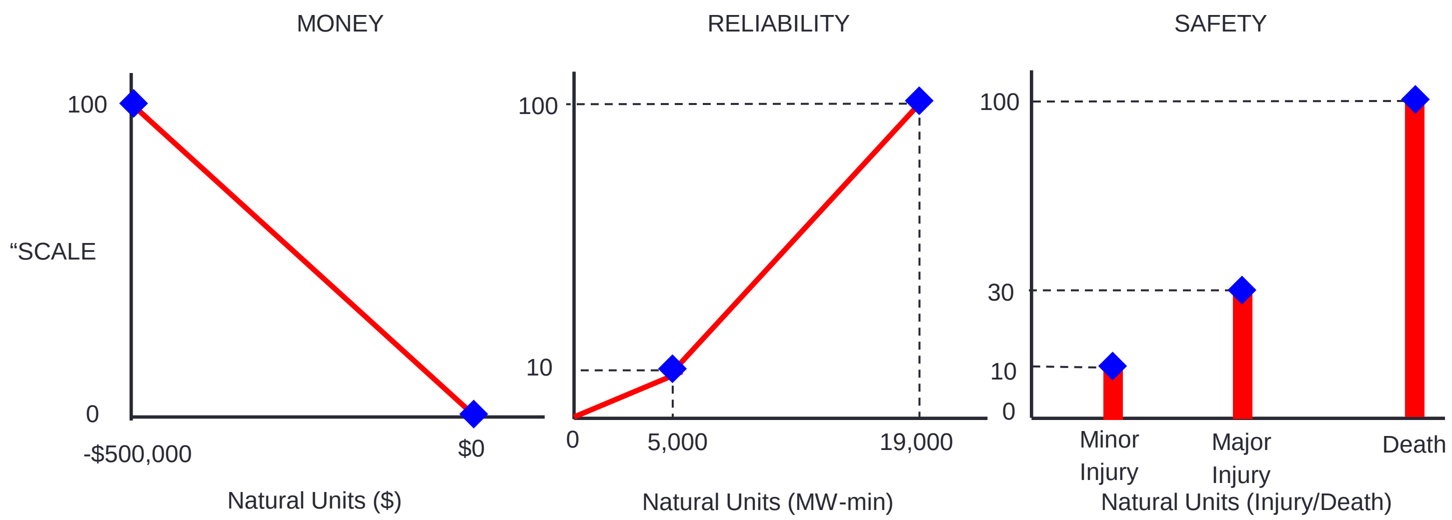
Measuring CoF (cont.)

- This approach was developed many years ago by economists
  - Straightforward to implement
- Actual multi-attribute value is dimensionless; just a number
  - No need to estimate the statistical value of life
  - Uses "natural units" to measure level of attributes (e.g., injuries, loss-of-service measures, $ impacts for financial, etc.)
  - Scales convert natural units into values.
  - Weights convert values into values that can be compared
- Critical to ensure that attribute ranges, scales, and weights are all internally consistent
  - Current utility approach does not do this

Implementation of this CoF Method

- For each attribute, the Commission and utilities must specify:
  - Attribute Range: This is span across which an attribute is measured, from the most benign level (presumably no impact if nothing happens) to the worst case outcome.
  - Attribute Scale: The consequences of a failure event for each attribute are scaled, from 0 (no consequence) to 100 (worst case outcome)
    - In our experience, using a 0 to 100 scale is easier for people to understand. However, any scale can be used.
  - Weights: Relative importance of each attribute as compared to other attributes
  - Can specify the safety weight to be at least 50%, so as to ensure safety is given greatest weight of all attributes

Multi-attribute Example



- In this example, three attributes: money, reliability, individual safety .
- Each is measured in natural units, e.g., worst case for money is $500,000 loss, worst case for reliability is 19,000 MW-min of lost service. Worst case for safety is death (100 units)
- Intermediate values are based on the relative tradeoffs identified by utility and regulators
    - Note that the money scale is linear; the reliability scale is piece-wise linear, and the safety scale is discrete

Multi-attribute Example (cont.)

- Suppose that, if a specific failure event takes place, it will result in:
  - Loss of $300,000:
    - Scaled value of 60 (300,000 is 60% of worst case outcome)
  - 2,000 MW-min of unserved electricity:
    - Scaled value of 4 (2,000 MW-min is 40% of 5,000 MW-min value of 10 risk units)
  - 50% chance of no injury, 25% chance of minor injury; 15% chance of major injury, and 10% chance of death. A total of 3 people will be exposed:
    - Scaled value of (0.50 *x* 0) + (0.25 *x* 10) + (0.15 *x* 30) + (0.10 *x* 100) = 17 per person, 51 units total
- Attribute weights.
  - 6.25% financial; 18.75% reliability; 75% safety

Multi-attribute Example (cont.)

- CoF score:

  (6.25% *x* 60) + (18.75% *x* 4) + (75% *x* 51) = 38.25

- Overall risk score for this event is LoF x CoF
  - Suppose LoF is 50%, then Risk = 50% x 38.25 = 19.125 risk units
- Can evaluate mitigation approaches:
  - If reduce LoF from 50% to 40%, then risk decreases by 10% x 38.25 = 3.825 risk units
  - If reduce number of individuals exposed from 3 to 2, then risk reduction is 50% x 75% x 17 units/person = 6.375 risk units.
- With risk reduction values, can determine most cost-effective management strategy

Current utility CoF approach does not clearly delineate changes along the scale

Impact Level	Description
Catastrophic (7)	Fatalities: Many fatalities and life threatening injuries
Severe (6)	Fatalities: Few fatalities and life threatening injuries
Extensive (5)	Permanent/Serious Injuries and Illnesses: Many
Major (4)	Permanent/Serious Injuries and Illnesses: Few
Moderate (3)	Minor Injuries or Illnesses: Minor to many persons
Minor (2)	Minor Injuries or Illnesses: Minor to few persons
Negligible (1)	No injury or illnesses, un-reported, negligible injury

- Definitions unclear: “more,” “few”?
- Scale is not additive → makes risk reduction estimates very difficult

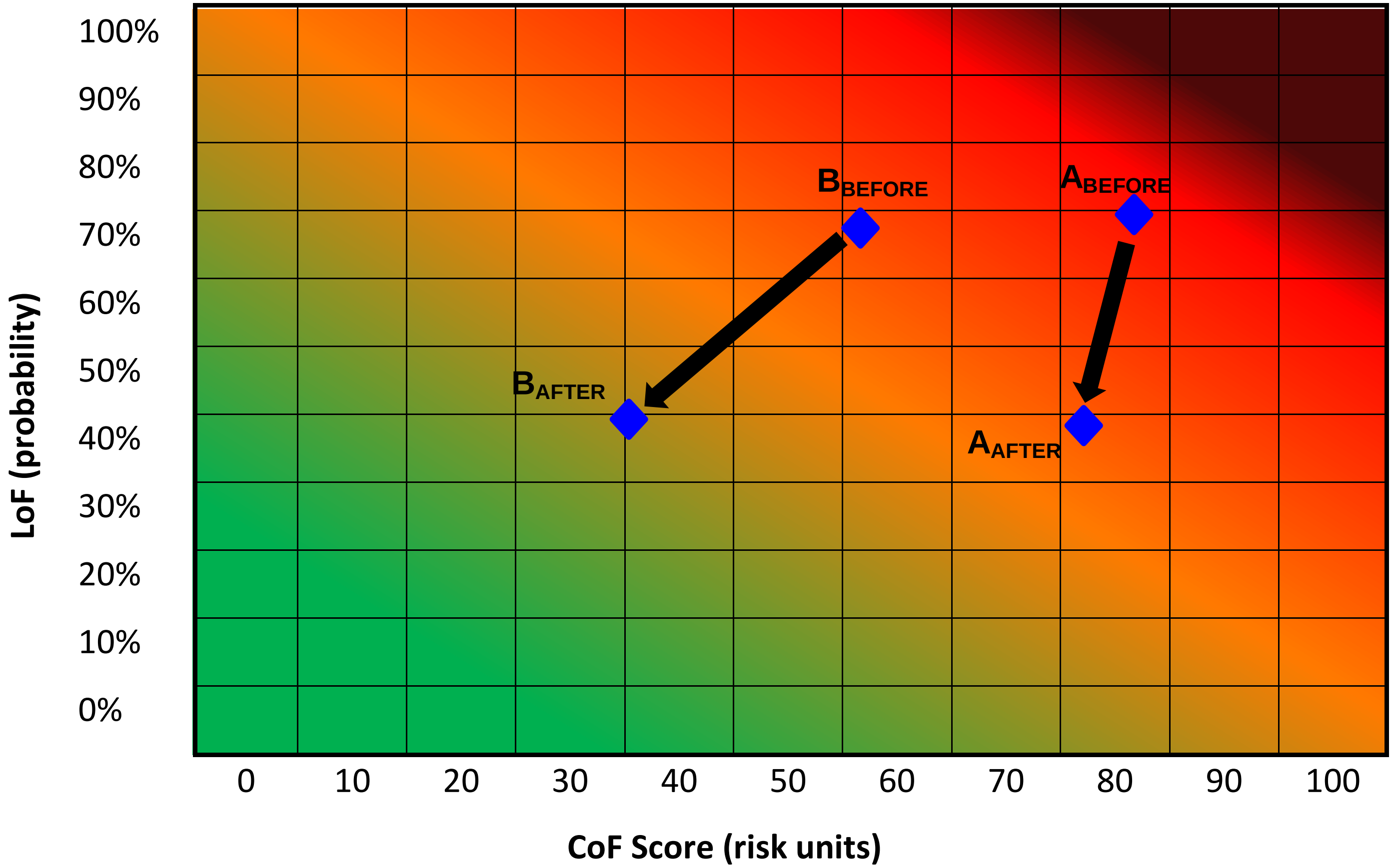
Approach to Measuring CoF Supports S-MAP Goals

- Supports making Safety the most important attribute
- Supports cost-effectiveness by making it possible to compute both risk reduction and cost-effectiveness in a straightforward way
- Supports understandability because unclear, non-additive 1-7 CoF scale is eliminated
- Supports transparency because it shows the direct link between risk reduction achieved through mitigation that results in changing the attribute levels

CoF Implementation

- CPUC should further highlight the treatment and weighting of safety
  - At a minimum, the CPUC should specify the relative weight of the safety attribute
  - Utility discretion to address and adjust other attribute weights, subject to review by stakeholders and CPUC
  - Utilities should be required to replace current weights with properly specified weights

Recommended Approach Creates a More Intuitive "Heat Map" with LoF and CoF Changes



Enables straightforward measurement and comparisons of risk reduction alternatives

Optimization: Proposed Methodology

- Step 1: The proposed risk management methodology can rank risk mitigation options based on risk reduction per dollar.
  - This is “Prioritization”
  - Can use commercially available software including Excel
- Step 2: Go beyond such ranking to select the optimal strategy for any given budget by solving a straightforward optimization problem
  - Prioritization and optimization can result in totally different strategies.
  - Use software developed by EPRI (and funded, in part, by PG&E, SCE, and SDG&E)

Optimization: Proposed Methodology (cont.)

- Step 3: The proposed methodology maximizes risk reduction subject to constraints
  - Utility identifies the constraints and clearly communicates the constraints considered, enabling review by stakeholders and CPUC
  - Constraints could include: Affordability, Available Labor and Resources, Avoiding Service Outages
- Step 4: Optimization effort leads to recommended risk mitigation actions, which are still subject to the judgment of the utility, Commission and other stakeholders

BENEFITS OF A WELL-CONSTRUCTED RISK MANAGEMENT METHODOLOGY

Prioritizes Safety

- Achieves Commission Safety Goals
- Reliance on actual probabilities rather than arrival rates more clearly reflects the uncertainty of occurrence of failure event
  - Conversion to the 1-7 scale may overestimate some risks and underestimate others
- A multi-attribute utility function for CoF allows the Commission to ensure that the utilities have properly prioritized safety

Results in a Cost Effective Portfolio Optimized to Funding and Other Constraints

- Using actual probabilities and well defined consequence scores allows the utility to calculate the risk reduction for any given project
- Determines the most effective portfolio of risk mitigation projects given identified constraints

Transparency, Understandability, Ease of Use

- The Commission and stakeholders can understand the process used by the utility to choose mitigation projects
- Results can be replicated because inputs and computations are available and clearly stated.
- Clarifies all information and assumptions that are used to determine LOF
- Measures the effect of changing attribute levels on the consequences of failure
- Provides a reviewable process for developing a risk mitigation portfolio

Allows for Common Application

- The proposed methodology can be adopted by any utility
  - Still allows for each utility to capture its own values and differences
- Serves goals of administrative efficiency and enables better comparison across the utilities

BUILDING AN EFFECTIVE RISK MANAGEMENT METHODOLOGY

Short Term Improvements to Utility Methodology—LoF, CoF, RR, P*

- Use condition-dependent hazard rates (LoF)
- Implement multi-attribute utility function to determine consequence scores and ensure that safety is prioritized (CoF)
- Compute and compare risk reduction of proposed mitigation projects (RR)
- Utility identifies key constraints and can select an optimum portfolio of projects within those constraints (P*)

Long-Term Improvements

- Further implementation of optimization techniques
- Acknowledge that asset condition changes over time and adopt optimization techniques that reflect the dynamic nature of assets

Questions?