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Substation Asset Composite Risk Model

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Substation Asset Risk Model

Existing Challenges

- Difficulty communicating risk
- Large aging asset base and limited funding
- Data challenges
- Previous risk model only used for replace decisions
- Inconsistent risk framework across asset classes



Communicating Risk

Documentation Benefits



- Consistent Framework across asset classes
- Transparency
- Mechanism by which to communicate revisions to asset risk model and receive feedback

Visual Management

Substation Risk Matrix

Probability (POF)	5					
	4					
	3					
	2					
	1					
		1	2	3	4	5
	Consequence (COF)					

PoF Avg. Conf. 50% CoF Avg. Conf. 50%

- Spreadsheets or lists make it hard to communicate asset risk
- With risk dashboards SMEs can provide a buffet of data/information to internal stakeholders and leadership

Risk in Dollars

ANNUALIZED RISK

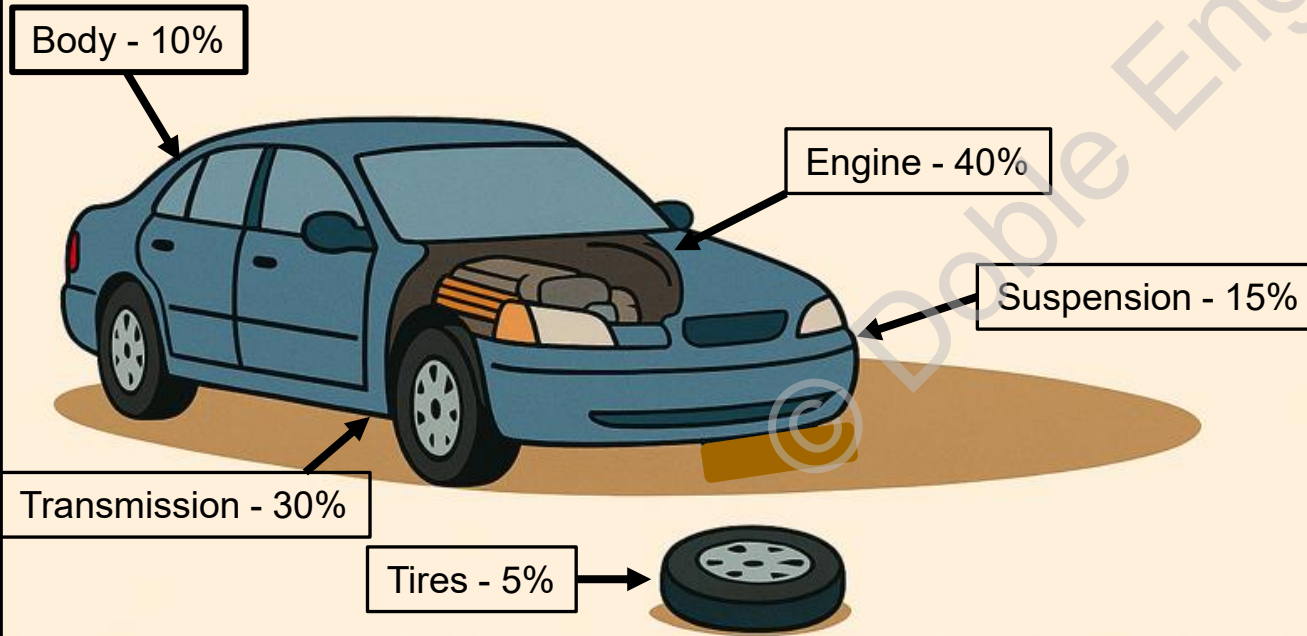


- Risk in dollars is universally understood
- Allows for risk spend efficiency calculations
- Company can compare asset risks with other risks within the company

“When you document it, you can talk about it” Quote by the great Dr. McGrail

End of Weighted Risk Ranking - Masking Risk

A weighted system is a bad idea because it can unintentionally mask components that can lead to asset failure.



Weighted System

Scale: 1 = Good, 100 = Bad

Engine Score - - - - - $4 \times 0.4 = 1.6$

Transmission Score - $2 \times 0.3 = 0.6$

Suspension Score - - $3 \times 0.15 = 0.45$

Body Score - - - - - $6 \times 0.1 = 0.6$

Tires Score - - - - - **95** $\times 0.05 = 4.75$

Health Score = 8 out of 100 = Low Risk

New System

Scale: 1 = Good, 100 = Bad

Engine Score - - - - - 4

Transmission Score - 2

Suspension Score - - 3

Body Score - - - - - 6

Tires Score - - - - - **95**

Highest Score Represents Risk

Health Score = **95** = High Risk - Tires

End of Weighted Risk Ranking - Mitigations

Scenario #1

Age/Paper Ins. Score - 1%	
DGA/Windings Score – 2%	Primary Risk Driver: Bushings at 80%
FQ/Ins. Oil Score - - - - 2.4%	2 nd Risk Driver: Insulating Oil at 2.4%
Bushings Score - - - - - 80%	
LTC Score - - - - - 0.5%	

Recommendation – Replace Bushings

Scenario #2

Age/Paper Ins. - - - - 75%	Primary Risk Driver: Bushings at 80%
DGA/Paper Score – 50%	2 nd Risk Driver: Age/Paper at 75%
FQ/Ins. Oil Score - - 2.4%	3 rd Risk Driver: DGA/Paper/Windings at 50%
Bushings Score - - - 80%	4 th Risk Driver: Insulating Oil at 2.4%
LTC Score - - - - - 0.5%	

Recommendation – Replace Transformer

- When you have a detailed understanding of what is driving the risk for an asset the proper prescription becomes evident.
- Meaningful risk spend efficiency scores can be created.
- Can identify good candidates for asset life extension

Confidence Scoring System

Initial Risk Model
Confidence ~50%



SME's dig deeper to verify risk and increase confidence to > 70% before making consequential investment decisions.



Things that Impact Confidence

- Frequency of data refresh
- Understanding of Consequence
- Dated Test Results
- Data Based Assumptions
- Availability of Asset Characteristic Data
- Availability of Operational Data
- Missing or lack of data

Benefits

- Provides transparency to users and leadership on the accuracy of the risk scoring.
- Identifies areas for data improvement
- Gives the SME freedom to create an ideal model unrestrained by data limitations.
- Ensures a risk value is produced on what we currently know despite data gaps/challenges

Beach = Fleet of Assets

Confidence Scoring System - Disclaimer

Transformer Bushing PoF = 1%

Data Used to Calculate Bushing PoF

- Age of the Transformer



Data Desired to Calculate Bushing PoF and Data Blueprint for What Good Looks Like

- Bushing Power Factor Test Results (100%)
 - Bushing Voltage
 - Bushing Model
 - Bushing Make
 - Doble DTA Web PF Standard Dev.
- Bushing Age (20%)
- **Transformer Age (15%)**

Annual PoF = 1%
Confidence = 15%
We don't know much



Note: Our previous transformer risk model didn't include Bushings due to the lack of data

Confidence Scoring System - Triaging Resources

		Substation Risk Matrix				
Probability (POF)	5					
	4				5	
	3	1		22		3
	2	102	6	17		
	1	98	67	56		
		1	2	3	4	5
		Consequence (COF)				

Focus time and resources to increase confidence for these assets first.

Avg. PoF Conf. = 50% Avg. CoF Conf. = 50%

- It is important to have a decent baseline level of confidence before deciding on which assets to prioritize for deeper level analysis.
- Over time there should be a goal by the organization to continue to increase baseline/default confidence.



Substation Risk Framework

- Risk Category Examples**
- Reliability
 - Employee Safety
 - Public Safety
 - Environmental

Total Asset Risk (\$)

The Sum of all Risk Categories

Risk Category #1
(Risk in \$)



Risk Category #2
(Risk in \$)

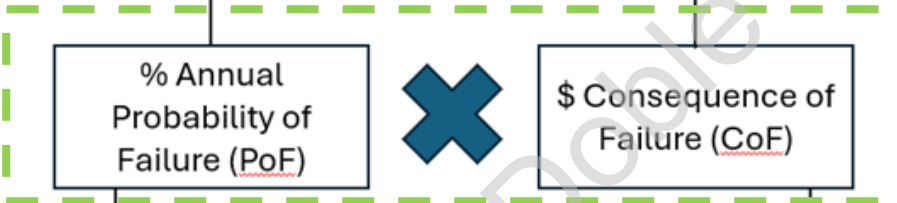


Risk Category #3
(Risk in \$)



Risk Category #N
(Risk in \$)

The Product of
PoF and CoF



Criteria Category with the
Largest PoF Represents

The Sum of all CoF Criteria Categories

% PoF Criteria Category #1 **OR** % PoF Criteria Category #2 **OR** ...% PoF Criteria Category N

\$ CoF Criteria Category #1 **+** \$ CoF Criteria Category #2 **+** ...\$ CoF Criteria Category N

Transmission Transformer Risk Categories

Key Take-away: The two predominate risks for Transmission Transformers are Reliability and Employee Safety.

Reliability

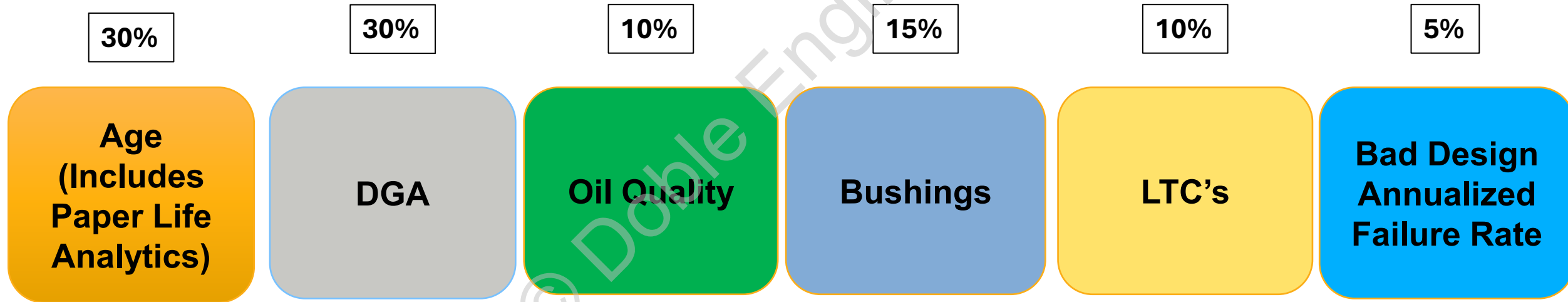
Substation Risk Matrix						
Probability (POF)	5	Orange	Orange	Red	Red	Red
	4	Yellow	Orange	Red	Red	Red
	3	Yellow	Yellow	Orange	Red	Red
	2	Green	Green	Yellow	Orange	Orange
	1	Green	Green	Yellow	Yellow	Orange
		1	2	3	4	5
	Consequence (COF)					

Employee Safety

Substation Risk Matrix						
Probability (POF)	5	Orange	Orange	Red	Red	Red
	4	Yellow	Orange	Red	Red	Red
	3	Yellow	Yellow	Orange	Red	Red
	2	Green	Green	Yellow	Orange	Orange
	1	Green	Green	Yellow	Yellow	Orange
		1	2	3	4	5
	Consequence (COF)					

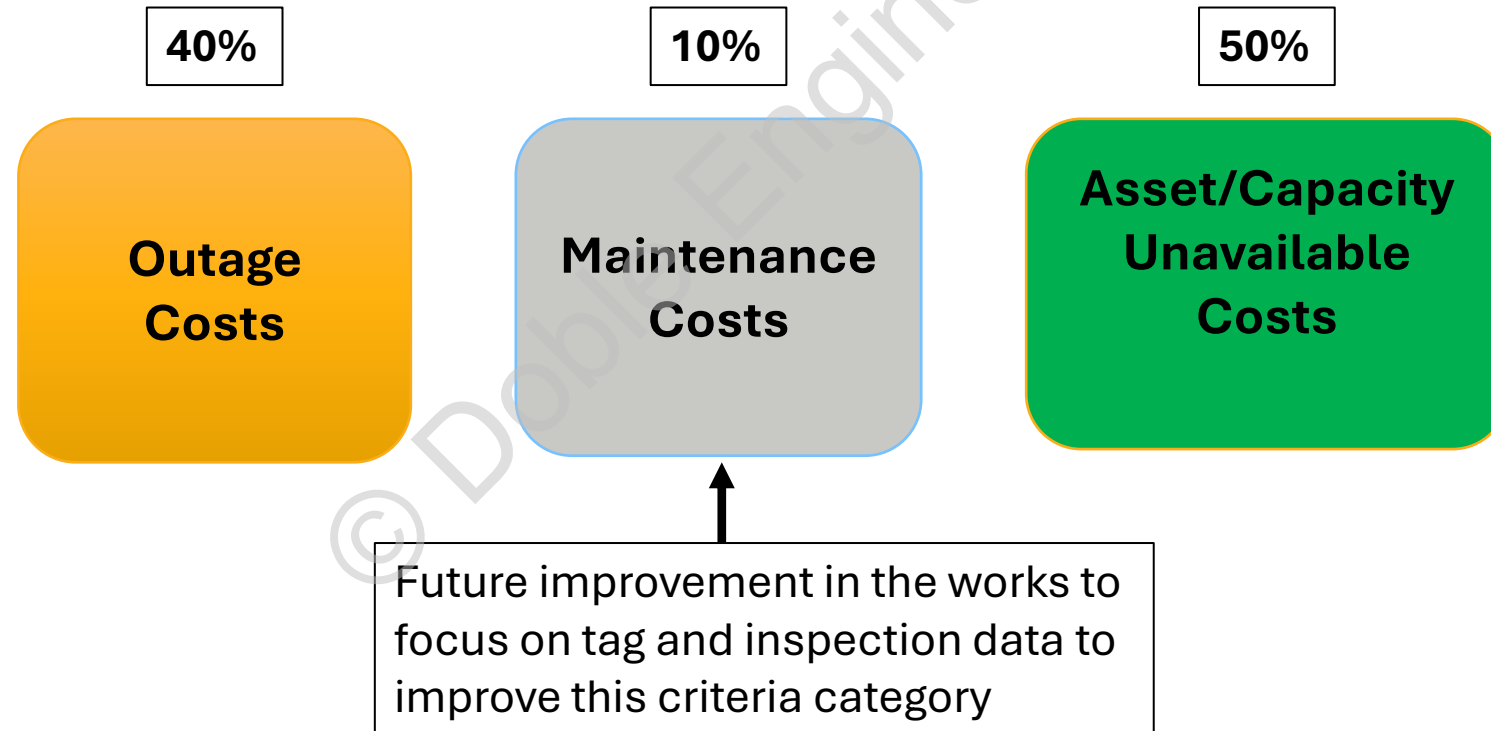
Transformer Reliability PoF Criteria Categories

Key Take-away: The confidence weighting is based on SME experience, failure data, and FMEA analysis.

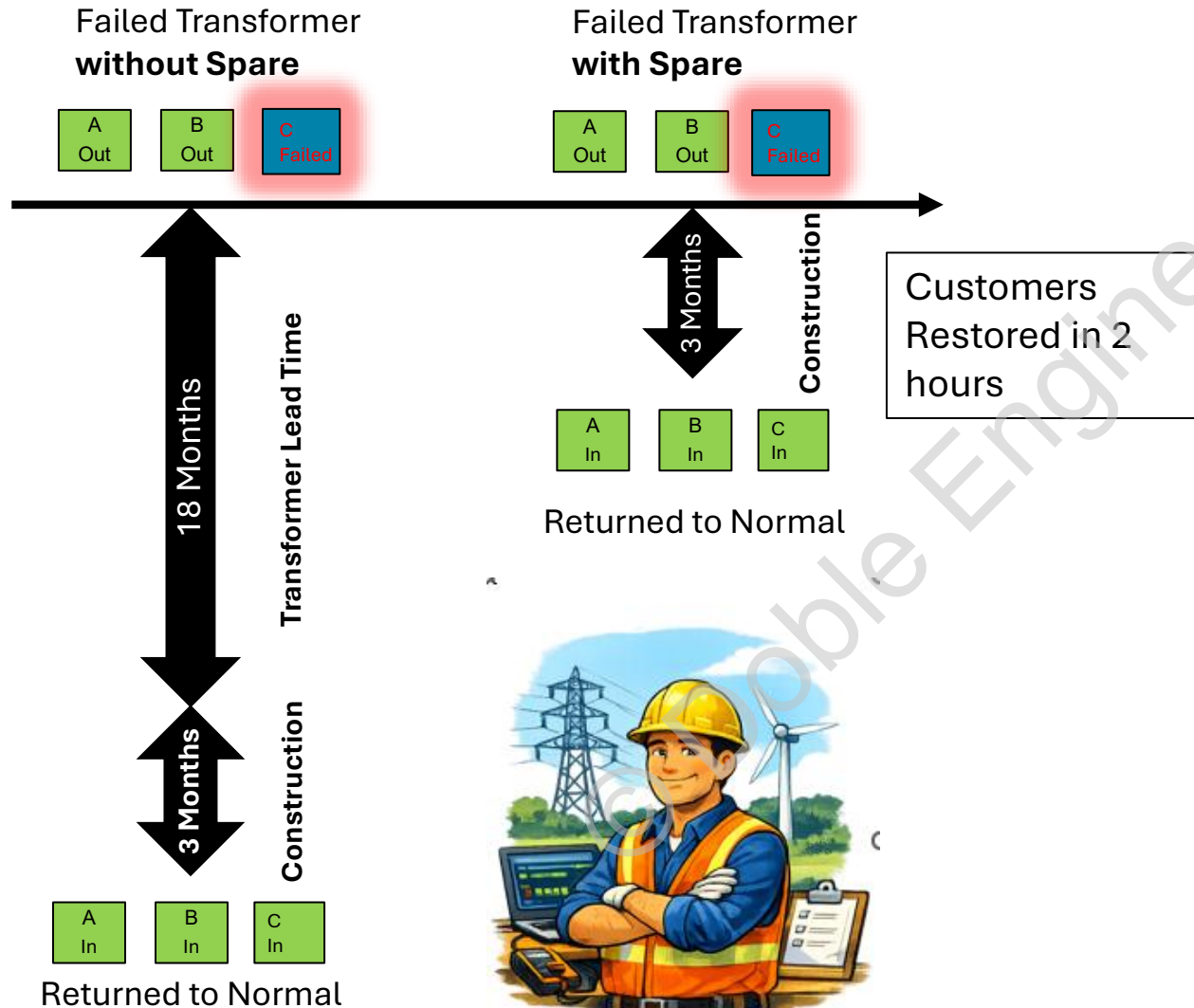


Reliability CoF Criteria Categories

Key Take-away: For Transmission Transformer failures it is not uncommon for there to be no customer outage.



Asset/Capacity Unavailable Costs



Potential Impacts Associated with Capacity Unavailable to Grid

- Congested revenue charges
- Increased loading/loss of life for surrounding assets
- Increased difficulty in obtaining clearances resulting in project delays and differed maintenance
- The next failure in the same planning area while in an N-1 configuration can result in a significantly larger outage.

Note: Placing a value on redundancy to the grid is especially helpful in properly conveying the value of networked Transmission substation assets.

Conclusion



Role of the Risk Model

The Risk Model provides a structured framework for communicating and prioritizing risk across asset management teams consistently.

Supporting Decision Making

It aids in resource triage and informs risk mitigation strategies through a transparent and repeatable combination of risk factors.

Limitations of the Risk Model

The model does not replace expert judgment, is not a perfect predictor, and is an evolving tool that improves over time.

Setting Expectations

Clear communication of the model's strengths and limits fosters trust and sets realistic expectations for its use in decisions.

Any Questions?

