Ameren MISSOURI | Callaway Energy Center

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Risk-Informing License Renewal – Exploring the Potential Callaway Cable Pilot Example

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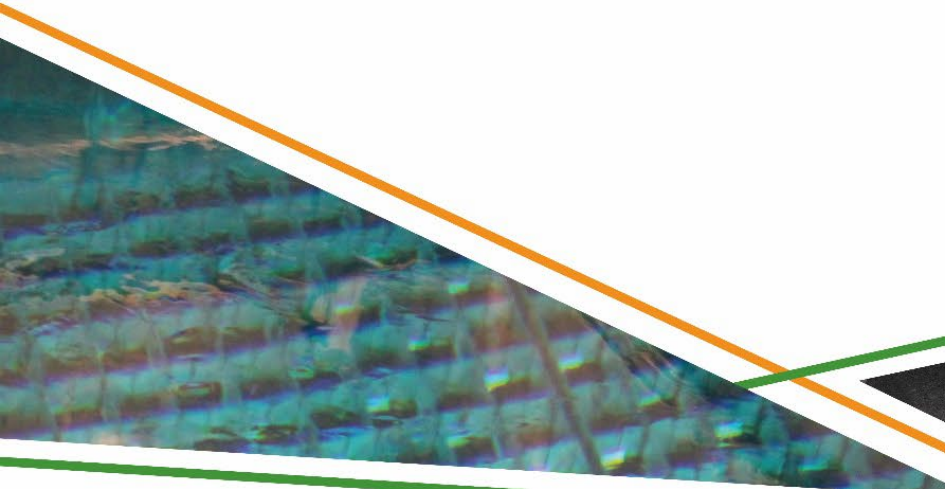
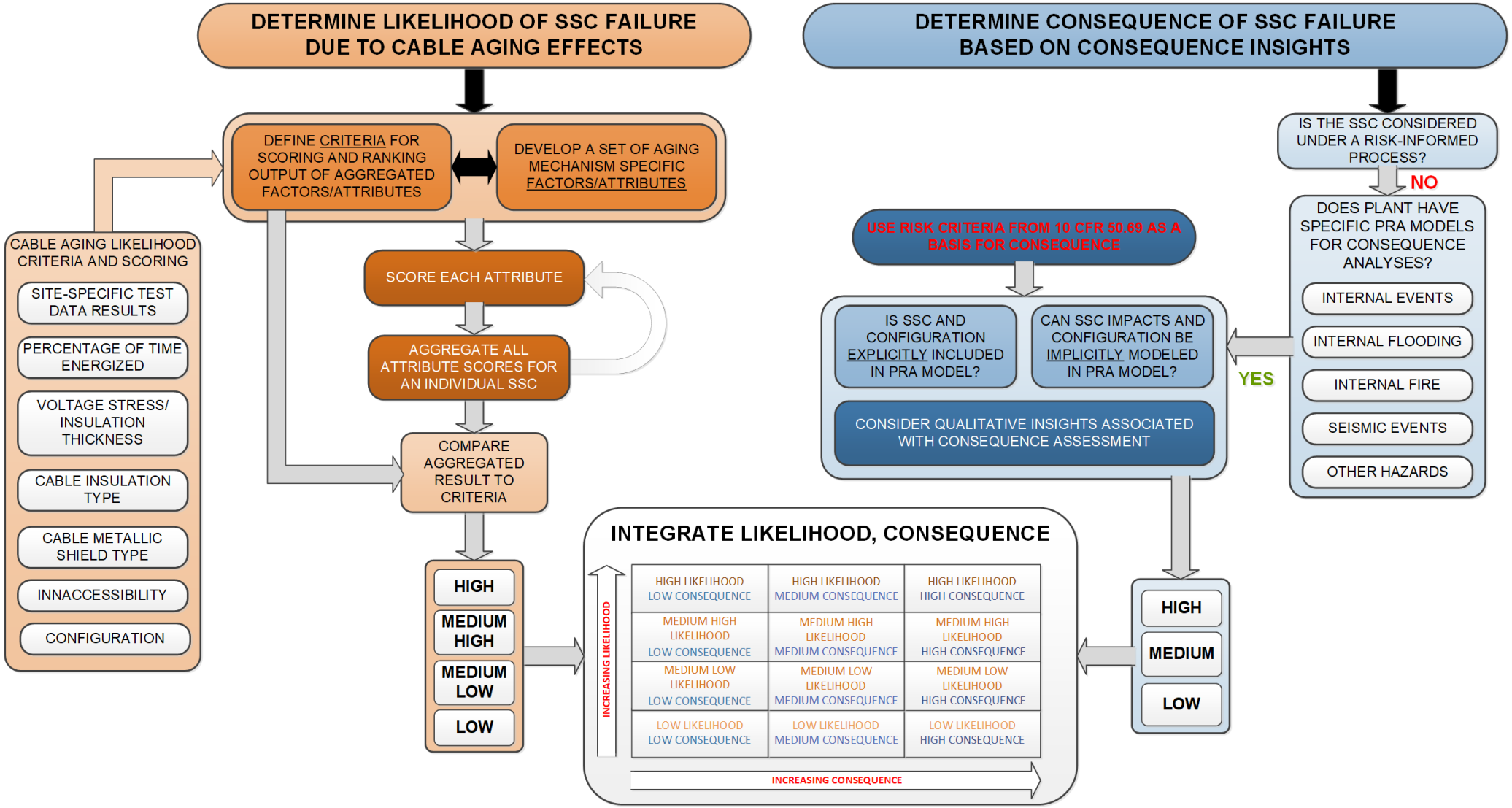


Cable Pilot Background

- EPRI initiative for risk-informing aging management
- Callaway participated in a pilot on the XI.E3 AMP (Inaccessible non-EQ cables)
  - The focus on this AMP is aging of cables from moisture
- Large scope of cables means significant time & resources for AMP required testing

- Objective: Provide solid technical bases for extending the test frequency of low risk MV cables from 6 years to 10 years
- Approach: Leverage risk insights to
  - Reduce efforts for cables with lower likelihood of failure and limited plant impact
  - Focus resources on cables where risk insights suggest more significant risk contribution

Overview of the risk-informed process utilized



Likelihood Table Development

- Likelihood aspects were developed specific to cable degradation due to wetting.
- Goal to create a likelihood index that can work for most plants.

- Parameters were determined, scored, and weighted based on influence to the failure mechanism.
- Scoring ranges were developed for low/medium-low/medium-high/high likelihood risk.

- Likelihood = living process that will require occasional updates if testing/inspection conditions change

Likelihood – Reference Table

LIKELIHOOD INDEX						
	5	4	3	2	1	0
Insulation	XLPE, Butyl rubber, compact				Pink/Brown EPR, TR-XLPE	PILC
Inaccessibility	Can't keep dry		Occasional wetting	Historically wet, but now kept dry	Always dry	
Shield Type			Zinc - wet	Zinc - dry	Copper, concentric, etc.	
Splices			Multiple splices	One splice	No splices	
Voltage Stress Ratio (V rating / service V)	<1		≥1 & ≤3 with 100% insulation rating *If shielded and unknown, assume 100%	≥1 & ≤3 with ≥133% insulation rating *If unshielded and unknown, assume ≥133%	>3	
Energization			>50% energized	≥25% & ≤50% energized	<25% energized	Never energized (installed spare)
Test Data	Action required	Further study required	No data – wet *assume previous wet cases until tested otherwise	No data - dry	One good test	Multiple good tests

Likelihood Scores & Callaway results

LIKELIHOOD SCORES:	
HIGH	≥23
MEDIUM-HIGH	19-22
MEDIUM-LOW	15-18
LOW	≤14

Minimum Score: 3
Maximum Score: 27

- Each Callaway cable was evaluated and scored for likelihood
- Callaway results for 59 test groups (111 individual MV cable #s):
  - LOW = 43 test groups
  - MEDIUM-LOW = 12 test groups
  - MEDIUM-HIGH = 4 test groups
  - HIGH = no test groups
    - This result was expected due to Callaway cable types and dewatering systems on most locations.

Consequence

- Consequence evaluation can utilize existing plant PRA processes such as 50.69.
- Callaway does not have 50.69 yet; other PRA models and qualitative information was utilized.
  - This successfully showed different methods already available to the plant can be utilized.

- Consequence focused on single-failure of the cable and the loss of connected equipment.
- The equipment of the highest plant impact was evaluated.

Consequence

CONSEQUENCE SCORES:	
HIGH	PRA risk significant (max CDF or LERF RAW >2)
MEDIUM	Not PRA risk significant, but augmented due to: -Qualitative: trip/partial trip or other higher significance to the plant, or impact to safety systems -CCDP/CLERP values
LOW	Not PRA risk significant

- Each cable was evaluated and classified as low, medium, or high consequence.
- Callaway results for the 59 test groups:
  - LOW = 16 test groups
  - MEDIUM = 13 test groups
  - HIGH = 30 test groups

Risk Matrix

- A risk matrix was developed using the 4 levels in the likelihood and 3 levels in the consequence

- Created three regions of proposed actions
  - Ensures the high likelihood cables remain at a frequency ≤6 years
  - High consequence cables either remain at a frequency ≤6 years or needs solid engineering justification to extend to 10 years (ONLY with low likelihood)

LIKELIHOOD	LOW	MEDIUM	HIGH
HIGH	≤6	≤6	≤6
MEDIUM-HIGH	6/10	≤6	≤6
MEDIUM-LOW	10	6/10	≤6
LOW	10	10	6/10
	CONSEQUENCE		

		PROPOSED FREQUENCIES:
≤6	≤6	Keep 6 years or less
	≤6/10	Keep 6 years OR solid engineering justification to extend to 10 years
10	10	Consider extending to 10 years

Risk Matrix – Preliminary Callaway Results

LIKELIHOOD	LOW (RAW <2)	MEDIUM (QUALITATIVE or CCDP/CLERP)	HIGH (RAW >2)
HIGH (≥23)			
MEDIUM-HIGH (19-22)	- Fire protection XFMR 1 - Fire protection XFMR 2		- Feed to AEPS XFMR
MEDIUM-LOW (15-18)	- AEPS 13.8kV bus (from Co-op) - CW/SW XFMR 1 - 3 - AEPS feeds from EDG to 13.8kV bus		- AEPS power panel
LOW (≤14)	- Motor control center 1 - Motor control center 2	- AEPS backup feed to safety bus A & B - RCP motors 1-4 - Motor control center 3	-AEPS feed to 5kV bus -ESF XFMR to safety bus A & B -NS AFW pump motor -MD AFW pump motor A & B -UHS XFMR A & B -ESW XFMR A & B -EDG A & B

CONSEQUENCE

PRELIMINARY results suggest of the 59 tan delta test groups:

- 54 test groups have a technical justification to extend to a 10 year frequency
- 5 test groups currently suggest remaining at a 6 year frequency
  - 2 groups due to HIGH consequence and likelihood >LOW
  - 3 groups (fire protection xfmrs) due to OE on the cables and engineering judgment

Pilot insights:

- Adds flexibility and reduces burden for low risk cables
- Reduced risk of inherent intrusive maintenance and maintenance-induced failures

- For Callaway, estimated cost reduction of ~**$6,500 to $17,000** per eliminated test. Total cost avoided in a 20 year period is estimated **~$600,000** based on elimination of an average of 2 test occurrences for each justified cable.
  - Potential application of framework to other AMP requirements = more cost/labor reduction

- Based on the success of the pilot, Callaway is pursuing other opportunities to apply the framework

Questions?