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Technique for Managing STPA Results in Physical Security Applications

Using FT appearance frequency to improve VAI

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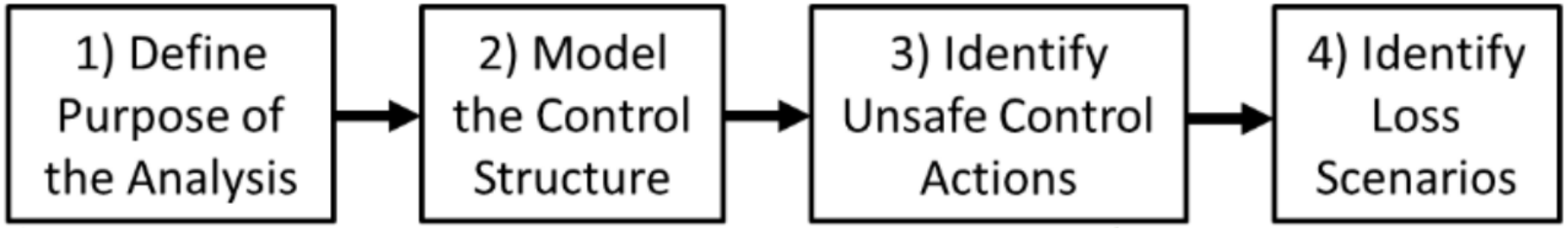
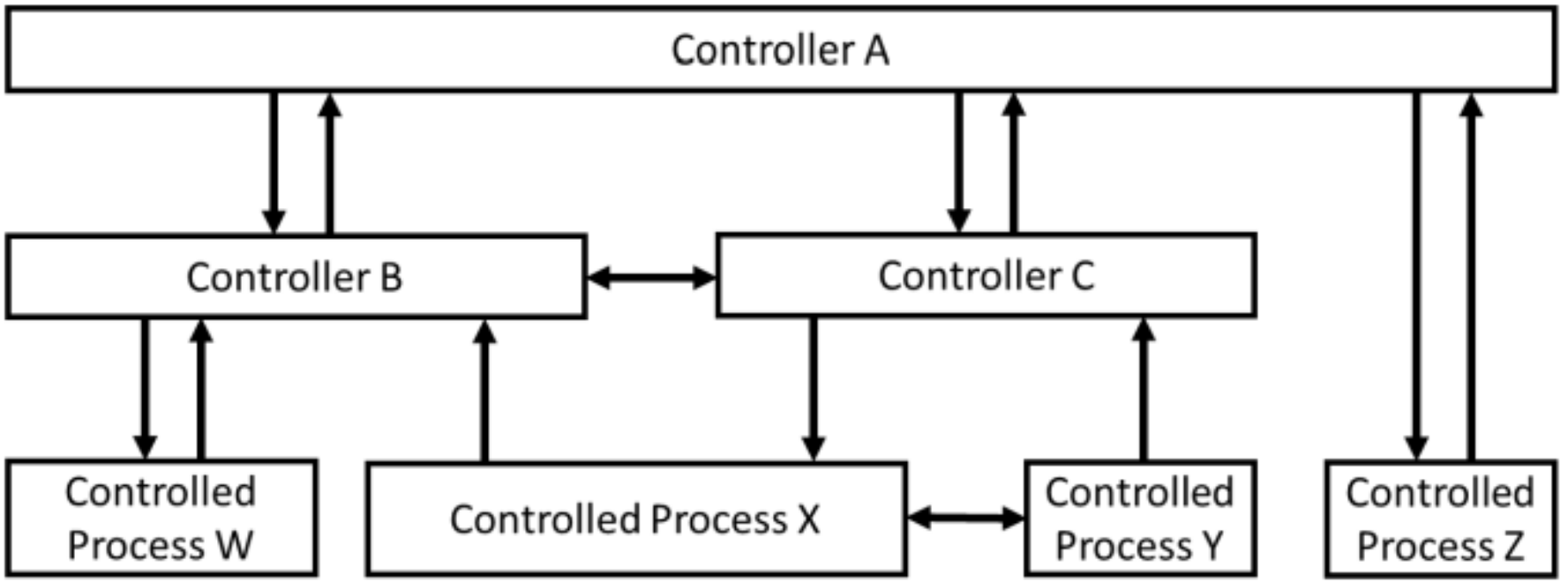
Outline

- STPA Overview (Advantages & Disadvantages)
- Overview of using STPA for physical security
- Case Study → Demonstrate benefit of STPA UCAs to expand traditional VAI fault trees
- Future work

Systems Theoretic Process Analysis Overview [1/2]





https://psas.scripts.mit.edu/home/get_file.php?name=STPA_handbook.pdf

STPA Overview [2/2]

- Limitations
  - Yields A LOT of output
  - Does not prioritize that output
  - Challenging to answer “what now?” question
- Implications for security applications
  - Security does not have 1E-6 threshold
  - All scenarios remain relevant
    - If within the Design Basis Threat (DBT)
  - $$$ limitations – infrastructure, personnel, supplies, etc.

Need for an opportunity for new thinking

- VAI: potential element of security to offer a chance to manage STPA results meaningfully

Vital Area Identification (VAI) Overview [1/2]

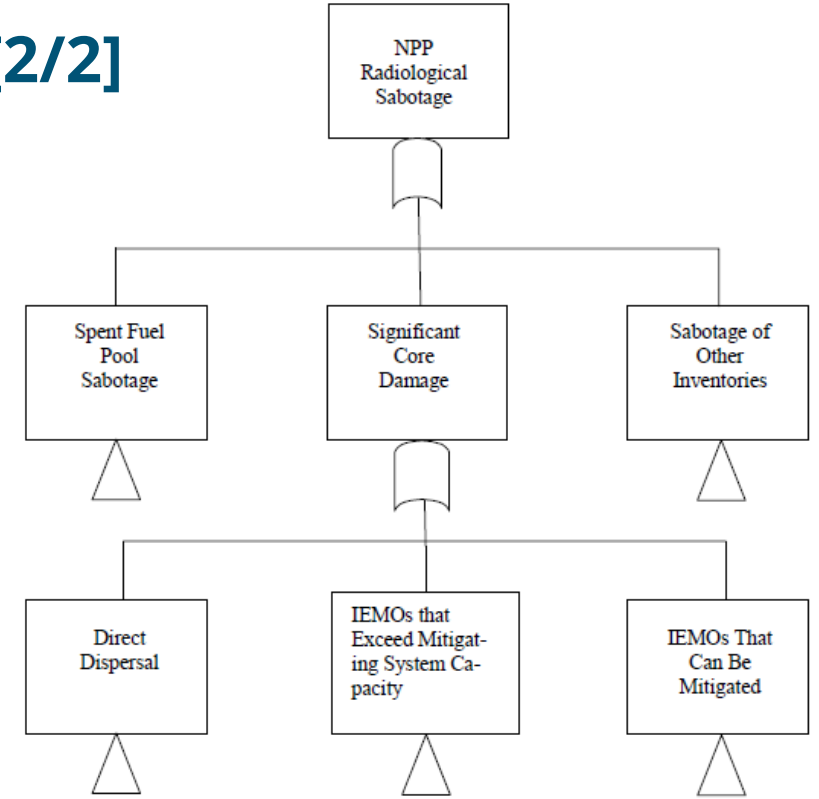
- *"Where do I need to keep the bad guys out of in order to prevent sabotage?"*
  - Minimize places, people (guards), infrastructure required to achieve objective
- A first attempt at bounding/identifying security risk
- Security risk thinking lags safety risk thinking
  - Efficiencies gained from "converting" safety analysis?
- Criticisms of traditional approaches to VAI…
  - Leverages safety-based PRAs… and their assumptions
  - Considers only **radiological** sabotage = only preventing release matters

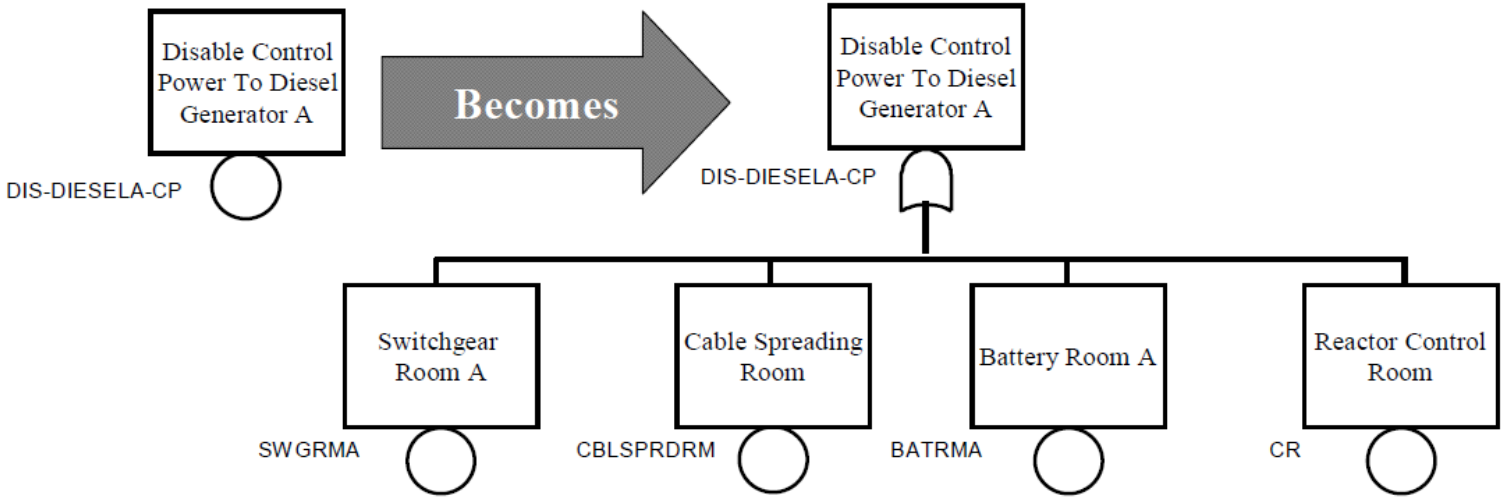
NO! Want to keep equipment working, keep making money, keep our reputation, etc.

- Y-12 – didn't reach the vital areas. Still had consequences.
- Surry attack on fresh fuel – not mandated vital area. Still had consequences.

Vital Area Identification (VAI) Overview [2/2]

- Methodology in practice is modified Fault Tree Analysis (FTA)
- Logic of Fault Trees (FTs) → top-down identification of all possible combinations leading to top event
- Even without including probabilities in the FTs, quantitative analysis can be used to categorize and prioritize results/solutions





Proposed Approach

VAI "converts" FT from basic component-level events to areas

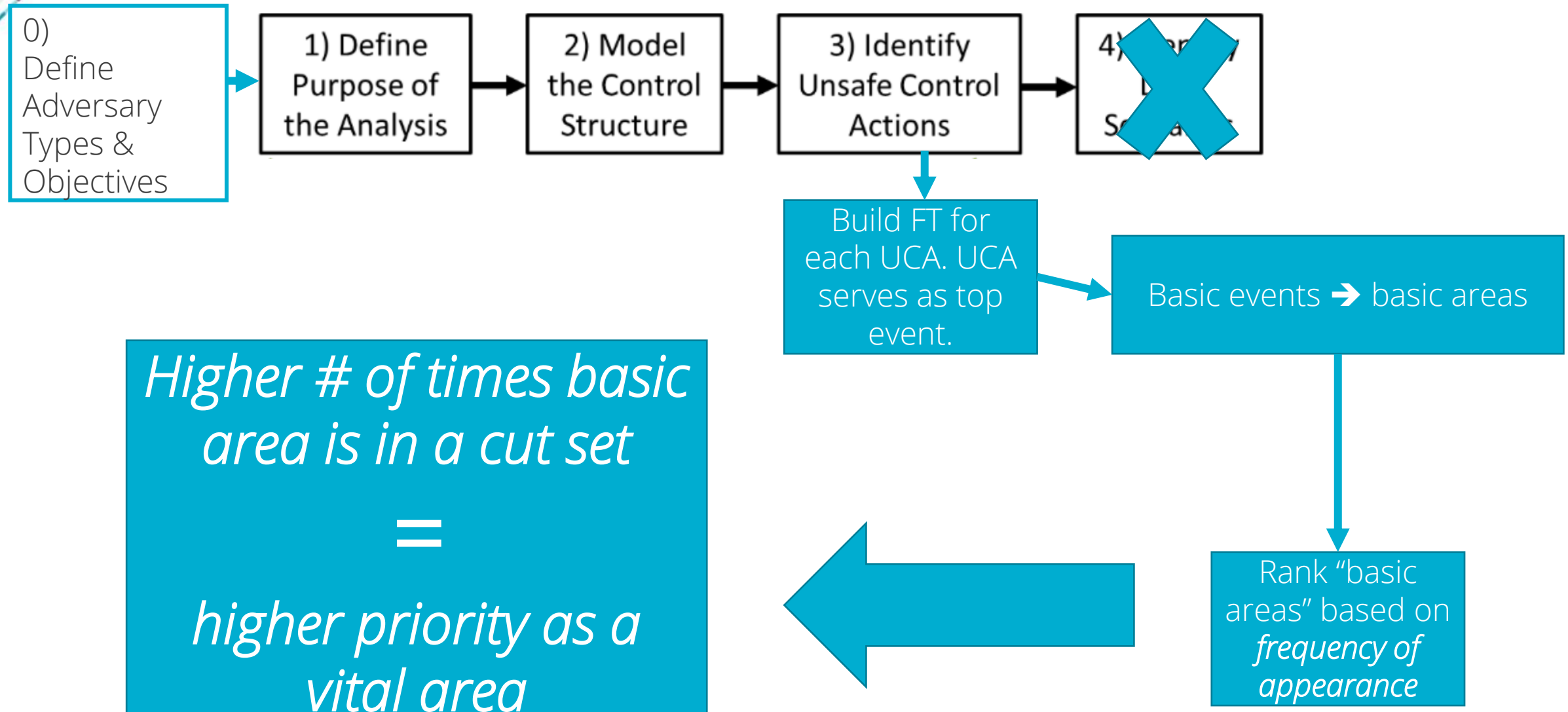
STPA good at identifying areas/items of concern missed by traditional approaches

...so

Integrating STPA into VAI methods could be beneficial.

HAZCADS has shown STPA is compatible with FTA in meaningful ways in safety/DI&C space.

How would it work?



How would it work?

End of STPA Step 3 yields Undesired Control Action (UCA) list

Example is from HARI (Hypothetical pool-type research reactor):

CA	Needed, not provided	Provided, not needed	Taken too early/late / wrong order	Given too long/Stopped too soon
CA1: water injected into pool	UCA1A: Operator did not inject water into pool when water was needed [H#]			

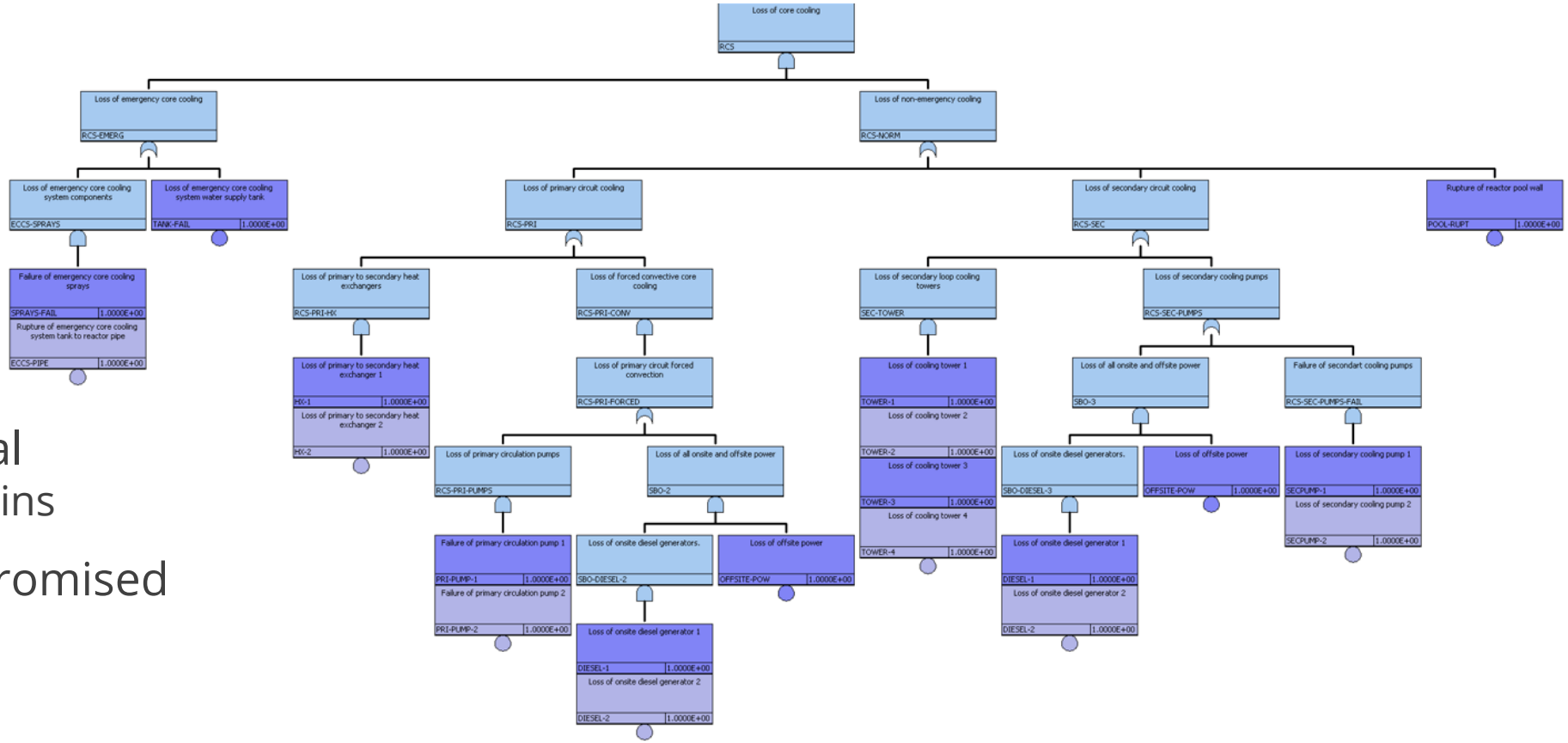
Note: only a sample UCA is included and carried forward from this table.

UCA1A: water not injected when needed

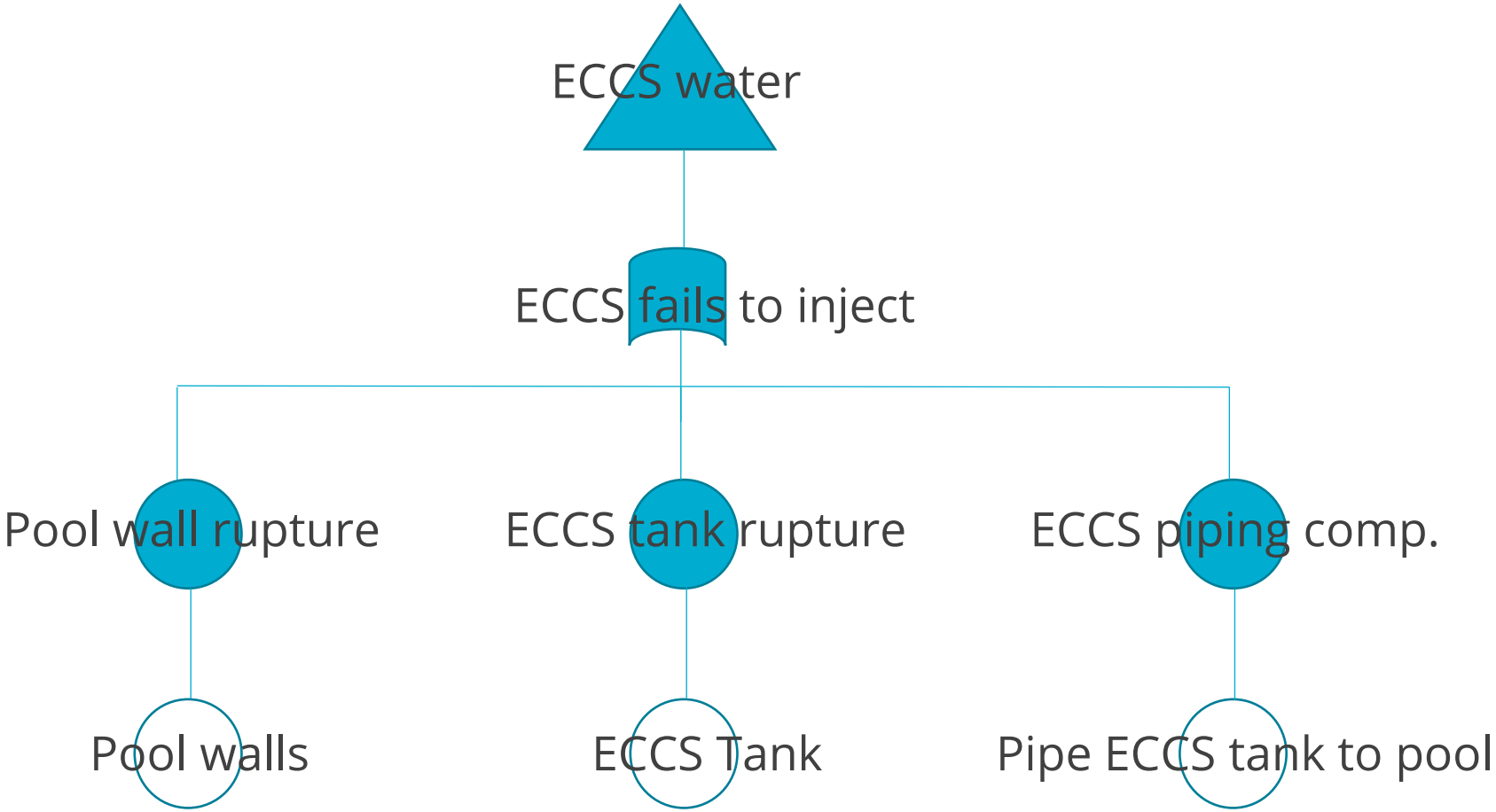
Consider:

- Lack of water
  - Various sources
- Piping compromised
  - Various systems
- Pumps non-functional
  - Various systems/trains
- Signal to inject compromised
- Operator error

Etc.



Sample FT Leg Conversion



Outcomes

Generate a frequency table:

(demonstrative table)

Area	Frequency
Pool wall (rupture)	5
ECCS piping	1
Primary pumps (co-located)	2
Cooling towers/heat sink	3
Secondary pumps (co-located)	2
Cabling from CR to pumps (co-located)	3

Based on this modified, hypothetical example,
Suggested VAs may be:

- Pool wall
- Cooling towers
- Cabling from CR

Next steps,

Implement these as VA and re-analyze.

What can I take away from this method?

	Analytical	Practical
Insights	• Can get VA candidates without using safety PRAs (A/SMR friendly) • Continued practicality of STPA in security AND STPA used in conjunction with other methods (FTA) • Considering sabotage beyond radiological	• Lends itself to planning (think A/SMRs) situations • Demonstrates prioritization without probabilities • Resiliency with DBT changes
Implications	• Using frequency of appearance as criterion for prioritization implies other characteristics not relevant	• May require iterations on front end • Need analysts who understand traditional VAI and STPA methods
Potential Benefits	• Appearance frequency as a proxy for importance, a quantitative measure of priority WITHOUT having to use probabilities • Overcome barrier of NOT having a complete safety PRA	• Can inform security (and facility) design in near real time • Risk-informing without challenges of uncertainty quantification and matriculation • Opportunity for physical security system design that moves away from costly retrofitting and prioritizing critical components for this protection

Conclusions

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- Probability free, yet provides prioritization
- Does not rely on PRA assumptions
- Does not rely directly on DBT
- Great for next generation of nuclear still in planning process

Potential Next Steps

- Potential for a hybrid method of this with *x* being frequency and *y* being consequence measure to determine importance.