How Not to Go Boom
Lessons for SREs from Oil Refineries

Emil Stolarsky | @EmilStolarsky
Resiliency
“If you get there and the Waffle House is closed? That's really bad.”

- Craig Fugate, Director of FEMA (2009 –2017)
Oil Refineries
Design for failure
Explosion Isolation Systems
Pressure Relief Systems
Safe and Rapid Isolation of Piping Systems
“If you think safety is expensive, try having an accident.”

- Trevor Kletz, Chemical Process Safety Expert
Fault Tree Analysis
p(B) = 2% + 2%
p(C) = 2% \cdot 2% \cdot 2%
p(E) = 2% \cdot 2%
\[ p(A) = p(B) + p(C) + p(D) \]

\[ p(B) = 2\% + 2\% \]

\[ p(C) = 2\% \cdot 2\% \cdot 2\% \]

\[ p(D) = 2\% + p(E) \]

\[ p(E) = 2\% \cdot 2\% \]
Subsystem A

\[ p(A) = p(B) + p(C) + p(D) \]

\[ p(B) = 4\% \]

\[ p(C) = 0.0008\% \]

\[ p(D) = 2\% + p(E) \]

\[ p(E) = 0.04\% \]
A

p(A) = p(B) + p(C) + p(D)

p(B) = 4%

p(C) = 0.0008%

p(D) = 2.04%

p(E) = 0.04%
The image depicts a hierarchical diagram labeled as Subsystem A. The diagram is structured as follows:

- **Subsystem A**
  - **A**
    - **B**
      - 2% 2%
    - **C**
      - 2% 2% 2%
    - **D**
      - 2%
    - **E**
      - 2% 2%

The probabilities are as follows:

- **p(A)** = 6.0408%
- **p(B)** = 4%
- **p(C)** = 0.0008%
- **p(D)** = 2.04%
- **p(E)** = 0.04%
A

B

C

D

E

Subsystem A

p(A) = ??%

p(B) = 4%

p(C) = 0.0008%

p(D) = ??%

p(E) = 0.04%
There is a diagram of a system with root node A. Below A are nodes B, C, and D. Node B has two branches, each with a probability of 2%. Node C has three branches, each with a probability of 2%. Node D has one branch with a probability of 2% and another with a probability of 0.04%. Node E has two branches, each with a probability of 2%.

The probabilities are as follows:
- \( p(B) = 4\% \)
- \( p(C) = 0.0008\% \)
- \( p(D) = 2\% \cdot 0.04\% \)
- \( p(E) = 0.04\% \)

The probability of node A is unknown and denoted as \( p(A) = ??\% \).
Subsystem A

p(A) = ??%
p(B) = 4%
p(C) = 0.0008%
p(D) = 0.0008%
p(E) = 0.04%
Subsystem A

p(A) = 6.0408%
p(B) = 4%
p(C) = 0.0008%
p(D) = 0.0008%
p(E) = 0.04%
Learning from Failure
Center for Chemical Process Safety
Steam Boilers
Thank you.