Bayes, Data and NUREG/CR-6928 Caveats

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Overview

- State-of-Knowledge Correlation
- Change-of-State Failure Mode
- LOCA Treatment
  - Plant Availability Factor
  - Zero Event Bayesian Updating

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State-of-Knowledge Correlation

- The correlation between data pools
- Use Monte Carlo or other sampling method and compare mean with point estimate (within 10% means you're done)
  - Sample on type codes so that multiple components reflect that correlation for a given sample
  - Must use sufficient sample size and a random seed or it defeats the purpose
- Select sensitivities can be a surrogate because one can do the accounting manually, and a sampling method is effectively a large set of sensitivities
- If the effect is large (>10%), should artificially account for SoKC in cutsets (e.g., via multiplier $E(\lambda^2)/E(\lambda)^2$)

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Change-of-State Failure Mode

- Two general methods are acknowledged in the industry
  - Failure on Demand
  - Failure in Standby
- NUREG-6823 suggests that either method individually or both methods can be acceptable together.
- Key consideration is that the data pools will likely be the same
  - Most likely that either failure mechanism was ultimately discovered when a demand on the component was initiated
  - If both methods are applied data would need to be appropriately parsed such that double counting does not occur, time consuming effort

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Change-of-State Failure Mode – Cont.

- US Industry being driven to consensus failure on demand, data more readily available.
- NUREG/CR-6928 discusses the standby failure mode in detail as follows:

  "Standby component failure modes such as pump FTS and valve FTO/C historically have been modeled as either demand related (failure probability upon demand) or standby time related (failure rate). For example, the NUREG-1150 studies expressed such events as probability per demand, while the Probabilistic Safety Analysis Procedures Guide expressed such events as rates per standby time. The present study follows the more traditional approach of probability per demand presently used in the SPAR models. Also, this same approach was taken for the INL system studies, in which significant effort was expended to develop state-of-the-art analysis methodologies… This decision was made mainly because the available data were typically collected on a per-demand basis..."

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LOCA Frequencies

- NUREG-1829 (Tables 7-17 through 7-19) should be used instead of NUREG/CR-6928
  - Identify approximate applicable break ranges and/or interpolate with a power law fit for specific sizes
  - Determine respective base frequencies from NUREG-1829; must convert from exceedance basis to interval basis (subtract) (NUREG suggests there is not statistical significance to treat percentiles similarly)
  - “Normalize” frequencies for at-power conditions; should use the same assumption that NUREG/CR-6928 used - that on average, the generic plant operates 90% of the year (divide by 0.9)
  - May need to divide frequencies for model impacts (e.g., per leg) - this should be captured in the Beta to maintain units

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Zero Event Bayesian Updating

- Frequencies in NUREG-1829 were used without any changes in NUREG/CR-6928, which was published in 2010; i.e., the experts concluded that NUREG-1829 frequencies remain applicable until at least 2010, without adjustment - therefore, Bayesian update should be back to the NUREG/CR-6928 publish date
- Bayesian probability distribution is a model of *our belief* in the true value of an event, and additional data, combined through Bayes' Theorem, serves to update our belief in the value; rather than representing random variation, the distribution represents uncertainty in our belief
- NUREG/CR-6928 does not treat them differently; in fact, it provides prior information for these events specifically for plant-specific use in Bayesian updating

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Questions?