



U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

Aleatory vs. Epistemic Uncertainties: Principles and Challenges

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"Aleatory" and "Epistemic" Uncertainties

Terminology/concepts built into multiple documents, e.g.,

- ASME/ANS PRA Standard
- Regulatory Guides
 - 1.200
 - 1.174
- NRC Reports
 - NUREG-1855
 - NUREG-1806
 - NUREG/CR-6833
- Training

aleatory uncertainty: the uncertainty inherent in a nondeterministic (stochastic, random) phenomenon... is reflected by modeling the phenomenon in terms of a probabilistic model... cannot be reduced by the accumulation of more data or additional information.

epistemic uncertainty: the uncertainty attributable to the incomplete knowledge about a phenomenon that affects our ability to model it... is reflected in ranges of values for parameters, a range of viable models, the level of model detail, multiple expert interpretations, and statistical confidence... can be reduced by the accumulation of additional information.

Observations

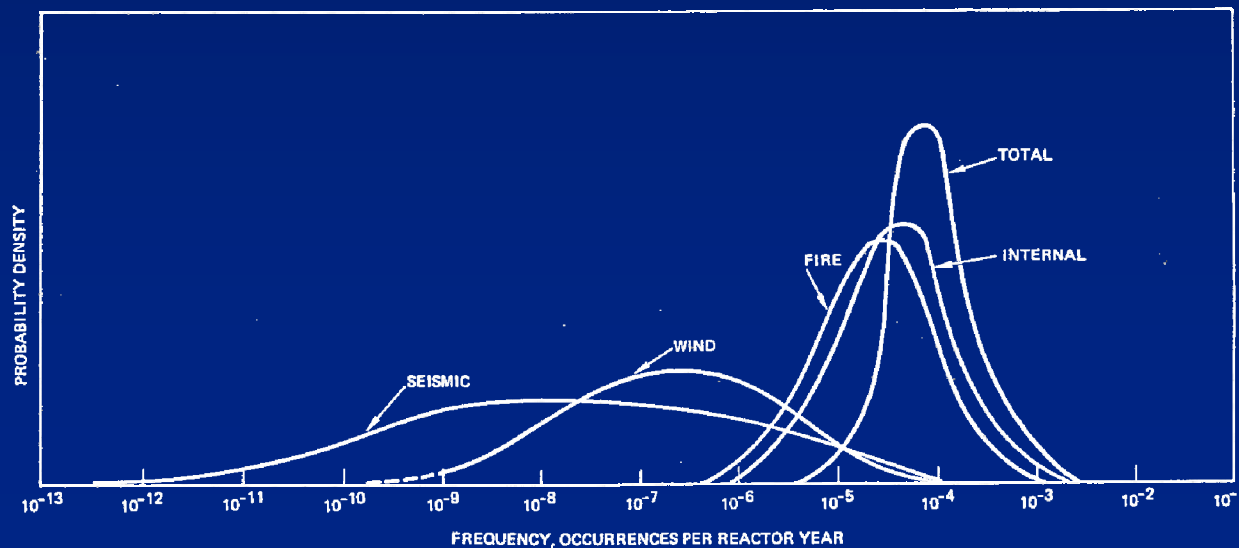
- Common understanding of conceptual modeling framework in routine Level 1 applications
- Challenges arise with departures from routine, e.g.,
 - Integrated phenomenological modeling
 - New issues (e.g., digital systems)
 - Very large uncertainties

Challenges

- Operationalization of conceptual framework (characterization and incorporation of uncertainties in computational model)
 - Model parameters
 - Model structure
 - Model scope/boundary conditions
 - Input data
- Communication of uncertainties and use in decision making

Some Challenge Sources

- Communication precision and completeness
 - What is the **X** in $P\{X|H\}$? What is **H**?
 - What is the scope of the system being analyzed?
 - What is the level of decomposition?
- Absolute vs. relative views on classification
- User perceptions on usefulness

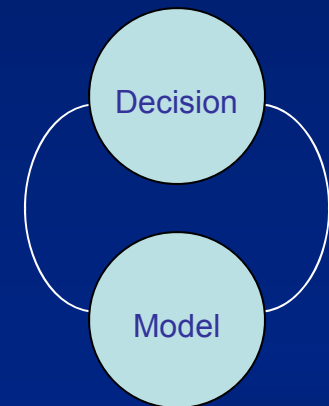


Risk Communication and Decision Support

- ASME/ANS RA-S-2009 HLR-QU-E:

Uncertainties in the PRA results shall be characterized. Sources of model uncertainty and related assumptions shall be identified, and their potential impact on the results understood.

- Decision problem may affect model and aleatory/epistemic allocation
- Allocation may affect perception





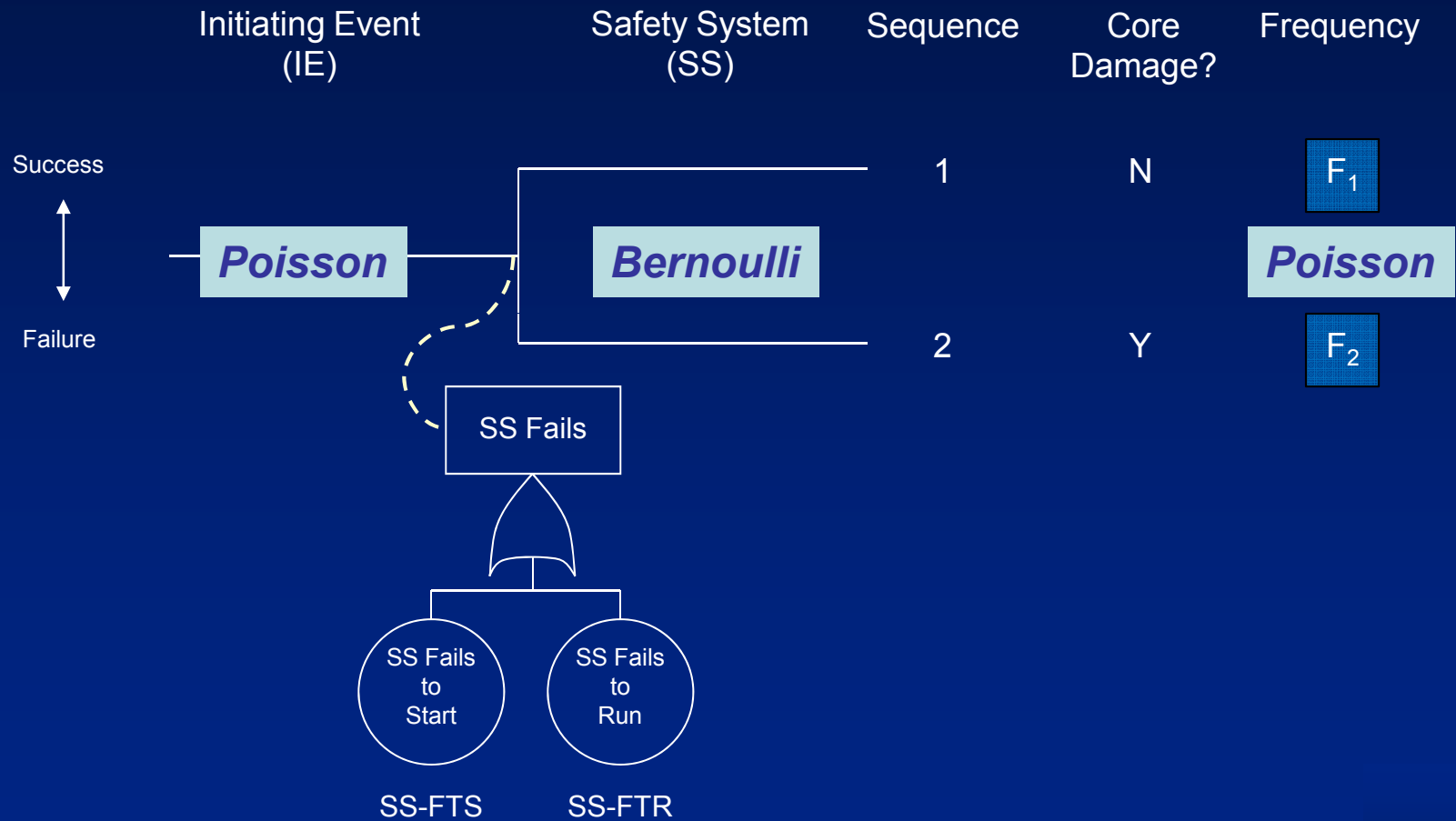
Recent and Upcoming Activities

- U. Stavanger Workshop "On the Assessment and Communication of Risk and Uncertainties in a Practical Decision Making Context: Beyond Traditional Frameworks," January 2010
- OECD/NEA/CSNI/WGRISK: technical discussion on risk communication to decision makers, April 2011
- PSAM 11/ESREL 2012, Technical Session on risk communication to decision makers, June 2012



BACKUP

Conceptual PRA Model - Aleatory Uncertainties



Conceptual PRA Model – Epistemic Uncertainties

