Need for An Integrated Risk Model

Michael Salmon, LANL
Voice: 505-665-7244
Fax: 505-665-2897
salmon@lanl.gov

Purpose

- To highlight some observations on safety strategy when concerned with NPH
- To encourage discussion and collaboration on the use of an integrated risk model at sites
- To propose a test case for use of a sample case

Observations

- ***SAFER Comments of Peer Reviewers***
  - ***There is a need to consider operator interaction***
  - ***What about fire following earthquake?***
  - ***What about flood following earthquake? – lessons from kashiwazake***
- ***Sites do not consider common cause initiating events***
- ***Investment decisions are not based on quantitative estimates of risk reduction***

DOE O 420.1c

- **Frequently Overlooked:**
  - **3(c):** NPH Analysis. The NPH analysis supporting design and construction of facilities and SSCs must be documented and include evaluation of—

    (1) potential damage to and failure of SSCs resulting from both direct and indirect NPH events; and

    (2) common cause/effect and interactions resulting from failures of other SSCs.
  - **3(d):** Evaluation and Upgrade requirements for existing DOE facilities:

    (1) A program for evaluation of DOE facility compliance with NPH requirements must be developed to ensure that modifications to existing DOE Facilities will not adversely impact the ability of SSCs to meet NPH requirements or intended safety functions during NPH events

    (2) If the evaluation of existing SSCs identifies NPH mitigation deficiencies, an upgrade plan must be implemented on a prioritized schedule based on the safety significance of the upgrades, timing or funding constraints, and mission requirements

SAFER Upgrades

- Structural Elements
  - Roof
  - Confining walls in basemat
  - Mezzanine support structures
- Non-structural Elements
  - Fire suppression system
  - Elements of active confinement

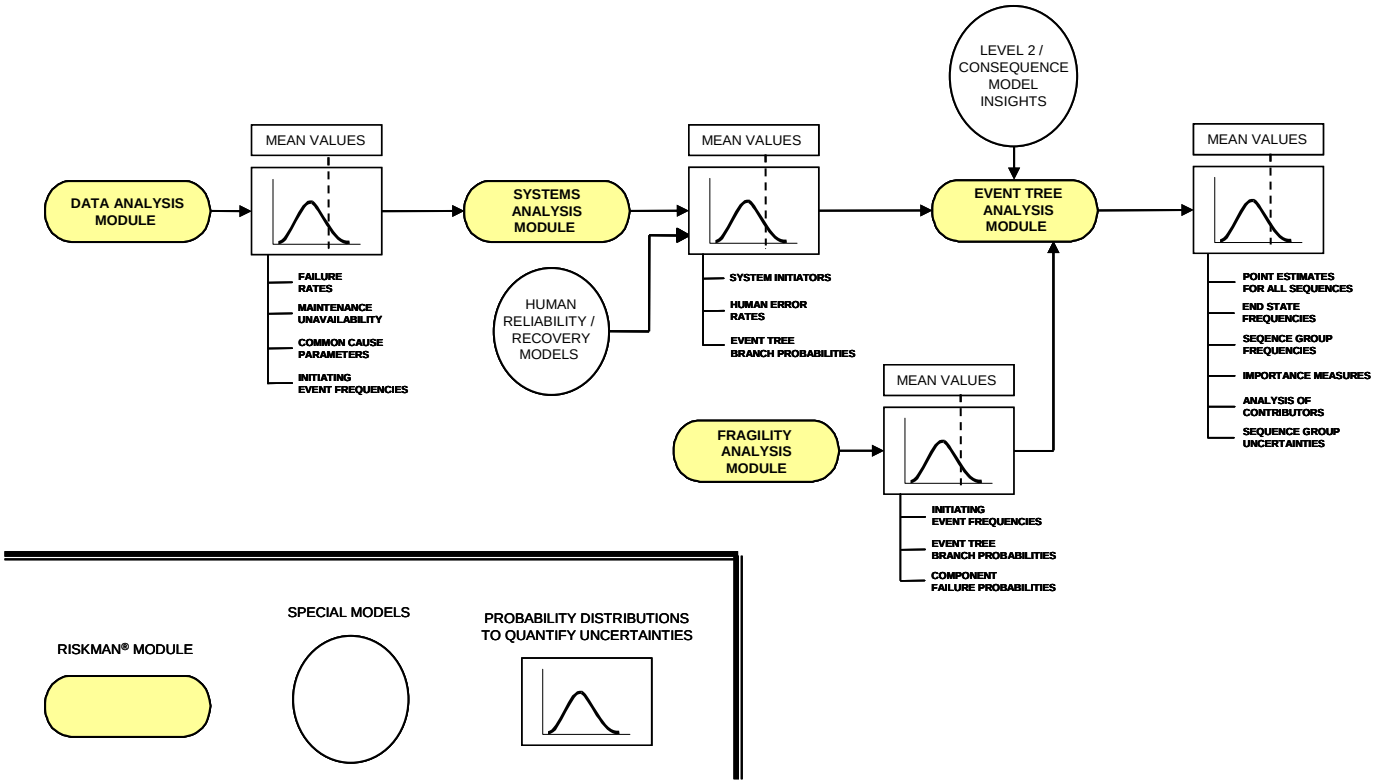
General Approach

- Select Design Basis EQ (Hd = 4x10-4/yr)
- Evaluate structures and components based on discussions with CSEs and report demand to capacity ratios
- For elements with D/C > 1.0 we assume failure and we immediately begin upgrades based on subjective interpretation of consequences of failure, and sometimes very conservative estimates of consequences

Preferred Approach

- PRA or other risk-informed scenario in which important information is passed to decision makers
- Model is needed that (eventually) will integrate seismic risk with other initiators
- Scenario approach definition
  - $R \equiv \{<s_i, l_i, x_i>\}_c$

Riskman


LEVEL 2 / CONSEQUENCE MODEL INSIGHTS
MEAN VALUES
DATA ANALYSIS MODULE
FAILURE RATES
MAINTENANCE UNAVAILABILITY
COMMON CAUSE PARAMETERS
INITIATING EVENT FREQUENCIES
SYSTEMS ANALYSIS MODULE
MEAN VALUES
HUMAN RELIABILITY / RECOVERY MODELS
SYSTEM INITIATORS
HUMAN ERROR RATES
EVENT TREE BRANCH PROBABILITIES
EVENT TREE ANALYSIS MODULE
MEAN VALUES
POINT ESTIMATES FOR ALL SEQUENCES
END STATE FREQUENCIES
SEQENCE GROUP FREQUENCIES
IMPORTANCE MEASURES
ANALYSIS OF CONTRIBUTORS
SEQUENCE GROUP UNCERTAINTIES
FRAGILITY ANALYSIS MODULE
MEAN VALUES
INITIATING EVENT FREQUENCIES
EVENT TREE BRANCH PROBABILITIES
COMPONENT FAILURE PROBABILITIES
RISKMAN® MODULE
SPECIAL MODELS
PROBABILITY DISTRIBUTIONS TO QUANTIFY UNCERTAINTIES

A Proposed Pilot Study

- Definition and characterization of endstates and risk measures of interest. What parameters are of interest to the decision makers.
- Definition of non-seismic normal and off-normal operations and configurations. Are different plant configurations possible that would impact the risk? This step would also construct the non-seismic success and failure sequences for each configuration of interest. Key in this activity is the specification of success criteria for any system or operator action.
- Gathering and processing of necessary facility and/or generic data.
- Development of logic models to support non-seismic sequence node quantification
- Characterization of Seismic Hazard
- Identification of seismic failure modes of interest
- Development of seismic fragilities
- Incorporation of seismic failures in development of scenarios (i.e., specifying seismic impact on system function and structures)
- Integration of seismic hazard information and seismic fragility information into model.
- Characterization of in-facility and external transport of hazardous material
- Endstate assignment and group identification

A Proposed Pilot Study

- Point estimate calculation of metrics of interest (e.g., endstate and group frequencies)
- Importance measure determination
- Uncertainty quantification
- Sensitivity analyses
- Report and presentation
- At the next DOE NPH Workshop – Santa Fe, NM