PRA Uncertainty Workshop
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LPSD Session Summary Presentation

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Establishing Level of Confidence in PRA Results and Insights

- Level of resolution in model is sufficient to meet the objectives of performing the analysis
- Characterization of uncertainty in numerical outcomes (although typically only mean values are required) – parameter uncertainty
- To identify issues :
  - That are not modeled but could affect the results (completeness)
  - For which our state of knowledge is such that there is no consensus approach and could lead to analyst to analyst variability in assumptions and modeling approaches (model uncertainty) and may affect the results

Sources of Uncertainty for LPSD PRA

- A significant number of issues were identified that could affect the results of and risk insights form the LPSD PRA
- Most of them were characterized as issues associated with the level of detail or degree of discretization in developing the initiating events and accident sequence models
  - Could be resolved by refinement of the model as needed to achieve the desired objectives – driven by how the PRA is to be used

Sources of Uncertainty for LPSD PRA (cont'd)

- Some issues were characterized as completeness issues
  - Missing initiating events
  - Missing phenomena associated with severe accident progression
- Some issues can be captured as parameter uncertainties
- Some true modeling uncertainties related to issues that would likely lead to potentially significant analyst to analyst variability

Sources of Uncertainty for LPSD PRA (cont'd)

- Couldn't always determine the significance of the issue because of a lack of experience with models with different level of detail and with using the models for decision-making
- The sources of uncertainty that are significant may be different for different uses of the PRA model

Examples of Issues associated with Refinement

- A coarse model that is based on subsuming variations into coarse groups tends to produce a conservative model: Examples
  - Use of limiting time for operator response for each POS. Is it necessary to expand the number POSs for a realistic analysis?
  - Modeling of forced outages by a few representative scenarios with different end states (hot shutdown, cold shutdown, mid-loop). For example, is it necessary to model early transition to mid-loop separate from late transition?

Potential Guidance

- Guidance on issues that need to be addressed when considering the level of discretization (or alternatively for subsuming) for the definition of initiating events and accident sequences

Completeness Issues

- The significance can generally not be determined before doing some analysis
- Examples:
  - Omission of heavy load drop scenarios
  - Omission of forced shutdown evolutions involving relatively low frequency safe stable states from end of at-power model
    - Example: Feed and Bleed
    - High pressure recirculation

Completeness Issues (cont'd)

- In principle, analysis of heavy load drops is within current capability but likely (as assessed by the group) to be a low contributor
- The completion of the cycle of return to power following forced outages addressed in the at-power PRA has not been addressed; the concern is whether they can fit into the representative forced outage categories used due to different conditions such as extended down times.

Refinement and Completeness

- Some issues were difficult to categorize cleanly, e.g.,
  - Assumption of equipment failing at the time of demand. Could a different ordering of the failures lead to more challenging scenarios than those modeled? e.g., if RHR is initially successful does this allow for a potential bypass scenario if it subsequently fails?

Parameter Uncertainties

- Availability and use of accident precursor data from other plants
  - Two issues – applicability of data and completeness of data
- Duration of POSs
- Unavailability due to maintenance when little or no data exists for the shutdown modes
- Could be an advantage to have a centralized data base for various aspects

Model/Completeness Issue

- Example of the assumption of a minimum mission time of 24 hours
- Significance
  - MEDIUM
  - What is the safe, stable, state and how do you get there
    - Is continuous refill an SSS?
    - Do we have to consider recovery of the primary function?
    - How many trains?
    - Consideration of offsite support?
  - Need to look at physical phenomena, and consider potential recovery actions

Model Uncertainty – Lack of Experience

- Insufficient knowledge-base about the various plant shutdown scenarios to give confidence we have the appropriate accident sequence or success criteria
  - Lack of T-H analysis results
  - Are codes applicable?
  - Impact on LERF
- Significance
  - MEDIUM

Model Uncertainty - HRA

- Several issues related to HRA modeling and because of the increased reliance on operator actions, this was considered to have a HIGH impact, particularly as it is likely to result in significant analyst to analyst variability
  - Applicability of standard HRA methods to shutdown conditions for post-initiator HFEs
    - Do the methods adequately address the types of responses modeled in shutdown PRAs?
    - Modification of existing methods to address shutdown-specific contextual factors
    - The applicability of HRA methods and data for sequences with a long term recovery to LPSD

Model Uncertainty – HRA (cont'd)

- Treatment of dependency between HFEs
  - Applicability of methods for at-power to shutdown
  - Can we construct a lower limit for a joint HEP in a sequence
  - Dependence between at-initiator and post-initiator HFEs
  - Do the dependency methods consistently consider intervening successes

Model uncertainty – another example

- Criteria for feasibility of operator actions
  - e.g., Should feasibility of operation in containment be based on some temperature criterion (e.g., onset of boiling in the vessel?)
  - No one definitive correct answer (some are clearly incorrect)
  - Likely to be variable from analyst to analyst

Conclusions

- There were many concerns about the level of detail to which the model should be developed
- While not model uncertainties in the sense used by NUREG-1855, they certainly leas to uncertainties in the results
- However, it is not a question of not knowing how to deal with them but a question of the resources that need to be expended to achieve the goal
- The preponderance of these issues that were identified vice true model uncertainties is perhaps a reflection of the immaturity of the method for developing LPSD PRAs, and in particular the lack of in-depth reviews of LPSD PRA models