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Protecting People and the Environment

RIC 2007
PRA Models, Methods, and Tools

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EPRI

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Issues with Current Methods….

- **MODELING**: Fault/Event Tree Approach to PRA Modeling
  - Developed in 1970's gave shape to our risk modeling efforts.
  - Modern applications have introduced new issues
- **QUANTIFICATION**: PRA is a simplified estimate of risk
  - Simplifications to reduce calculation time (e.g., truncation and rare event approximation)
  - Risk metrics can change as a result the simplifications
- **DOCUMENTATION**: Visualization, Documentation & Navigation
  - Need to "control" PRA model, documentation, and applications
  - Demonstrate the PRA reflects "as-built" & "as-operated" plant

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Solutions to these issues…

- New and improved logic modeling, quantification, and documentation techniques.
  - "Evolutionary" as opposed to "revolutionary"
  - Easy to develop, maintain, verify and review
- **Declarative Modeling** can advance current logic modeling.
- **Direct Probability Calculation (DPC) and BDD** can address many of the simplifications.
- **PRA DocAssist and KB3** can minimize resources associated with PRA documentation.

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Overall Approach

- Long term (low cost) program to develop the next generation of risk tools
- Modular in nature – addressing each issue
- Prove in principle
- Develop several products with:
  - much more capability
  - Faster speed
  - Less simplification
  - “simulation” type environment

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Declarative Modeling

- Allows attributes to be assigned to fault tree elements
  - Fault Tree Elements: Initiators, Basic Events, and Gates
  - Attributes include
    - Probability, frequency or conditional values
    - Settings under various conditions (True, False, or Probability)
    - Notes or comments
    - Others
- Adds flexibility to handle complex issues
    - Time phased analyses
    - Convolution
    - Conditional and dependent events
    - Simplify recovery analysis

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Declarative Modeling

- Simplify model or quantification
  - **Recovery and Post Processing (2006 - 2007)**
    - Treat dependent human actions in the fault tree
    - Specify mutually exclusive events within fault tree
    - Handle phase mission times such as loss of offsite power recovery
  - Simplify Logic Model
    - Plant alignments and frequency without using additional events
    - Specify initiating event impacts without repetitive houses/events
  - Documentation and Reviewability
    - Notes to clarify logic development
    - Fault tree viewed by attributes, such as initiator specific trees or with and without dependent human actions or recovery

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Direct Probability Calculation (DPC)

- DPC and Binary Decision Diagram (BDD) differ from minimal cutset upper bound (MCUB)
  - Rare event approximation is not used
  - Negated or “not” logic is handled appropriately
  - Provide an “exact” answer
  - Require considerable computer resources
- BDD cannot quantify large fault trees
- DPC produces no cutsets but can quantify to very low truncations

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Exact Solution (ES) Research

- Combination of available approaches
  - Determine truncation limit for MCUB
  - Use DPC to determine “exact” solution
  - Use BDD to determine cutset values and importances
- PROs
  - Fast “exact” solution with cutsets and importances
  - More stable importance measures
  - Removes or reduces simplifications
- CONs
  - Multi step process
  - Relatively slow (only DPC)
  - Some simplifications will remain

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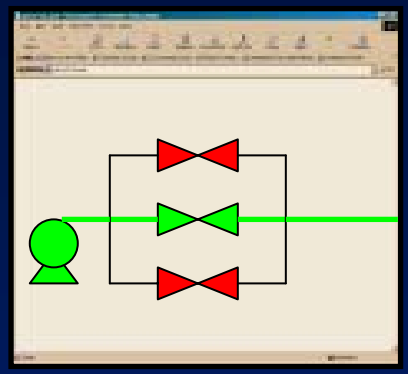
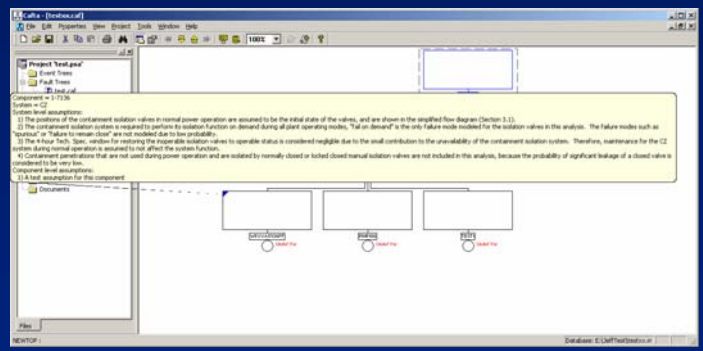
The Vision…"PRA Simulation Environment"

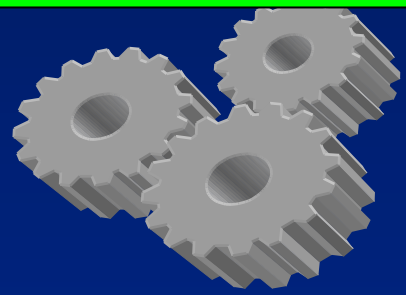
Visual Interface





Declarative Modeling

Quantification Engine



PRA DocAssist™ Database

PRA DocAssist™