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Ongoing NRC Activities in Level 2 Probabilistic Safety Assessment

Meeting with IRSN
April 28th, 2009
Paris, France

Meeting with ENSI/PSI
April 29th, 2009
Villigen, Switzerland
Current usage

- Most licensing activities rely on a partial Level 2
  - Large early release frequency (LERF)
  - Conditional containment failure probability
- A few activities still require offsite consequence analyses
  - License renewal severe accident mitigation alternatives (SAMAs)
  - Design certification severe accident mitigation design alternatives (SAMDAs)
  - Cost/benefit analyses
- For new light-water reactors:
  - Large release frequency (LRF) is the metric
  - A full Level 2 is required
Recent NRC activity

• Updating of severe accident consequence estimates
  – NRC State-of-the art Reactor Consequence Analysis (SOARCA)
  – Most recent publicly available information is at:
    • [http://www.nrc.gov/about-nrc/regulatory/research/soar.html](http://www.nrc.gov/about-nrc/regulatory/research/soar.html)
    • See 2009 SOARCA RIC Session at the bottom of the “Overview” page

• Cognizance of international activities
  – ASAMPSA2 Level 2 Best Practices effort
  – Involved in October 2009 OECD Severe Accident Management workshop

• Licensing activities mentioned on Slide 2
• ANS Level 2 and Level 3 PRA standard development
Recent NRC activity (2)

• Increased interest in non-LWRs
  – Development of a non-LWR PRA standard

• Development of 3 demonstration Level 2 models based on traditional methods:
  – Systems availability coupled to Level 1
  – Phenomenology handled via DETs / rule sets

• Scoping of advanced Level 2/3 modeling techniques
Status of the ANS Level 2 standard

• A limited-scope working draft has been developed
• Progress has been slow due to the ‘volunteer’ nature of the effort
• Next working group meeting tentatively scheduled for June 2009
• Current schedule calls for completion in 2010
Status of Level 2 methods used for routine risk applications

• A spectrum of methods are used by NRC and US licensees/vendors, including:
  – Simple screening multipliers for estimating LERF
  – Simplified LERF models using standardized event trees
  – LERF models using plant/design-specific event trees
  – Full-scope models using plant/design-specific event trees

• Underlying model structure and treatment of interface issues, sequence grouping, and human interaction vary
Advanced methods

• NRC has an activity underway to investigate evolutionary methods
  – Looking at traditional methods, dynamic event tree methods, and sampling-based simulation
  – Focused for the time-being on research applications, but with an eye for developing practical insights regarding where simplification is justified vs. where it is not
Advanced methods (2)

• Attributes being sought:
  – Be more phenomenological
  – Address method shortcomings identified by related NRC projects
  – Improve treatment of human interaction and mitigation
  – Make process and results more scrutable
  – Allow for looking at alternative risk metrics
  – Exploit computational/technology advances
  – Allow for ease in treating uncertainty
  – Be conducive for future simplification

• Additional challenges:
  – External hazards (e.g., seismic)
  – Model maintenance
Sample view of method evolution

Class 1: Modified traditional approaches
Class 2: Hybrid event tree approaches
Class 3: Dynamic event tree approaches
Class 4: Sampling-based simulation

Potential shifts in key characteristics:
- Increased focus on depth, as opposed to breadth
- Increased computational requirements
- Increased reliance on phenomenological tools
- Decreased reliance on intermediate layers of modeling
- Decreased burden on practitioner to track temporal effects and system/human/phenomena interplay
Acronyms

- ANS – American Nuclear Society
- ASAMPSA2 – Advanced safety assessment methodologies: Level 2 probabilistic safety assessment
- CSNI – Committee on the Safety of Nuclear Installations
- DET – Decomposition event tree
- ENSI – The Swiss Federal Nuclear Safety Inspectorate
- IAEA – International Atomic Energy Agency
- IRSN – Institut de Radioprotection et de Sûreté Nucléaire
- LERF – Large early release frequency
- LRF – Large release frequency
- LWR – Light-water reactor
- NEA – Nuclear Energy Agency
- NRC – Nuclear Regulatory Commission
- OECD – Organization for Economic Cooperation and Development
- PRA – Probabilistic risk assessment
- PSA – Probabilistic safety assessment
- PSI – Paul Scherrer Institut
- RIC – Regulatory Information Conference
- SAMA – Severe accident mitigation alternative
- SAMDA – Severe accident mitigation design alternative
- SOARCA - State-of-the art reactor consequence analysis