Probabilistic Risk Assessment

Summary and Closing Remarks

Lecture 10-1

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Key Topics

- Course overview
- Closing comments

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Course Objectives and Approach

- Learning Objectives:
  - Knowledge of basic probabilistic risk assessment (PRA) and risk-informed decision making (RIDM) concepts and the use environment;
  - Exposure to and limited practice with nuclear power plant (NPP) PRA: modeling approaches, elements, and mechanics; and critical thinking
  - Awareness of PRA/RIDM history, recent developments and controversies, and future challenges
- Delivery via lectures (with some knowledge checks and thought exercises), workshops, discussion

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Schedule

	Wednesday 1/16	Thursday 1/17	Friday 1/18	Tuesday 1/22	Wednesday 1/23
Module	***1: Introduction***	***3: Characterizing Uncertainty***	***5: Basic Events***	***7: Learning from Operational Events***	***9: The PRA Frontier***
9:00-9:45	L1-1: What is RIDM?	L3-1: Probabilistic modeling for NPP PRA	L5-1: Evidence and estimation	L7-1: Retrospective PRA	L9-1: Challenges for NPP PRA
9:45-10:00	**Break**	**Break**	**Break**	**Break**	**Break**
10:00-11:00	L1-2: RIDM in the nuclear industry	L3-2: Uncertainty and uncertainties	L5-2: Human Reliability Analysis (HRA)	L7-2: Notable events and lessons for PRA	L9-2: Improved PRA using existing technology
11:00-12:00	W1: Risk-informed thinking	W2: Characterizing uncertainties	W4: Bayesian estimation	W6: Retrospective Analysis	L9-3: The frontier: grand challenges and advanced methods
12:00-1:30	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**
Module	***2: PRA Overview***	***4: Accident Sequence Modeling***	***6: Special Technical Topics***	***8: Applications and Challenges***	***10: Recap***
1:30-2:15	L2-1: NPP PRA and RIDM: early history	L4-1: Initiating events	L6-1: Dependent failures	L8-1: Risk-informed regulatory applications L8-2: PRA and RIDM infrastructure	L10-1: Summary and closing remarks
2:15-2:30	**Break**	**Break**	**Break**	**Break**	
2:30-3:30	L2-2: NPP PRA models and results	L4-2: Modeling plant and system response	L6-2: Spatial hazards and dependencies	L8-3: Risk-informed fire protection	Discussion: course feedback
3:30-4:30	L2-3: PRA and RIDM: point-counterpoint	W3: Plant systems modeling	L6-3: Other operational modes L6-4: Level 2/3 PRA: beyond core damage	L8-4: Risk communication	Open Discussion
4:30-4:45	**Break**	**Break**	**Break**	**Break**	
4:45-5:30	Open Discussion	W3: Plant systems modeling (cont.)	W5: External Hazards modeling	Open Discussion	
5:30-6:00		Open Discussion	Open Discussion		

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On Risk-Informed Decision Making (RIDM) and Probabilistic Risk Assessment (PRA)

- Risk has qualitative and quantitative elements
  - What can go wrong
  - Consequences
  - Likelihood
- RIDM considers risk as an important but not sole factor
- PRA provides a formal, probabilistic view on risk
- PRA has identified potential vulnerabilities and supported improvements
  - Plant design and operations
  - Process efficiencies
- PRA has weaknesses as well as strengths; skeptics have valid concerns
- Critical PRA elements
  - Search for failures – not a cookbook
  - Fully characterize uncertainties

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On PRA – The Technical Process

- "The math" (probability and statistics) is important, but not the be-all/end-all. "System" understanding (engineering, science) is critical for realism, communication, and confidence:
  - How do things work?
  - How can things fail?
- Details matter: need plant-specific information (e.g., from walkdowns) and understanding of operational experience
- PRA models are complex, but complexity has evolved from problem needs
  - System scope, technical disciplines
  - Rare events, sparse data
  - Importance of dependencies (aleatory – functional, shared equipment, environmental, human-caused, etc. – and epistemic)

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On PRA – The Social Side

- Modeling is a subjective enterprise
  - Analysts need to make choices, need to take ownership of choices.
  - Documentation and external review are critical
- Multiple technical disciplines are involved
  - Different viewpoints on importance of scenario features, appropriate methods for analysis; need to avoid polarization
  - Results are heterogeneous; degree varies with topic
- Risk communication is challenging
  - Interchange rather than “education”
  - Comparisons with safety goals often don’t work
  - Trust is critical

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On PRA Technical Improvements

- Developers, analysts, and users have different perspectives on “needed” improvements
- PRA (and RIDM) benefit from more information, community open mindedness
  - Extracting more from past work (vs. focusing on weaknesses, inapplicability)
  - Considering new approaches (“why not” vs. “why”)
- Need to
  - Avoid force fitting (“If all you have is a hammer…”)
  - Recognize implementation costs, fundamental value-added question

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Final Remarks

- RIDM is a sensible approach to safety-related decision making
  - Accounts for risk as we understand it
  - Includes backstops for limitations in technology, knowledge
- PRA (the product) is a tool
  - Can be well-used or misused
  - Not easy to understand; complexity is driven by problem needs
- PRA (the process) is a human enterprise
  - Human strengths and weaknesses
  - Integrates disciplines, supports learning
  - Searches for failures but is an expression of optimism: we understand enough, can make improvements

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A Final RIDM Question

How many in the car?