Probabilistic Risk Assessment

Risk Communication restored and the sales

Lecture 8-4

Region III

efficiency. The NRC staff's PRA Implementation Plan describes activities now under way on planned to expand this use. These activities include, for example, providing guidance for NRC inspectors on focusing inspection resources on risk-important equipment, as well as reassessing plants with relatively high core damage frequencies for possible backfits.

Another activity under way in response to the policy statement is using PRA to support decisions to modify an individual plant's licensing basis (LB). This regulatory guide provides guidance on the use of PRA findings

Overview





- Definition
- Challenges
- Do's and Don'ts



Resources

- J.L. Marble, N. Siu, and K. Coyne, "Risk communication within a risk-informed regulatory decision-making environment," *Proceedings International Conference on Probabilistic Safety and Assessment (PSAM 11/ESREL 2012)*, Helsinki, Finland, June 25-29, 2012. (ADAMS ML120480139)
- J. Persensky, et al., "Effective Risk Communication: The Nuclear Regulatory Commission's Guidelines for External Risk Communication," *NUREG/BR-0308*, January 2004.
- A. Szabo, et al., "Effective Risk Communication: Guidelines for Internal Risk Communication," *NUREG/BR-0318*, December 2004.



Other References

- National Research Council, Understanding Risk: Informing Decisions in a Democratic Society, P.C. Stern and H.V. Fineberg (eds), National Academies Press, 1996.
- V.T. Covello and F. Allen, "Seven Cardinal Rules of Risk Communication," *OPA-87-020*, U.S. Environmental Protection Agency, 1988.
- B. Fischhoff, "Risk perception and communication unplugged: 20 years of process," *Risk Analysis*, **15**, 137–145, 1995.
- Food and Agriculture Organization of the United Nations/ World Health Organization, "Risk Characterization of Microbiological Hazards in Foods: Guidelines," *Microbiological Risk Assessment Series*, **17**, Rome, 2009.
- P.S. Dull, A Battle History of the Imperial Japanese Navy (1941-1945), Naval Institute Press, Annapolis, MD, 1978.



Defining Risk Communication

Com•mu•ni•ca•tion, *n*. The imparting or interchange of thoughts, opinions, or information.

- For PRA/RIDM advocates usually viewed as
 - "imparting" rather than "interchange," education rather than dialog ("information deficit" model)
 - a means to an end (a desired point of view, decision)
- Note: educational approach
 - Works for some, can be resented and resisted ("equal and opposite reaction") by others
 - Requires effort (apparent as well as actual) to understand audience needs
 - Involves more than just "the numbers" needs to address mental models of processes creating and controlling risk



Points of Communication Breakdowns

- Between risk managers and "public:"
 - Differences in perception of information
 - Relevance
 - Consistency with prior beliefs
 - Lack of understanding of underlying science
 - Conflicting agendas
 - Failure to listen
 - Trust
- Given breadth of risk problems, likely similar concerns with "internal" risk communication



Different Perceptions of Information

- Perception is subjective => varies with stakeholders; beware of stereotypes (e.g., "the public")
- Relevance
 - Does risk information address important issues?
 - Is information timely? ("traffic cop" vs. "co-pilot")
- Frameworks and language: what are we talking about?
 - Technical, e.g., Risk $\equiv \{s_i, C_i, p_i\}$
 - Others, e.g., Risk \equiv Hazard + Outrage

"Language is not merely a tool for human communication; language is itself a means by which the realities of the world are divided and viewed."

- P.S. Dull, 1978



Relevance: Example Stakeholder Issues

- Appropriateness of PRA modeling concept of aleatory (random) failures to stakeholder's domain of expertise
 - Digital I&C
 - Security-related applications
- Completeness of scenarios
 - Acknowledged gaps ("known unknowns")
 - Unrecognized gaps ("unknown unknowns")
- Relevance of computed consequence metrics to values
 - Personal impact (non-radiological effects, disruption)
 - Impact on particular groups ("sensitive cohorts")
 - Environment (contamination)
- Scope of risk management actions

Challenges



Lack of Understanding

Risk information is broad, complex, and uncertain – unrealistic to expect effective communication of all details?

- Simplifications
 - Can be affected by personal preferences of actors (communicators and recipients) and by organizational processes
 - Require considerable effort ("messaging")
 - Can be overdone => sound bites, memes
- Education is only part of solution
 - Emphasize science/engineering, not math
 - Intended recipient needs to be receptive
 - Major decision problems can last for years
 => educational strategy needs to account for stakeholder changes





Challenges

Conflicting Agendas

• Neutral: Interchange to inform upcoming decisions



- Advocacy
 - Persuade (e.g., desired responses to emergency directions, acceptance of nuclear technology, relaxation of regulatory criteria and processes)
 - Rationalize past decisions



Failure to Listen

- Failure to hear underlying questions and concerns
- Various drivers
 - Social (e.g., anxiety to achieve objective, make a key point, demonstrate expertise, establish hierarchy)
 - Cultural differences (e.g., frameworks, language)
- Common behaviors
 - Ignoring
 - Talking over
 - "Helpful" translation
- Leads to polarization, increasing barriers to communication



Trust

- Critical to effective communication
- Is a result of social processes
 - Can be difficult to gain, easy to lose
 - For complex subjects, can be a substitute for understanding
 - Past relationships (rapport) and credentials can be important
- Can be affected by demonstrated actions, e.g.,
 - "Right" actions demonstrating shared values
 - Acceptance of new information



Communication Considerations

- Communications 101
 - Why are we communicating?
 - Who is our audience?
 - What do our audiences want to know?
 - How will we communicate?
 - How will we respond?
 - Who will carry out the plans? When?
 - What problems or barriers have we planned for?
 - Have we succeeded (in communicating)?
- For risk communication...
 - Special challenges are technical (e.g., rarity of events, complexity of subject, analysis uncertainties) and organizational (importance => multiple stakeholders at different levels, multiple views => alternate sources, increased complexity)
 - No "cookbook" beyond general good practices; need to treat as a dynamic, interactive process

Social Aspect => No Easy Solution ("One man's meat...")

Sympathetic Listening:

- Critical to trust by some
- Viewed as sign of weakness by others



Additional Cautions

- Be extremely careful when using PRA to "prove" plant safety
 - Technical limitations (particularly completeness uncertainties)
 - Long experience (starting with WASH-1400) => argument doesn't work with many stakeholders (often including intended target audience)
 - Can lead to bad behaviors



WASH-1400 (1975)





Current Discussions on Safety Margins and Regulatory Relaxation





Additional Cautions

- Recognize framing effect, sometimes resulting from simplifications during communication
 - Metric
 - Frequency vs. probability
 - Radiological vs. all effects
 - Unit of analysis
 - Single plant
 - Fleet





Additional Cautions

- Recognize human heuristics for dealing with uncertain information (e.g., representativeness, availability, anchoring and adjustment) and resulting biases.
- Examples
 - Desire for certainty ("one-handed scientist")
 - Responses to different presentation modes
 - Analytics vs. "stories"
 - Biasing from video



Analytics vs. Narratives ("Stories")

Traffic Accident Fatalities (2015)

		BAC ≥ 0.08	
State	Total	Number	%
MA	316	96	31
MD	513	159	31
USA	35,092	10,265	29

National Highway Traffic Safety Administration, "Traffic Safety Facts: Alcohol-Impaired Driving," *DOT HS 812 350*, December 2016.

On the evening of June 25, 2015, Sam, Wootton High School's star quarterback was going over 100 mph on a neighborhood road, trying to go fast enough to avoid speed camera detection ("whipping"). Out of control on a sweeping curve, the car hit a fence and two trees, and flipped. Two unbelted passengers were ejected and died at the scene. Sam and the front seat passenger were seriously injured. All four were teenagers. All had just left an underage drinking party and were drunk. Sam was indicted on counts of vehicular manslaughter, alcohol related vehicular homicide and causing a life-threatening injury while driving under the influence of alcohol. The parent of the girl hosting the party, pled guilty to two criminal citations for allowing underage drinking at his home and was ordered to pay \$5,000 in fines.



Video – Some Subjects Are Easy...

- 9/11
- Fire and Explosions

HEAF Video

OECD/NEA High Energy Arcing Fault (HEAF) Program Phase 1 Project information: http://www.oecd-nea.org/jointproj/heaf.html

Flood





Others Require More Work (Story Telling + Viewer Processing)

- Human Errors
- Successes/Safety

Non-Event Video



Additional Cautions

- Be cognizant of potential unintended consequences
 - Message persistence
 - Unanticipated response to message



Message Persistence

Recognize that risk communication aimed at supporting an immediate decision establishes anchors (knowledge, biases, attitudes) that can influence later decisions





Unanticipated Responses

ID	Fire PRA "Issue"	ID	Fire PRA "Issue"
11	Adequacy of fire events database	P1	Circuit interactions
12	I2 Scenario frequencies		Availability of safe shutdown equipment
13	I3 Effect of plant operations, including comp measures		Fire scenario cognitive impact
14	I4 Likelihood of severe fires		Impact of fire induced environment on operators
E1	Source fire modeling	P5	Role of fire brigade in plant response
E2	Compartment fire modeling	R1	Main control room fires
E3	Multi-compartment fire modeling	D0	Turbine building fires
E4	Smoke generation and transport modeling	<u> </u>	ontainment fires
H1	Circuit failure mode and likelihood	R	Seismic/fire interactions
H2	Thermal fragilities		Multiple unit interactions
H3	Smoke fragilities	κυ	non-power and degraded conditions
H4	Suppressant-related fragilities	R7	Decommissioning and decontamination
B1	Adequacy of data for active and passive barriers	R8	Fire-induced non-reactor radiological releases
B2	Barrier performance analysis tools	R9	Flammable gas lines
B3	Barrier qualification	R10	Scenario dynamics
B4	Penetration seals	R11	Precursor analysis methods
S1	Adequacy of detection time data	R12	Uncertainty analysis
S2	S2 Fire protection system reliability/availability		Learning from experience
S3	S3 Suppression effectiveness (automatic, manual)		Learning from others
S4	S4 Effect of compensatory measures on suppression		Comparison of methodologies
S5	65 Scenario-specific detection and suppression analysis		Standardization of methods

From: N. Siu, J.T. Chen, and E. Chelliah, "Research Needs in Fire Risk Assessment," NUREG/CP-0162, Vol. 2, 1997.



Looking Ahead – Beyond Paper?

- Many displays based on paper forms
 - Not always easy to understand
 - Effectiveness in message transmission? Retention?
- Technology can enable different ways to engage audience
 - Video
 - Others?
 - Interaction
 - Immersion
 - Non-visual
- Need to consider biases, appropriate balancing



