U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Integrated Risk-Informed Decision Making ~ USNRC Experience

IAEA Technical Meeting
on Integrated Risk Informed Decision Making
Vienna, AUSTRIA

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U.S. Nuclear Regulatory Commission

Presentation Outline

- Integrated Risk-Informed Decision Making (IRIDM)
  - General Approach
  - Risk-Informed Regulation
  - Risk Tools and Metrics
  - Thoughts on Uncertainty
- Making Good Decisions
  - The Decision Making Process
  - Importance of Critical Thinking
- Current Applications
- Conclusion

General Approach

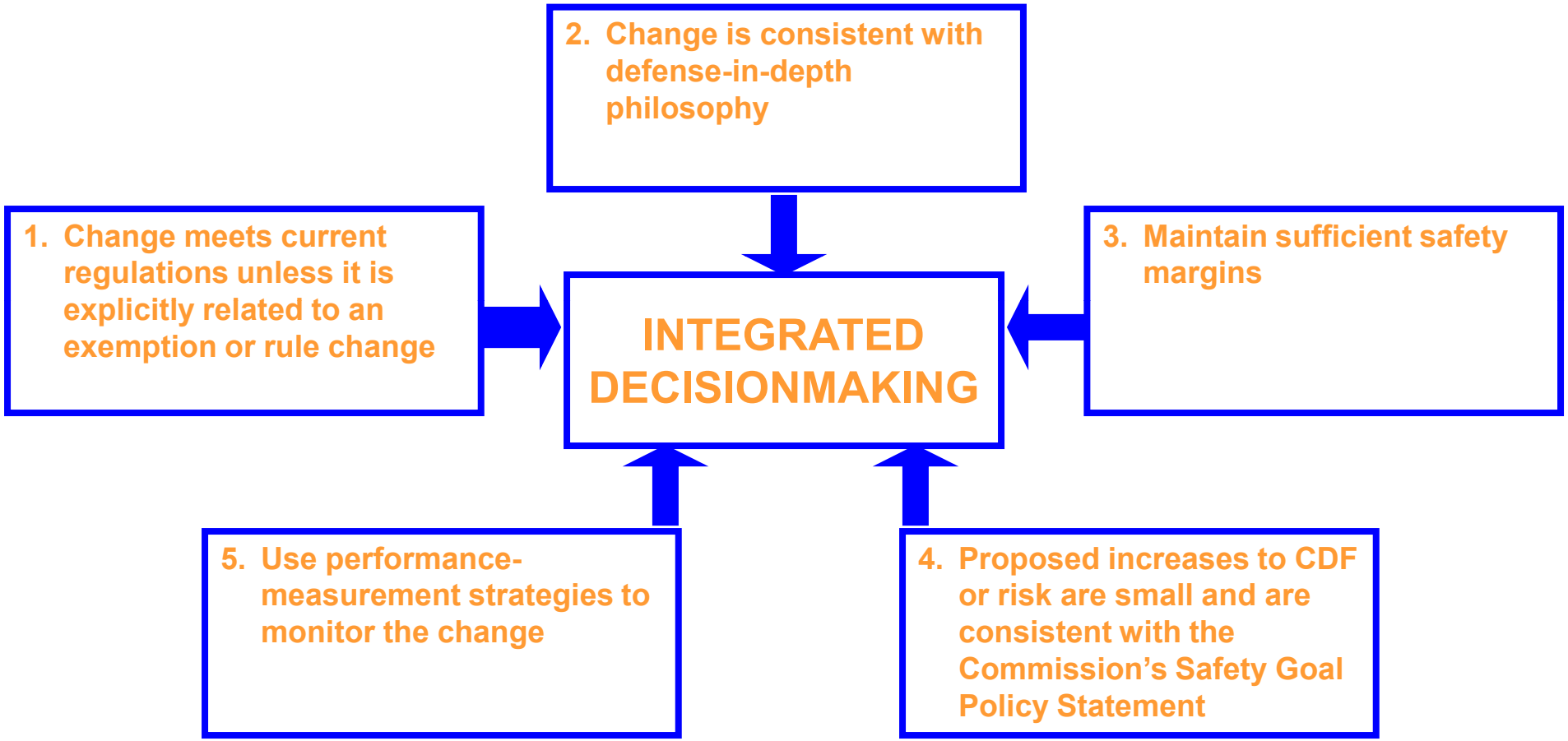
- A Structured Process in Which All Insights and Requirements Relating to a Safety or Regulatory Issue Are Considered in Reaching a Decision
- IRIDM Process Includes Recognition of the Following:
  - Any mandatory requirements
  - Insights from deterministic and probabilistic analyses
  - Any other applicable insights
- Once Made, the Decision Needs to be Implemented and Monitored to Ensure No Unintended Consequences
  - Revise, If Necessary

Risk-Informed Regulation

- NRC policy statement on the use of PRA* included four main statements:
  1. Increase use of PRA to the extent supported by the state-of-the-art and in a way that complements traditional engineering approaches
  2. Use PRA both to reduce unnecessary conservatism in current requirements and to support proposals for additional regulatory requirements
  3. Be as realistic as practicable
  4. Consider uncertainties appropriately when using the NRC's safety goals and subsidiary numerical objectives

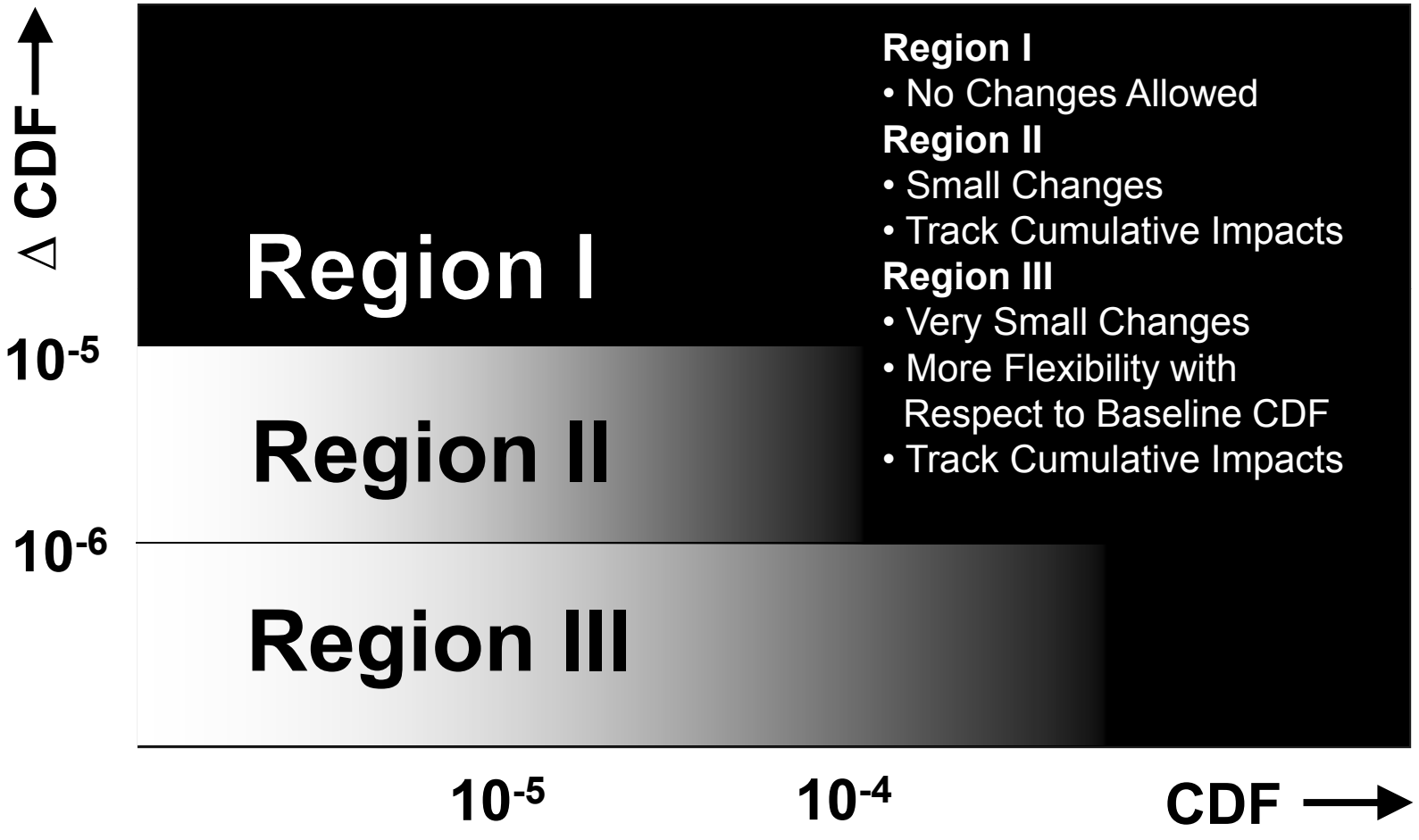
**** 8/16/95***

Key Principles of Risk-Informed Regulation

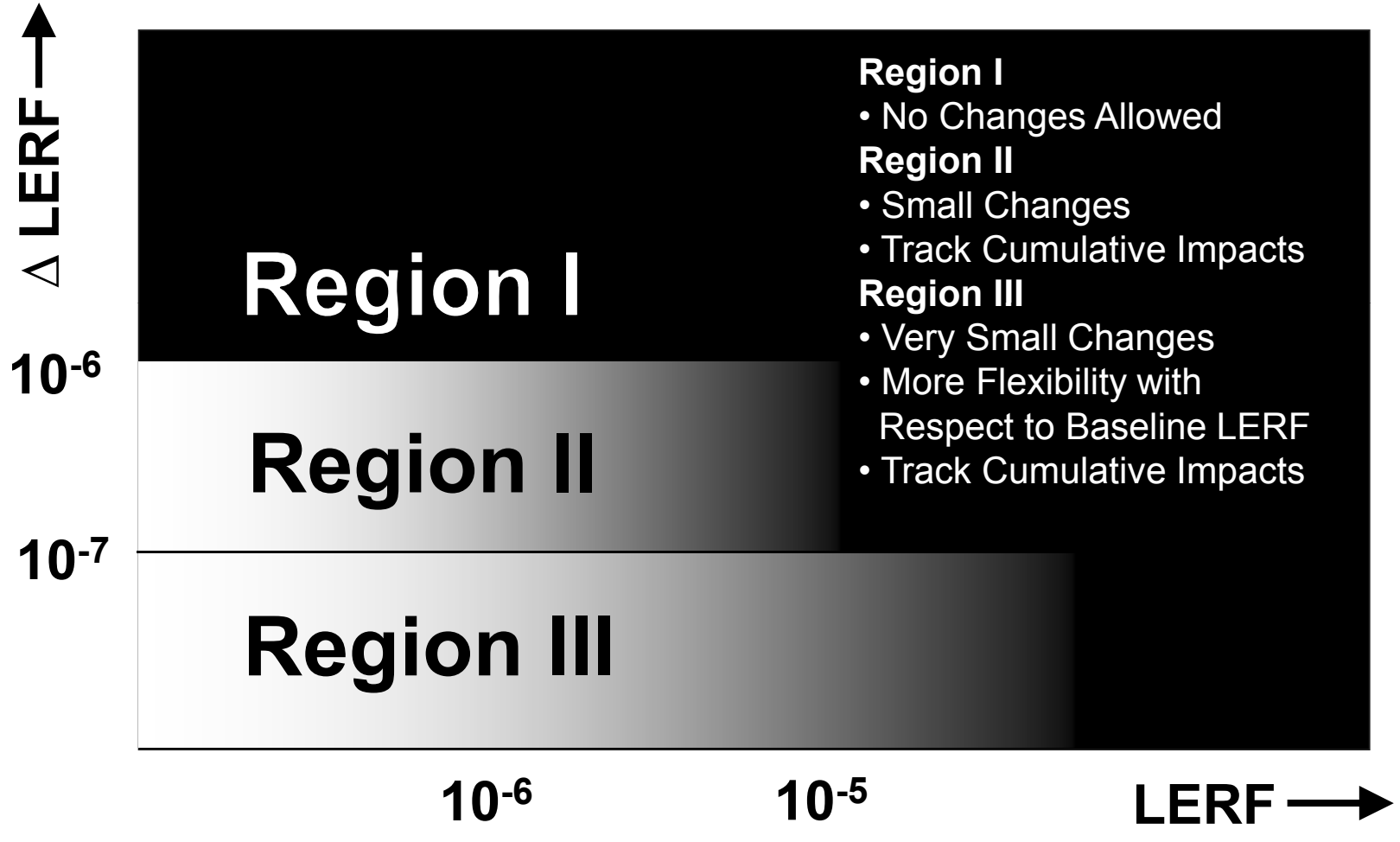


**** RG 1.174, 11/2002***

Risk Increases



Risk Increases



Risk Tools and Metrics

- Risk Tools
  - Probabilistic Risk Assessment (PRA) Methods, importance analyses, sensitivity analyses and uncertainty analyses
  - Alternate methods ~ Qualitative arguments, bounding analyses, screening tools
- Risk Metrics
  - Core damage frequency (CDF), change in CDF, core damage probability (CDP), conditional CDP (CCDP), incremental CCDP, (equivalent definitions for large early release frequency)
  - Importance measures ~ Risk achievement worth (RAW), risk reduction worth (RRW), Fussell-Vesely (FV), Birnbaum

Thoughts on Uncertainty

- Aleatory (stochastic) uncertainty
  - Inherent randomness

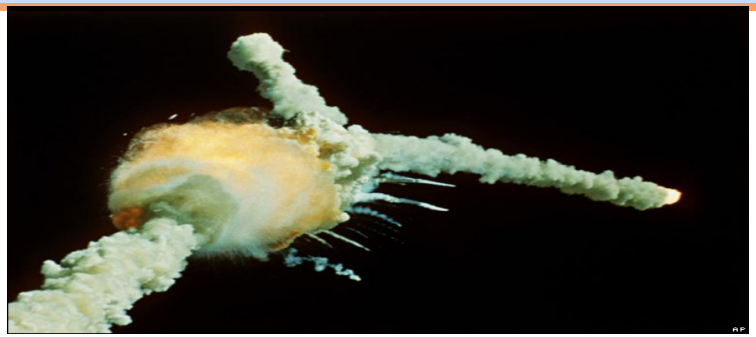
- Epistemic uncertainty
  - "State of knowledge" uncertainty
    - Parameter uncertainty ~ initiating event frequencies, component failure probabilities, human error probabilities
  - Model uncertainty
    - Success criteria
    - Reactor coolant pump seal LOCA model
  - Completeness
    - Not modeled, e.g., operator error of commission

How do we make decisions given the uncertainty?

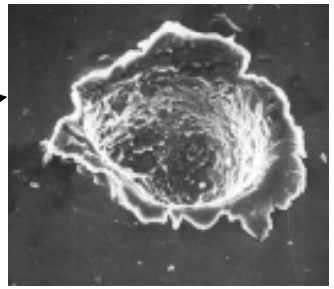
- The results obtained from the PRA are compared with acceptance criteria relevant to the application
- Acceptability of the risk associated with the application must take into account the uncertainties in the results of the risk analysis
- The uncertainty analysis provides the decision maker with confidence in the assessment of the risk input
- Decision makers should be provided with:
  - Risk metrics expressed as the mean of a distribution, where possible
  - A discussion of key assumptions and sensitivity studies performed
  - Information on defense in depth, safety margins, and performance monitoring, as applicable

Making Good Decisions
Poor Decisions may be Disastrous!

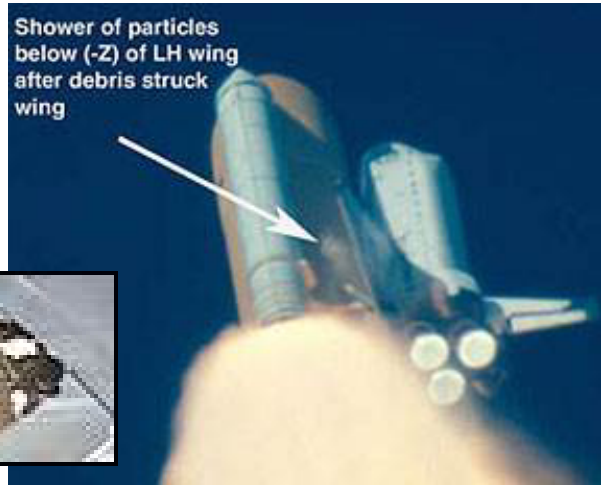
- NASA Challenger
  - Data interpreted without seeing temperature relationship



- Davis-Besse
  - Numerous issues and failures in the process

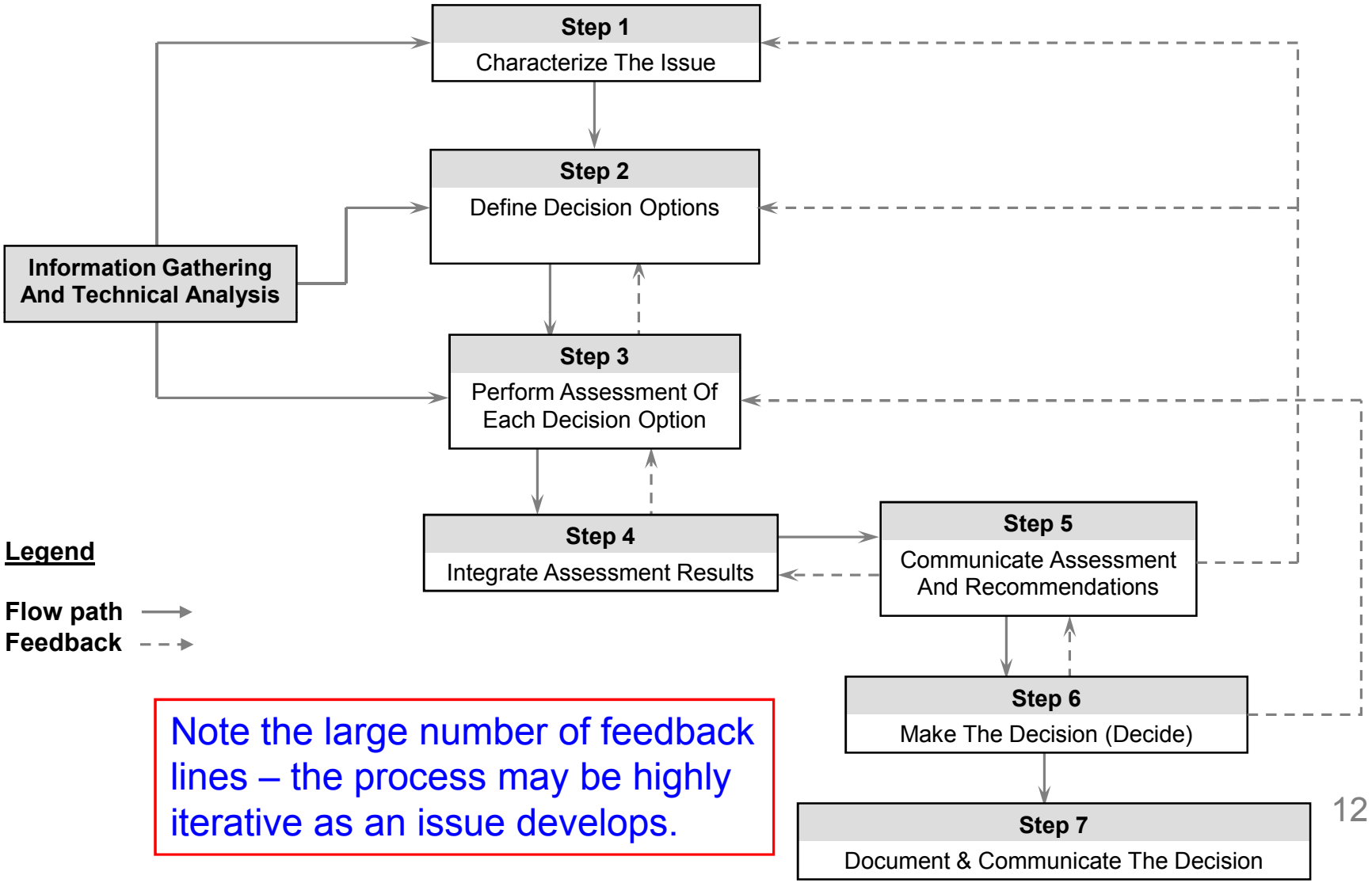


- NASA Columbia
  - Believed foam not an issue
  - Focused on other impacts



Decision Making Process

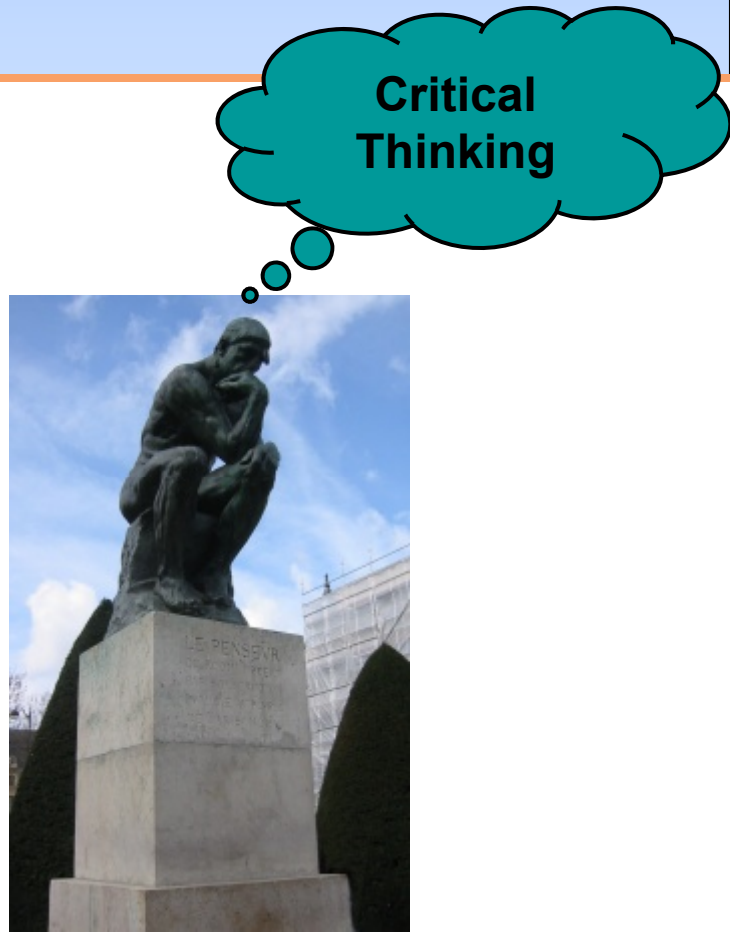
Technical Activities **Analysis & Synthesis Activities** **Communication Activities**



Note the large number of feedback lines – the process may be highly iterative as an issue develops.

Importance of Critical Thinking

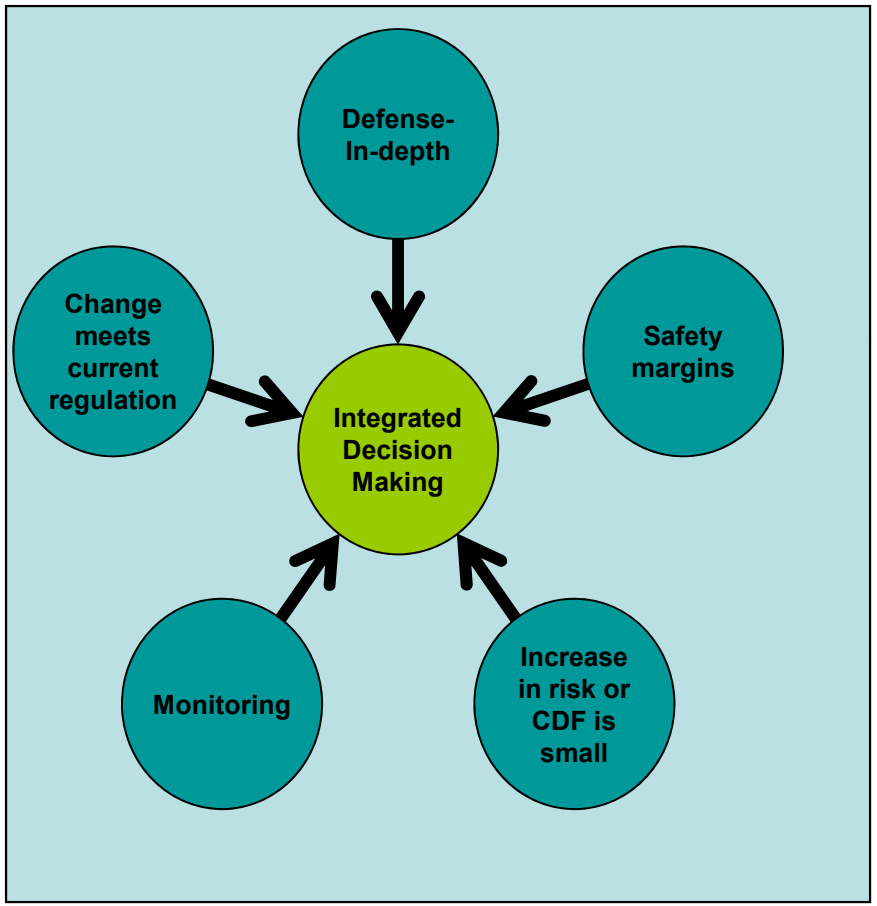
- Essential to making quality decisions
- Three aspects to consider:
  - Approaching the issue
  - Getting good input
  - Asking questions



Good Decisions Require Good Input

- Analyses need to provide bases for concluding that…
  - Regulatory position provides reasonable assurance of adequate protection of public health and safety

- All five principles of risk-informed regulation are potentially contributing support for a conclusion
  - Integrated approach to decision making

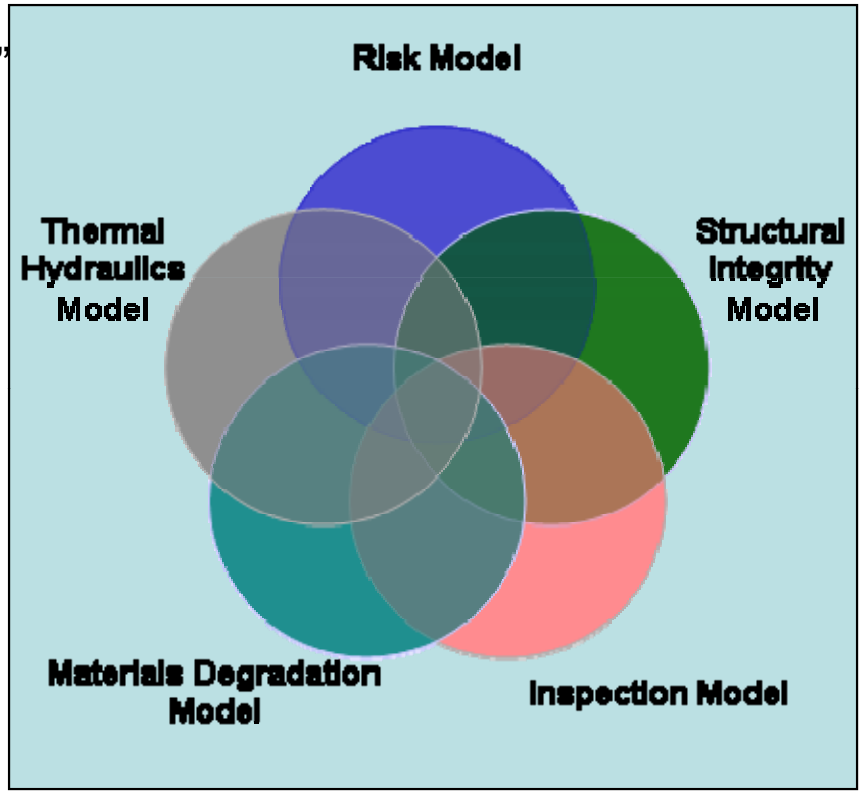


Good Decisions Require Good Input

- Decision-makers need to be "educated" about analyses
  - Assumptions
  - Boundary conditions
  - Limitations
  - Uncertainties
  - Confidence in results

- Inadequate communication/ education leads to less-than-ideal decisions
- Gather the information to make a good decision

  Ask for it ~ Demand it
  (have a questioning attitude)
- Practice critical thinking



Effective decision making requires integration of information from many sources

Decision Makers Need to Question

- Questioning attitude helps
  - Understand assumptions, limitations, boundary conditions
  - Ensure results make logical sense ("sanity check")
  - Identify/understand uncertainties
  - Engender confidence in the decision

- All aspects of the process "fair game" for thoughtful questions

e.g., Separating "knowns" from assumptions

"Information Theory, Inference, and Learning Algorithms" D. MacKay

Current Applications

- Integrated Risk-Informed Decision Making Process for Emergent Issues ~ NRR Office Instruction LIC-504, Revision 3, April 2010

- Significance Determination Process (SDP) and Enforcement Review Panel (SERP) for determining significance of inspection findings

- Risk-informed license amendment applications
  - Risk-informed Technical Specification Initiatives 4b (risk-informed allowed outage times) and 5b (risk-informed surveillance test intervals)
  - Risk-informed In-Service Inspection reviews
  - NFPA 805 fire protection program reviews

Conclusion

- IRIDM process is a tool to ensure
  - Risks are identified and considered for making decisions
  - Stakeholder interests are considered
  - Decision makers can justify and make easy-to-explain decisions
  - Uncertainties are treated explicitly
- Successful applications in USNRC regulatory activities
  - Justification for Continued Operation decisions
  - Reactor Oversight Process activities
  - Risk-informed license amendment applications

Questions?