


Addressing Uncertainty: The Hobgoblin of Risk-informed Decision-making

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Presented by:
Doug True

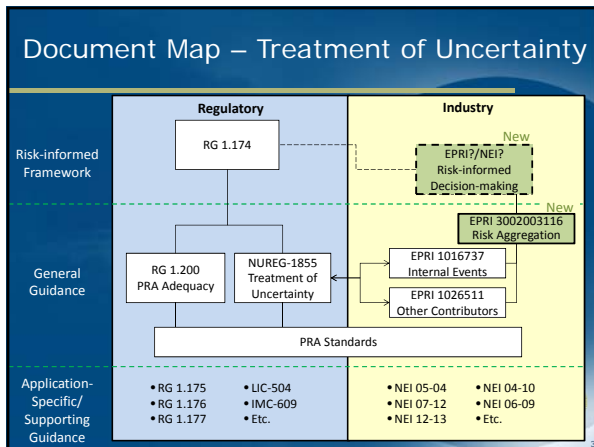
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Uncertainty Implications in Risk-informed Decision-making

- PRA results are the product of a model that contains uncertainties and biases
- RG 1.174 outlines an integrated decision-making framework, in part to address uncertainties in PRA results
 - PRA is one input
 - Too often, the elements are treated separately
- Some key issues:
 - Treatment of uncertainties
 - Aggregation of risk results
 - Interpretation of risk results
 - Truly integrated decision-making





Aggregation

- Summation of mean values is a natural outcome of a PRA
- The sum should not be viewed as anything more than a relative indicator
 - Insights come from the disaggregation of the results into scenarios
- Use of top-level risk criteria as strict limits ignores:
 - Uncertainties differ across contributors
 - Contributors with differing levels of realism
 - Inherent margins in quantitative acceptance guidelines
 - The valuable information underlying the PRA result

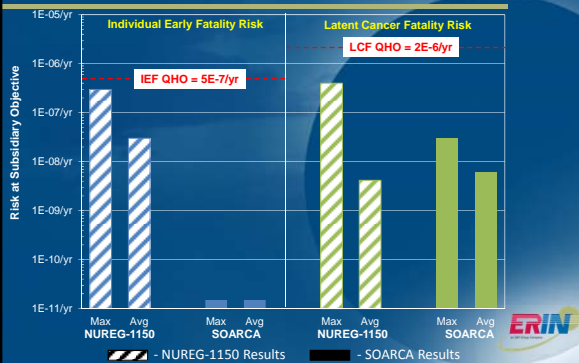


Surrogate Risk Acceptance Guidelines

- Quantitative Health Objectives (QHOs) establish NRC policy on acceptable risk
- Surrogate risk acceptance guidelines have been developed for use in risk-informed applications:
 - Early fatality QHO → total mean LERF < $1 \times 10^{-5}/\text{yr}$
 - Latent cancer QHO → total mean CDF < $1 \times 10^{-4}/\text{yr}$
- NUREG-1860 demonstrated on a bounding basis (NUREG-1150 maximums) that these guidelines are appropriate
- Many advances in severe accident research since NUREG-1150




Risks At Subsidiary Objectives



Insights on Surrogate Guidelines

- Both more representative average results and more recent SOARCA results indicate that significant margin exists between subsidiary guidelines for CDF/LERF and the QHOs
 - Factor of 100 margin (or more) based on SOARCA
- This margin should allow:
 - Mean values to be used with confidence in risk-informed decision-making
 - No need for knife-edged treatment, treat as “guidelines”, not limits
 - Uncertainties should not impede decision-making

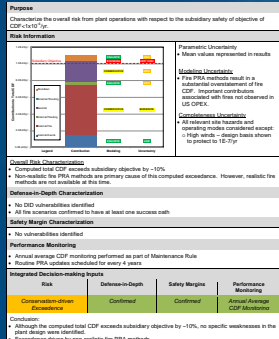


Integrating the Decision

- The whole idea of an “integrated” process is bring them together to treat as a whole
 - Not a linear series of gates
- This process should allow us to deal with the uncertainties, strengths, and limitations of PRA while making good safety decisions
- Requires decision-makers be provided with all of the elements, including the implications of uncertainties



A Possible Risk-informed Rubric



Objective: Characterize the overall risk from plant operations with respect to the subsidiary safety objective of CDF 10^{-7}

Risk Information: [Bar chart showing risk levels for various components]

Parametric Uncertainty: Mean values represented in results

Modeling Uncertainty: PRA PRA methods result in a conservative overestimate of the CDF. Resonant conditions associated with fires not observed in US NPPs.

Conductance Uncertainty: All relevant risk-bearing and operating modes considered except in high winds - energy levels shown to protect to 10:2P.

Overall Risk Characterization:

- Completed total CDF exceeds subsidiary objective by $+10%$
- Non-negligible PRA methods are primary cause of this computed exceedance. However, realistic fire methods are not available at this time.

Defense-in-Depth Characterization:

- No DD vulnerabilities identified
- All fire scenarios confirmed to have at least one success path

Safety Margin Characterization:

- No vulnerabilities identified

Performance Monitoring:


- Annual average CDF monitoring performed as part of Maintenance Rule
- Routine PRA updates scheduled for every 4 years

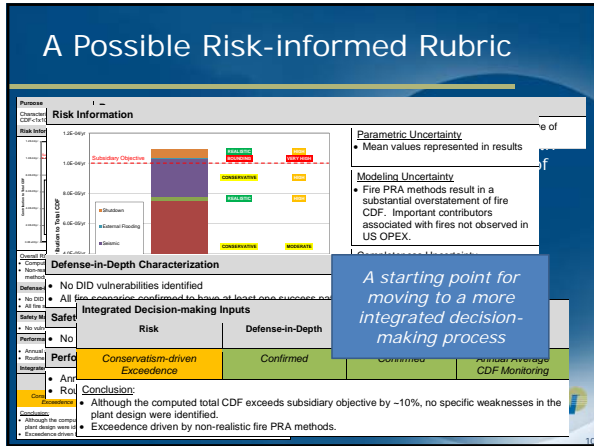
Integrated Decision-making Rubric			
Risk	Defense-in-Depth	Safety Margins	Performance Monitoring
Conservative/Non-Conservative	Confirmed	Confirmed	Annual Average CDF Monitoring

Conclusion:

- Although the computed total CDF exceeds subsidiary objective by $+10%$, no specific weaknesses in the plant design were identified.
- Exceedance driven by non-realistic fire PRA methods.

- EPRI has conceived a standard risk-informed rubric for decision-makers
- Builds upon principles described in other guidance
- Address both the risk information and the other elements of the risk-informed decision
- To be published as part of EPRI 3002003116





Summary

- Uncertainties must be honestly understood and characterized for risk-informed decision-makers
- No need to treat acceptance guidelines as risk limits
- A truly integrated decision-making process is needed to gain the value from risk-informed applications
- Progress being made, but still work to do

The promise of risk-informed regulatory decision-making lies in the objective and integrated insights that can be gained
