

NRC's Fukushima Response: Lessons Learned and Lessons Unheeded

Edwin Lyman
Senior Scientist
Union of Concerned Scientists (UCS)
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Overview

- UCS acknowledges the enormous effort on the part of the NRC and the industry to address safety vulnerabilities post-Fukushima
- However, the lack of a revised regulatory framework and NRC's use of an old and flawed methodology has resulted in to an overly complex and confusing set of activities, and led to some bad decisions
- Consequently, it is difficult for UCS to assess to what degree safety is being improved fleet-wide and if the improvements are sufficient to reduce the risk of a Fukushima-scale event in the United States

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UCS View of Mitigating Strategies/FLEX

- "Diverse and flexible" response is necessary, but perhaps not sufficient
 - French "hardened safety core" (protected against beyond-design-basis events) may also be needed
- FLEX boundary conditions are narrow and artificial
 - Confusion surrounding how to address external hazard reevaluations
 - Assumption of ac power through inverters
- FLEX does not fulfill the original intent of the Near-Term Task Force
 - Stakeholder input influenced the NRC staff to pursue a more performance-based approach [e.g. FLEX] to improve the safety of operating power reactors than envisioned in NTF Recommendation 4.2 ... - boilerplate language in NRC Safety Evaluation Reports
 - Variations in implementation of "reasonable" and "robust" protection across the fleet
 - "Nobody seems to be able to tell what that [robust protection] means." - John Stetkar, ACRS chairman, October 6, 2015
 - Lack of defined coping period durations and minimum safety margins

Large uncertainties imply need for generous safety margins

- Computer modeling (eg. MAAP)
- Emerging phenomena (eg. RCP seal corrosion)
- Obstacles not accounted for in FLEX boundary conditions (eg. beyond-design-basis seismic damage)
- Human reliability analysis uncertainties

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FLEX inspections

- Performance-based requirements need performance testing-based inspections
- UCS proposes that the effectiveness of mitigating strategies be inspected through a series of stress test scenarios, supplemented by performance testing where appropriate
- An approach along the lines of the "alternate mitigating strategies" assessment in NEI 12-06 Rev. 2 App. G makes more sense
 - Damage states may be less extensive or more extensive than FLEX boundary conditions (eg. loss of DC power, distribution systems)
 - Force-on-force security inspections, rather than emergency preparedness exercises, should be the model
- Goal: to assure that FLEX can provide plausible success paths for a sufficiently broad spectrum of beyond-design-basis events

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NTTF Recommendation 1

- The NRC has terminated nearly all activities related to NTTF Recommendation 1
- However, UCS still believes in the necessity of a comprehensive overhaul of the flawed regulatory patchwork to establish a "logical, systematic, and coherent regulatory framework for adequate protection that appropriately balances defense-in-depth and risk considerations."

The results of a flawed framework

- UCS strongly disagrees with a number of staff positions and/or Commission decisions rejecting new requirements to address mitigation of severe accident/sabotage risks and reducing the magnitude of large radiological releases and strengthening defense-in-depth
 - Expedited transfer of spent fuel to dry casks
 - Filtered vents/CPRR rulemaking
 - Regulatory treatment of SAMGs
 - Containment protection for PWRs and Mark III BWRs (hydrogen control)
 - Other Tier 3 issues (EPZ size)
- Defense-in-depth is not only a valid but an essential consideration when evaluating the benefits of regulatory requirements for post-core damage measures (e.g. SAMGs and filtered vents)

The flaw in common

- These analyses had one major aspect in common: each proposed action was deemed not to meet the Backfit Rule's "substantial safety enhancement" criterion:
 - "a substantial increase in the overall protection of the public health and safety or the common defense and security to be derived from the backfit"
- This was determined by comparing the absolute level of safety, characterized as the average risk of a latent cancer fatality to an individual within the 10-mile EPZ, to the latent cancer Quantitative Health Objective ($2 \times 10^{-9}/\text{yr}$)
- However, for at least three reasons, this is an improper approach
 - The safety goals were never meant as a litmus test for determining what constitutes a substantial safety enhancement
 - The backfit rule refers to "a substantial increase." Thus the relevant parameter is the magnitude of a change in risk, not the absolute risk
 - The safety goals, which are expressed in terms of individual risks, do not provide acceptable limits on societal risk (see comments by former NRC Commissioner Bernthal about siting a reactor in Central Park)

Example: Societal risk of long-term displacement

- Consideration of societal risks could lead to different outcomes
- Example: average number of people displaced annually by natural disasters worldwide: 27 million (dwarfs manmade disasters)
 - Average risk $\sim 4 \times 10^{-3}$ per year (1.5×10^{-3} for U.S. alone)
- Associated "safety goal" would be 1.5×10^{-6} per year if only U.S. risk is considered (note this is an individual, not collective, metric)
- But compare to the annual average risk of long-term displacement within 50 miles of Limerick as the result of an unmitigated ELAP (from the CPRR regulatory analysis):
 - $3 \times 10^{-5} \times 0.06 = 2 \times 10^{-6}$
 - comparable to the safety goal
- Therefore, regulatory action would be warranted if this safety goal were utilized for screening

Towards a new framework

- Revised risk and regulatory guidance
 - PRA results should only be used only where technically justifiable and with appropriate consideration of uncertainty
 - Given uncertainties, severe accidents should be regulated more tightly – e.g. at the 95th percentile, not the mean
 - Credit for defense-in-depth should be given more weight and formalized
 - Safety goals based on collective (or societal) consequence metrics should be adopted
 - Site-specific geographic and demographic factors should be taken into account in determining new requirements
- New IPE/IPEEE program
 - Consistent methodology across the fleet
 - New Severe Accident Mitigation Alternatives analyses using revised guidance
 - "Stress tests" to identify cliff-edges and other vulnerabilities

Conclusions

- Mitigating strategies need more comprehensive and transparent validation
- NRC still needs to revise its regulatory framework for severe accidents to
 - Give more credit to defense-in-depth
 - Incorporate a wider range of severe accident consequence metrics, including collective or societal metrics, into its regulatory decision-making process
 - Several bad NRC decisions might have come out differently in a new framework
- Draft rule on mitigation of beyond-design-basis events misses an opportunity to address these outstanding issues and others
