Regulatory Implications of Fukushima for Nuclear Power Plants in the U.S.

Commissioner George Apostolakis
U.S. Nuclear Regulatory Commission
CmrApostolakis@nrc.gov

Carnegie Nuclear Policy Program Conference
6 March 2012
NRC Actions After Fukushima

- NRC process for reaching decisions has been systematic
  - Promptly conducted inspections at all 104 plants
  - Formed Fukushima Near-Term Task Force to provide recommendations in 90 days
  - NRC senior management review of recommendations
  - Input from external stakeholders
  - Evaluation by Advisory Committee on Reactor Safeguards
  - Commission decisions
High-Priority Actions

• Orders
  - Protection of mitigation strategies equipment
  - Reliable hardened vents for BWR Mark I & Mark II containments
  - Spent fuel pool instrumentation

• Request for information
  - Seismic and flood plant walkdowns
  - Seismic and flood hazard reevaluations
  - Emergency preparedness staffing and communications assessments

• Rulemaking
  - Revision of station blackout requirements
  - Strengthening and integration of emergency operating procedures, severe accident management guidelines (SAMGs), and extensive damage mitigation guidelines
The accident was not of extremely low probability, i.e., it was not “unthinkable” or “unforeseen”

- Tsunami hazard was underestimated
- Critical equipment located in lower plant elevations
- Flooding risk assessment would have identified existing vulnerabilities
- No single decision maker during the accident

Still, there are lessons to be learned
• We should be mindful of striking a proper balance between confirming the correctness of the design basis and expanding the design basis of U.S. plants.

• The public has an understandable sense of urgency.

• Thoughtful analysis and deliberation should not suffer as a result of a failure to take into account the fact that significant mistakes contributed to the accident.

• Not every lesson learned from Fukushima is necessarily of higher priority than ongoing work on existing safety issues, e.g., fire protection.
Regulatory Approach

• **A Design Basis Accident** is a postulated accident that a facility is designed and built to withstand without exceeding the offsite exposure guidelines of the NRC’s siting regulation.

• **Defense in Depth** is an element of the NRC’s safety philosophy that employs successive compensatory measures to prevent accidents or mitigate damage if a malfunction, accident, or naturally caused event occurs at a nuclear facility. [Commission’s White Paper, February 1999]

• These concepts protect against “unknown unknowns”.
Regulatory Treatment of Design Basis Accidents

- Evaluated using conservative codes
- Subjected to surveillance, inspection, and maintenance requirements
- Controlled under rigid quality assurance requirements
Regulatory Treatment of Beyond-Design-Basis Accidents

• Treatment has been inconsistent ("patchwork")
• Some addressed in specific regulations
  ➢ Station Blackout
  ➢ Anticipated Transient Without Scram
  ➢ Loss of large areas due to fires and explosions
• Some addressed through voluntary industry initiatives
  ➢ Severe accident management guidelines
  ➢ Mark I hardened containment vents
• Quality requirements vary
High-Priority Actions

• Orders
  ➢ Protection of mitigation strategies equipment
  ➢ Reliable hardened vents for BWR Mark I & Mark II containments
  ➢ Spent fuel pool instrumentation

• Request for information
  ➢ Seismic and flood plant walkdowns
  ➢ Seismic and flood hazard reevaluations
  ➢ Emergency preparedness staffing and communications assessments

• Rulemaking
  ➢ Revision of station blackout requirements
  ➢ Strengthening and integration of emergency operating procedures, severe accident management guidelines (SAMGs), and extensive damage mitigation guidelines
NRC Backfit Rule

• **Imposition of new requirements is governed by NRC’s Backfit Rule (10 CFR 50.109)**

• **A backfit:**
  - Is the modification of or addition to systems, structures, components, or design of a facility; or the procedures or organization required to design, construct or operate a facility
  - Results from new or amended NRC regulations or guidance issued after the facility has been licensed to operate
Components of Backfit Rule

- A backfit can be imposed if it provides a substantial increase in protection to public health and safety that is cost justified
  - Qualitative consideration of benefits also permissible, to account for non-quantifiable (or difficult to quantify) benefits

- Exceptions
  - Compliance
  - Necessary for adequate protection
  - Defining or redefining what is needed for adequate protection

- The Commission may administratively exempt proposed NRC action from Backfit Rule
Adequate Protection

- NRC mission is to ensure adequate protection of public health and safety, promote the common defense and security, and protect the environment.
- Adequate protection is not defined by statute or regulation.
- It does not mean zero risk or absolute protection.
- Commission is charged by law with deciding what measures are necessary to provide reasonable assurance that the public will be protected.
• “If it so desires, however, the Commission may impose safety measures on licensees or applicants over and above those required by section 182(a)'s adequate-protection standard.”

• “The exercise of this authority is entirely discretionary. If the Commission wishes to do so, it may order power plants already satisfying the standard of adequate protection to take additional safety precautions. When the Commission determines whether and to what extent to exercise this power, it may consider economic costs or any other factor.”

Court of Appeals for the D.C. Circuit (Union of Concerned Scientists v. NRC, 824 F.2d 108, 120 (D.C. Cir. 1987))
Probabilistic Risk Assessment

• PRA is a structured analytical process that provides both qualitative insights and quantitative estimates of risk.

• PRA answers the following questions:
  1) What can go wrong?
  2) How likely is it?
  3) What are the consequences?
Quantitative Health Objectives 1986

• Early and latent cancer mortality risks to an individual living near the plant should not exceed 0.1 percent of the background accident or cancer mortality risk, approximately $5 \times 10^{-7}$/year for early death and $2 \times 10^{-6}$/year for death from cancer.

• Subsidiary goals
  - Core damage frequency: $10^{-4}$ per year
  - Large early release frequency: $10^{-5}$ per year
Fukushima Near-Term Task Force
Recommendation 1

- Establish a logical, systematic, and coherent regulatory framework for adequate protection that appropriately balances defense in depth and risk considerations

- NRC staff proposal to be submitted to Commission in early 2013
Risk Management Task Force


- Task Force charter is to develop a strategic vision and options for adopting a more comprehensive and holistic risk-informed, performance-based regulatory approach for reactors, materials, waste, fuel cycle, and transportation that would continue to ensure the safe and secure use of nuclear material

- Final report in Spring 2012
Risk Management Task Force recommendation:

NRC should establish via rulemaking a design enhancement category of regulatory treatment for beyond-design-basis accidents. This category should use risk as the safety measure, be performance-based (including the provision for periodic updates), include consideration of costs, and be implemented on a site-specific basis.
Proposed Regulatory Framework: Power Reactors

- Design basis event?
  - Adequate protection rule?
    - Current cost-beneficial safety enhancement rule?
      - Included risk-important scenario?
        - Remaining scenarios
          - Proposed Residual Risk Category
          - Proposed Design Enhancement Category
          - Adequate Protection Category
Concluding Remarks

• Highest priority actions are progressing

• Plan for remaining actions due this summer

• Orders raise questions on adequate protection

• Need for updating the regulatory structure