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United States Nuclear Regulatory Commission
Protecting People and the Environment

RESPONDING TO FUKUSHIMA-DAIICHI

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Overview

- Timeline
- Near-Term Task Force
- Enhancements
- Spent Fuel Safety
- Conclusions

Timeline

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TODAY
Ongoing Stakeholder involvement as staff prepares to issue orders and requests for information

December 16, 2011
Japan Announces Cold Shutdown Fukushima Units 1, 2, and 3

December 15, 2011
Commission approved proceeding with next highest priority recommendations

October 18, 2011
Commission approved proceeding with high priority recommendations

July 12, 2011
Near-Term Task Force Report

March 11, 2011
Earthquake, Tsunami, Nuclear Emergency

Current U.S. Plant Safety

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- Similar sequence of events in the U.S. is unlikely
- Existing mitigation measures could reduce the likelihood of core damage and radiological releases
- No imminent risk from continued operation and licensing activities

Enhancements without Delay

- Reevaluate external hazards, including seismic and flooding hazards
- Perform seismic and flooding hazard walkdowns
- Modify SBO rule to require enhanced capability to mitigate prolonged SBO

Enhancements without Delay (cont'd)

- Mitigation Strategies for Beyond Design Basis External Events
- Require reliable hardened vent designs in BWRs with Mark I and II containments
- Enhancement of spent fuel pool instrumentation

Enhancements without Delay (cont'd)

- Strengthen and integrate onsite emergency response capabilities
- Require staffing and communications equipment to respond to multiunit events and prolonged SBO

Recommendations for Other Actions

- Tier 2 Recommendations – Could not be initiated in the near term due to resource or critical skill set limitations
- Tier 3 Recommendations – Require further staff study to support a regulatory action

Additional Issues

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- Filtration of Containment Vents
- Seismic Monitoring Instruments
- Emergency Planning Zone Size
- KI Beyond 10 Miles
- Dry Cask Storage
- Loss of Ultimate Heat Sink

Approach on Near Term Enhancements

- Commission approved implementation of specific recommendations
  - Issue orders, requests for information (50.54(f) letters), and new regulations
  - Seek stakeholder input in determining action on each recommendation

Schedule

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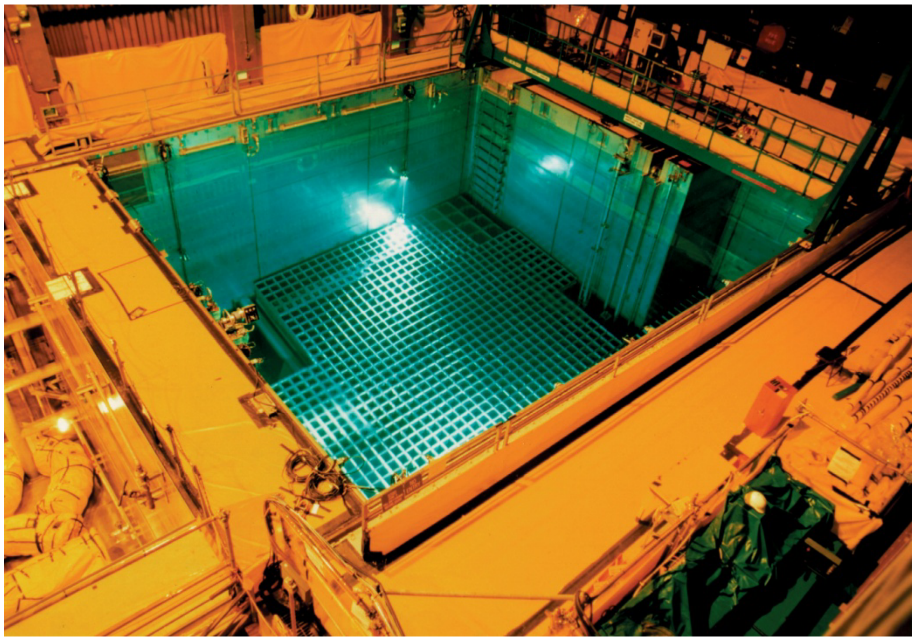
- FY2012 Appropriations – Accelerate schedule
- NRC goal is to issue Tier 1 Orders and 50.54(f) letters by March 11th
- Planning to submit to the Commission by February 17; Commission will direct the staff
- Overall Goal – Complete enhancements in 5 years

NRC Follow-up

- Review and assess licensee responses
- Establish necessary regulatory framework
- Inspect to ensure compliance with all new regulatory requirements
- Consider implications for other nuclear facilities

U.S. Spent Fuel Pools



- Spent fuel rods stored in spent fuel pools (SFPs) under at least 20 feet of water
- Typically ~1/4 to 1/3 of fuel in reactor replaced with fresh fuel every 18 to 24 months
- Spent fuel stored in pools minimum of 5 years

Spent Fuel Safety

- Spent Fuel Pools (SFP) originally designed for limited storage of spent fuel until removed off-site
- Safety achieved primarily by maintaining water inventory, geometry, and soluble boron (PWRs)
- Drain down can lead to uncovered fuel, heat-up, and the release of radionuclides

Risk of Large Release

- SFP risk is low, due to the very low likelihood of events that could damage the thick reinforced pool walls
  - Likelihood of fuel uncovery is low; 6E-7 to 2E-6/yr (NUREG-1738)
  - Potential consequences may be large due to heatup of the fuel in the pool
  - Heatup of the fuel in the pool can lead to “zirconium fire” initiation and propagation
  - Large inventory of ^{137}Cs available for release

Spent Fuel Safety and Security

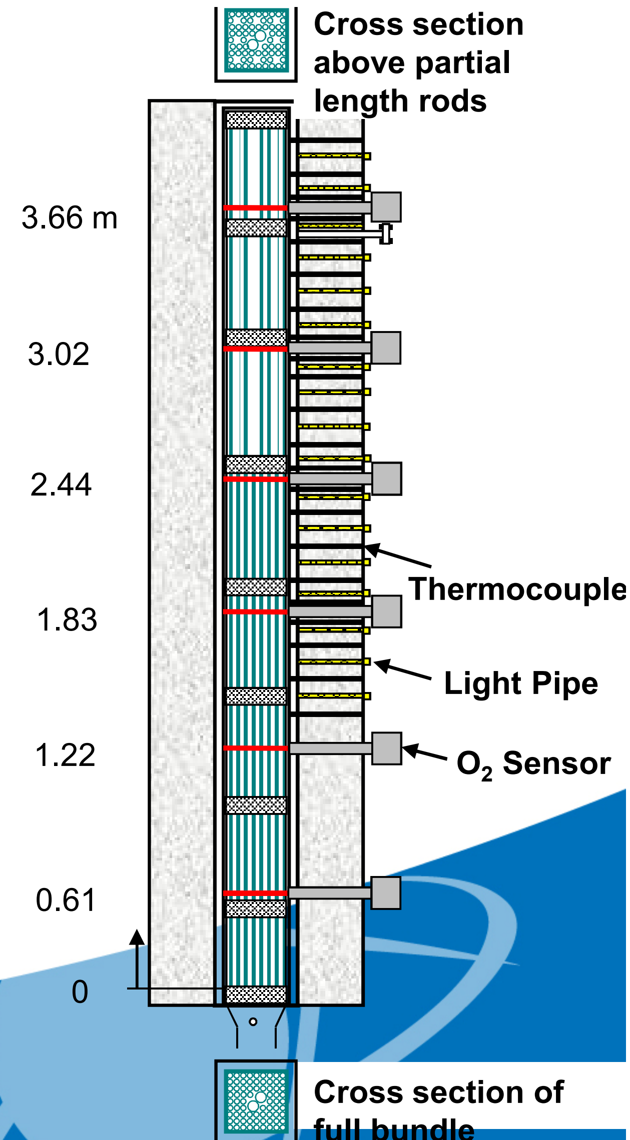
- NRC extensively reexamined pool safety and security after 9-11 attacks
  - Low vulnerability to attack
  - Significantly improved analysis of fuel coolability / heatup
  - Mitigation measures improved passive coolability of fuel
    - Improved fuel configuration within the pool achieves substantially greater passive cooling capability by natural convection

Spent Fuel Safety and Security

- NRC required spray capability for each site to improve active cooling capability
- Licensees performed site-specific assessments; NRC inspected
- Coolability of fuel within pools has been enhanced by measures identified and assessed as part of post-9/11 measures
- Conducting research to confirm understanding and validate analytical modeling

Zirconium Fire Investigations During SFP Loss of Coolant Accident (LOCA)

- Prototypic full length 9×9 BWR hardware
  - Single pool rack cell
  - Upper & lower tie plates with seven spacers
  - Water tubes and channel box
  - 74 electric heater rods with Zr-2 cladding (eight partial length)
  - 5000 W simulating a 100 day old assembly
- Measurements
  - Temp profiles: Axial and radial
  - Induced flow: Effect of ignition on flow
  - O_2 concentration: Determine depletion
  - Nature of fire: Initiation location & axial burn rate



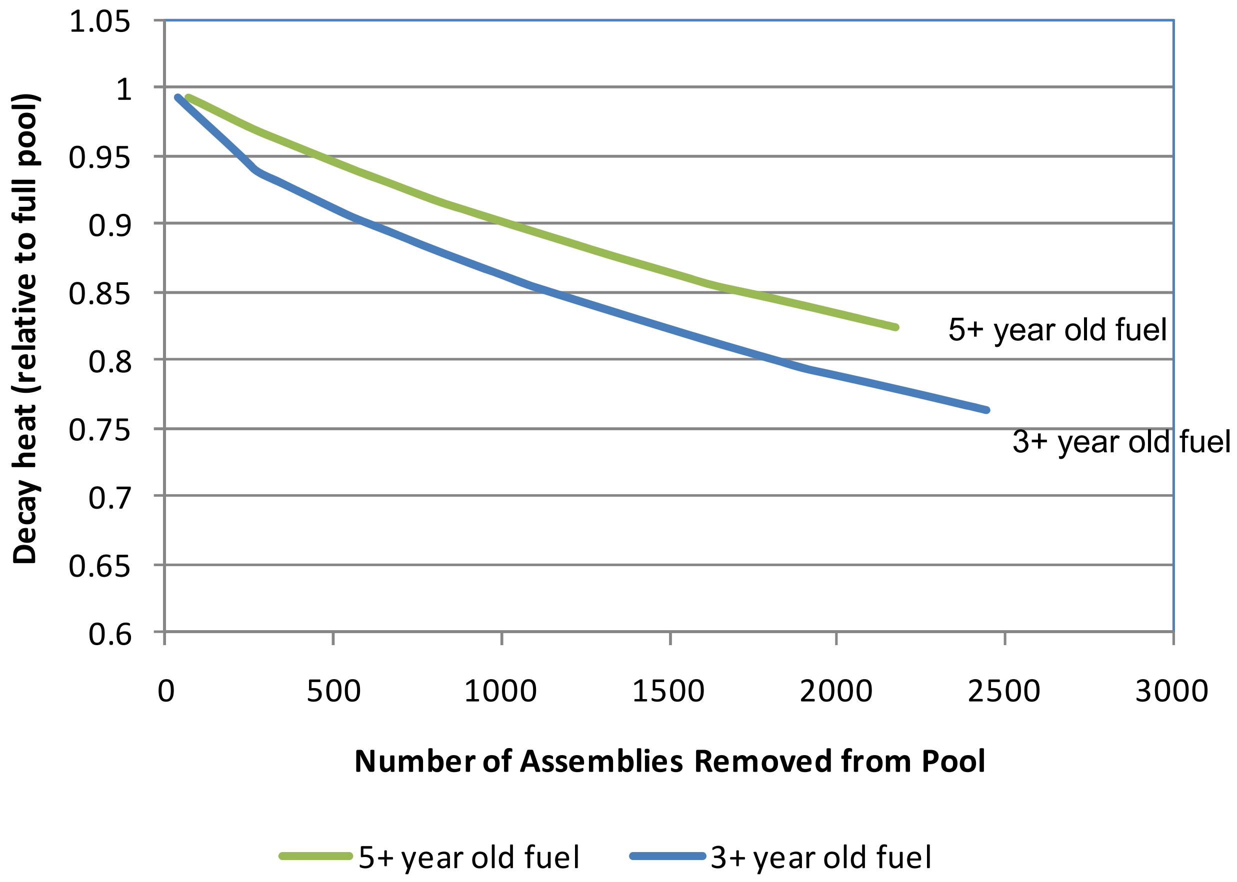
Zirc Fire Investigations During SFP LOCA – Post-test

Removing Fuel from Pools

- NRC has considered benefits of removal of fuel from the pool and returning to a low density racking type configuration
- There are competing factors in such a consideration
  - Storage in dry casks must be consistent with cask design
  - Discharging of fuel increases the risk of cask drops and increases worker doses
  - Removal of fuel will decrease the inventory of Cesium-137
  - Removal of fuel does not appreciably reduce decay heat (most of the decay heat is from recently discharged fuel)
  - Reduction in potential land contamination and economic impacts, if a large release occurred

Impact of Removing Assemblies

Reduction of pool thermal heat load



Spent Fuel Pool Scoping Study

- NRC has initiated an updated SFP study
- Estimate the change in accident consequences associated with removing older fuel from the SFP and placing it in dry storage
- Limited scope analysis (e.g., single SFP/operating cycle for low/high density racking)
- Does not comprehensively consider competing factors (e.g., impact of more fuel moves)

Comparative Consequences

- Technical approach relies on realistic analysis using expedient and technically-defensible deterministic methods and assumptions
- Elements of study include
  - Information gathering
  - Seismic and structural assessment
  - Accessibility, decay heat, and radionuclide inventory assessment
  - Accident progression (MELCOR) and offsite consequence analysis (MACCS2)
  - Emergency planning assessment

Conclusions

- No immediate safety concerns based on Fukushima nuclear emergency
- Confirmed the existing safety measures for nuclear power plants, including SFPs
- Moving forward with nuclear power plant enhancements
- Examining additional near-term and long-term reviews
- Spent fuel must be managed safely and securely