

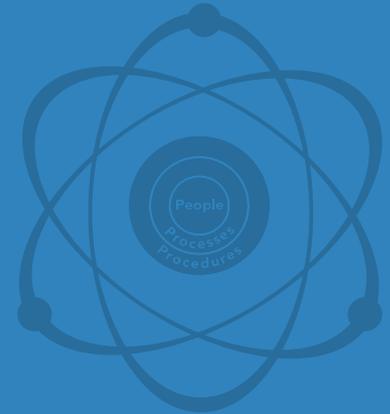
Nuclear Power Generation Post-Fukushima Initiatives

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US Department of Energy – FSO Coal and Power Course

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US Department of Energy – Foreign Service Officers

Overview

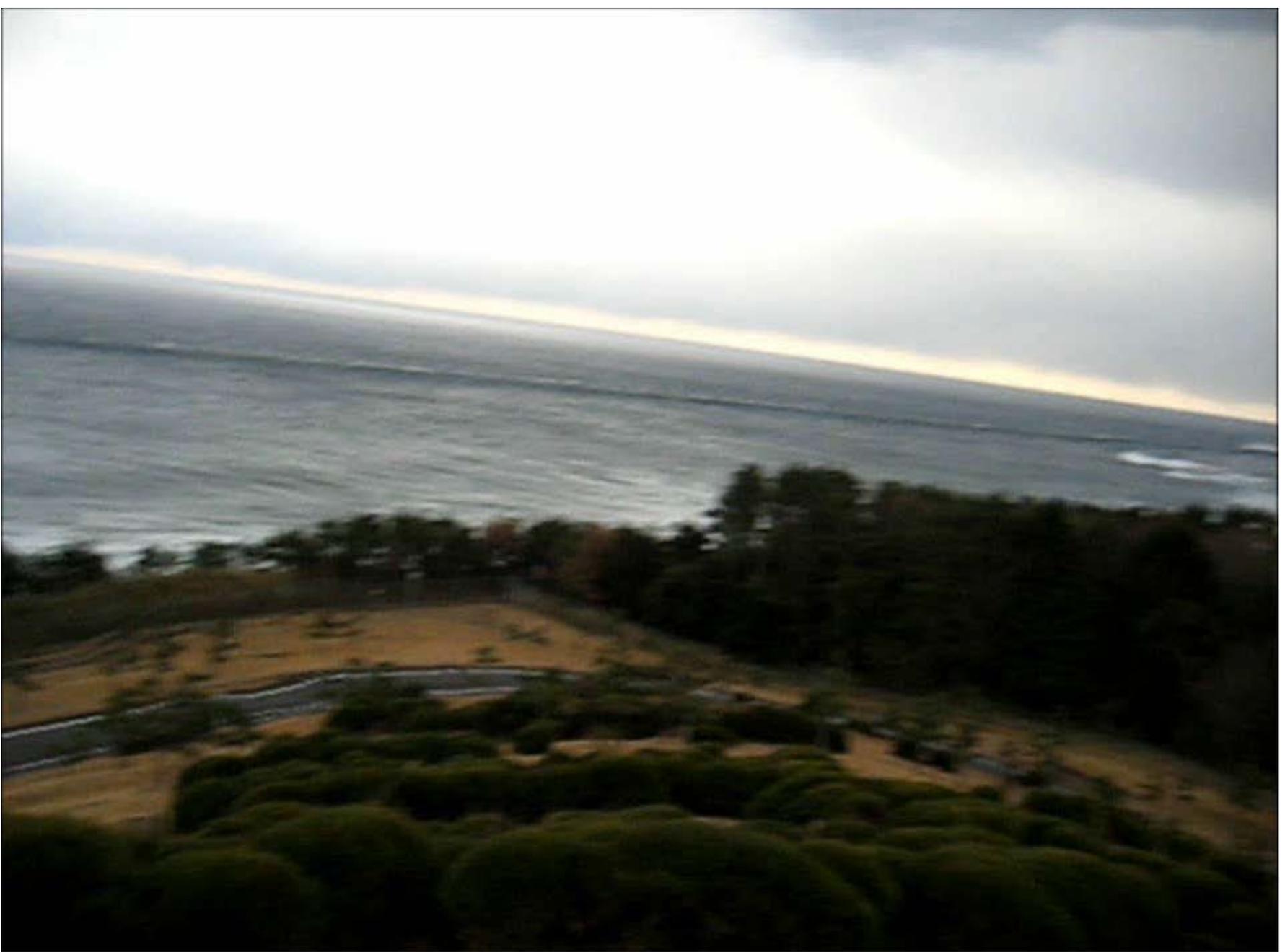
- **Discuss the events impacting Japan and the Daiichi nuclear power plant**
- **Discuss the initiatives being taken worldwide related to the Fukushima event**
- **Provide personal insights from Japan as they relate to Nuclear Safety Culture**

Fukushima Daiichi

Overview of Japan Nuclear Event

- **On March 11 a magnitude 9.0 earthquake occurred off the east coast of Japan**
 - All operating nuclear power plants shut down safely
- **In the next hour a massive tsunami—about 45 feet high—struck the east coast**
 - Critical equipment at Fukushima Daiichi plant was destroyed





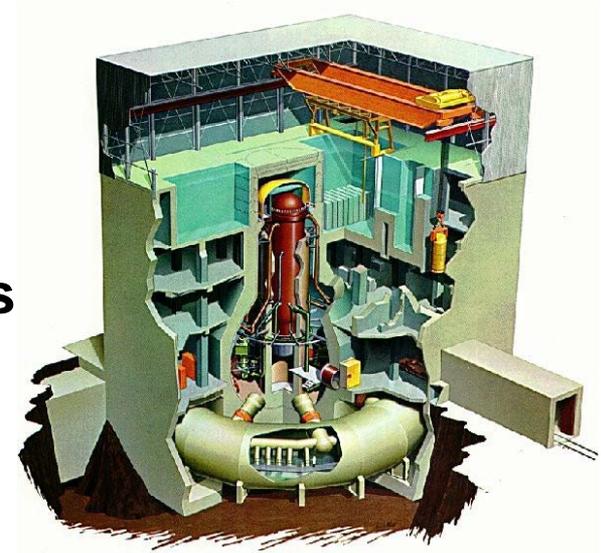
Fukushima Daiichi

- March 11, 2011 14:46 - Earthquake
 - **Reactors Trip Automatically**
 - **Power grid in northern Japan fails**
 - **Reactors are undamaged**
- Reactor Trip
 - **Power generation due to Fission of Uranium stops**
 - **Heat generation due to radioactive decay of Fission Products**
 - **After Scram ~6%**
 - **After 1 Day ~1%**
 - **After 5 Days ~0.5%**

Fukushima Daiichi

Lost Backup Power for Cooling Systems

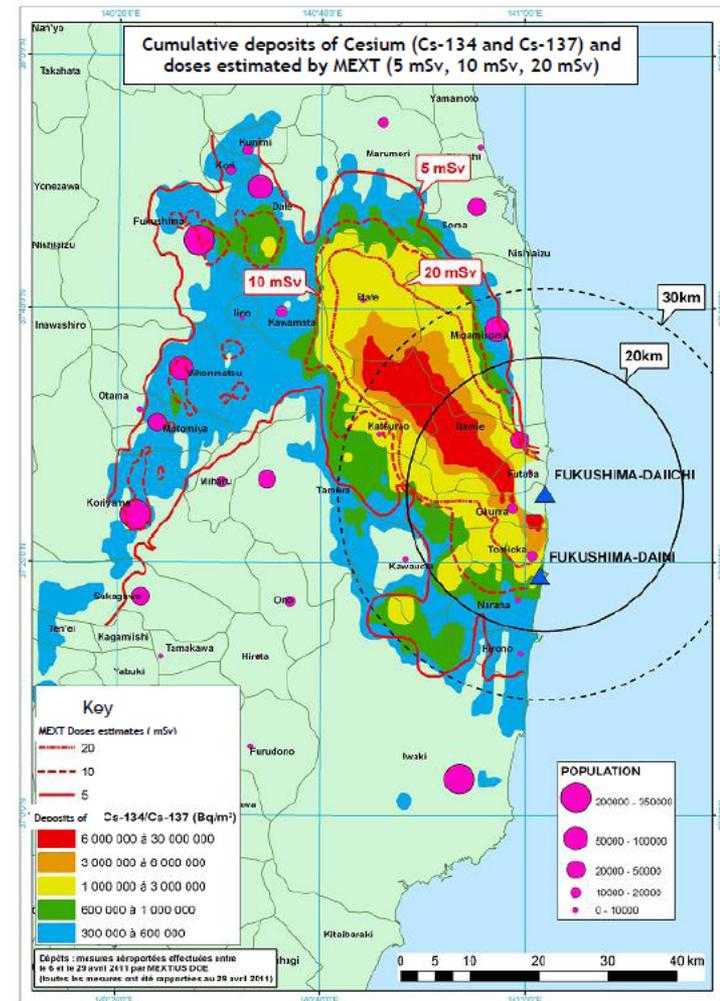
- **Cooling systems stopped working due to lack of off-site and back-up power systems**
- **Fuel in reactor heated up**
 - Fuel cladding reacted with water at high temperature, generating hydrogen gas
- **Containment pressure increased; TEPCO vented hydrogen in containment to atmosphere to prevent overpressure**
- **Hydrogen explosions occurred in secondary containment**
- **Plant operators injected seawater into reactors to cool fuel, prevent further damage; processed water now being provided**
- **Fuel pools; helicopters initially dumped water. Water then injected into pools. Now on recirculation cooling.**





Fukushima Daiichi Continued Recovery Efforts

- Continue to cool reactors 1-3 (current status)
- Maintain releases of radioactive material low
- Maintain and improve reliability for the long-term cleanup and cooling systems
- Process and dispose of radioactive water – water inventory challenge
- Continue detailed evaluation of event and determination of lessons learned
- Continue to maintain recirculation cooling to the Spent Fuel Pools at Units 1-4
- Establish conditions for evacuees to return – on going efforts
- Decommission Fukushima reactors



Fukushima Lessons Learned

- **New scientific knowledge**
 - Projected earthquake magnitude
 - Tsunami projections (and historical studies)
- **Readiness to respond to the unexpected**
 - Events beyond design basis
- **Command and control and decision making under duress**
 - Onsite Emergency Response
 - Local and prefectural government
 - Federal government

Worldwide Response to Fukushima

■ **United States**

- Taskforce 90 Day report – 12 recommendations
- NRC bulletin issued, orders, 50.54(f) requests and future rulemaking in progress
- Timely industry actions
 - IER L1 11-1 Walkdowns
 - IER L1 11-2 Spent Fuel Pools Cooling and Inventory
 - IER L1 11-4 Extended Station Blackout
 - IER L1 13-10 Fukushima Lessons Learned

■ **Europe (Germany)**

- Stress-test analyses

■ **Asia (Japan)**

- Slowed commitments for new nuclear construction
- Modified Stress-tests

U.S. Response to Fukushima

- **The way forward document – identifies industry-wide response, coordination and communications**
- **Review for seismic and flooding considerations requested as information which incorporates “new knowledge.”**
- **Information requests also for staffing and communications**
- **Orders and Rulemaking**
- **Future regulatory actions**
- **INPO IER L1 13-10**
 - International use
 - US implementation guide



Current Regulatory Actions

- **Request for Information – 10CFR50.54(f)**
 - Seismic Re-evaluations and walkdowns
 - Flooding Re-evaluations and walkdowns
 - Emergency Preparedness – Communications and Staffing
- **Three Orders – Immediately Effective**
 - Mitigation Strategies (FLEX)
 - Spent Fuel Pool Level Instrumentation
 - Containment Vents – Mark I & II (BWRs)
- **Proposed Rulemaking “Loss of AC”**
- **Proposed Rulemaking “Emergency Response Capability”**
 - Integration & Command and Control

Future Regulatory Considerations

- **Containment Filters**
- **Hardened Containment Vents for Other Designs**
- **Seismically Induced Fires and Floods**
- **Hydrogen Control and Mitigation**
- **Transfer of Spent Fuel to Dry Cask Storage**
- **Reactor & Containment Instruments Beyond**
- **Emergency Preparedness**
 - EPZ size
 - KI beyond 10 miles
- **Reactor Oversight Modifications**
- **Staff Training**



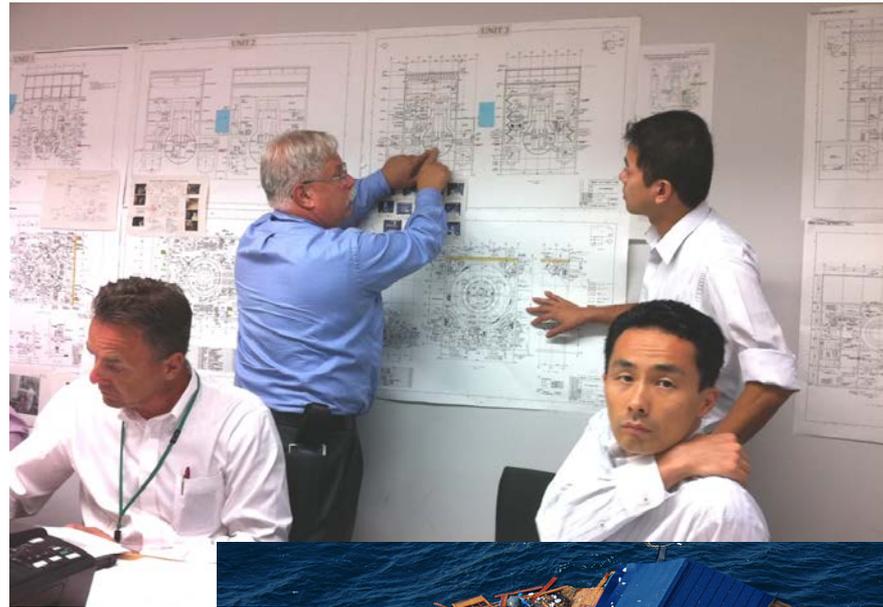
Nature's Stress Test of Our Industry

- **Fukushima – earthquake (9.0) and tsunami (> design)**
- **TVA – Multiple tornados**
- **Surry – tornado affecting switchyard**
- **Cooper & Fort Calhoon – flooding**
- **North Anna – earthquake**
- **San Onofre – California blackout (5 million)**
- **Increased solar flare activity**
- **Tritium in steam release at Byron & San Onofre**



Insights from Japan

- **Devastating event**
- **Japanese people are enthusiastic and rapidly rebuilding**
- **Not the case for 20 km radius**
- **Thought provoking observations**





Principles for a Strong Nuclear Safety Culture

- 1. Everyone is personally responsible for nuclear safety.**
- 2. Leaders demonstrate commitment to safety.**
- 3. Trust permeates the organization.**
- 4. Decision making reflects safety first.**
- 5. Nuclear technology is recognized as special and unique.**
- 6. A questioning attitude is cultivated.**
- 7. Organizational learning is embraced.**
- 8. Nuclear safety undergoes constant examination.**

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- 8. Nuclear safety undergoes constant examination.**
- 9. Organizational ability to respond to the unexpected is maintained and enhanced**

Nuclear Energy

■ Summary

- Actions continue worldwide to incorporate the lessons learned
- US Industry has taken measures to ensure nuclear facilities are in a high state of readiness
- US Regulatory action is in progress
- Our responsibilities to live up to the principles of a strong nuclear safety culture cannot be understated as we continue to bring in the next generation of nuclear leaders.

“As much as we want to believe this is a technical business about a machine, it will always be a business about people. About how those people work together to safely operate that machine.”

Questions & Answers

