# SCIENCE AND ENGINEERING FOR DISASTER REDUCTION AND POST-FUKUSHIMA RECOMMENDATIONS

Presented to the SDR

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Office of Nuclear Regulatory Research

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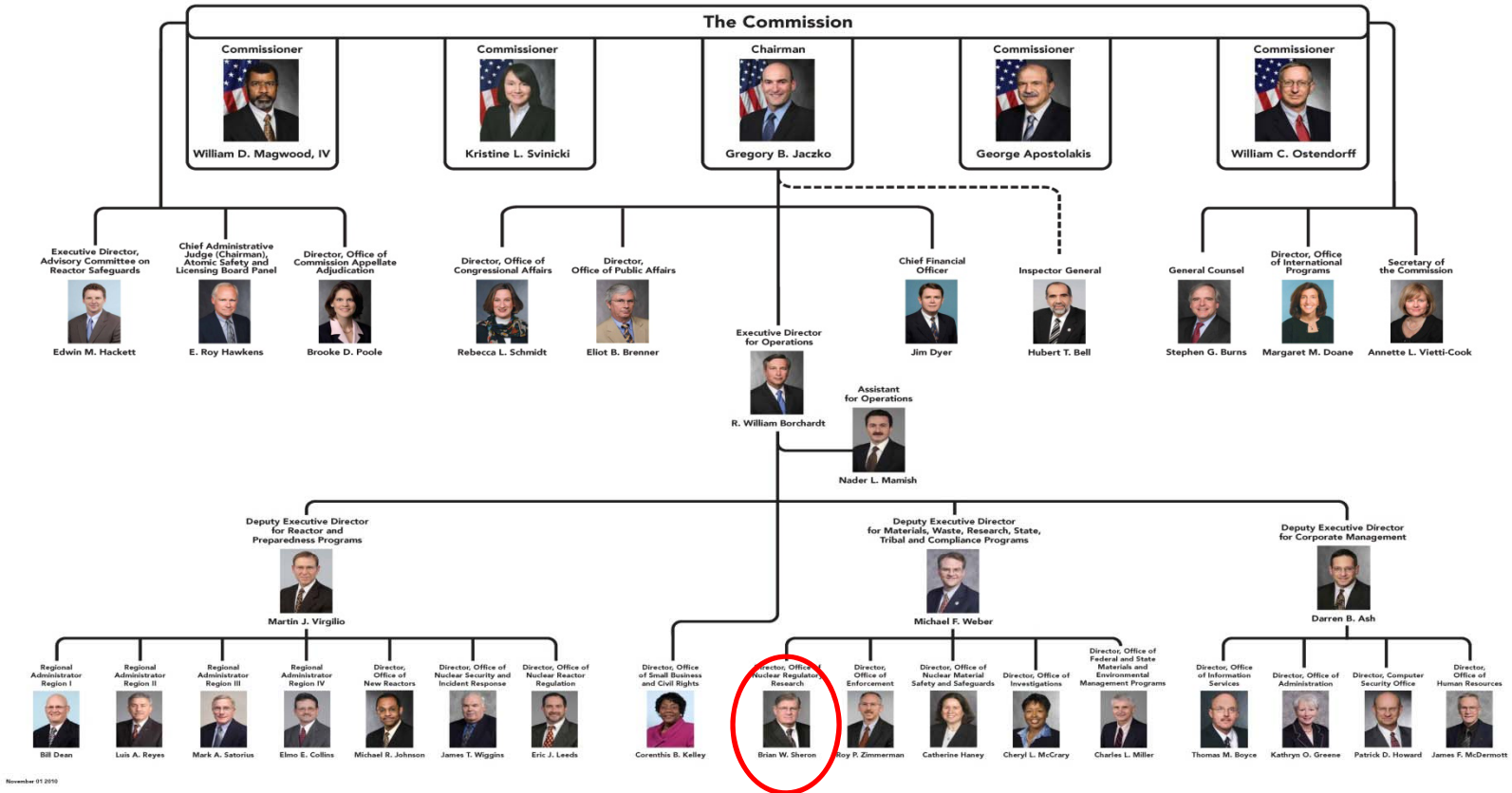
# U.S. Nuclear Regulatory Commission

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# Overview of NPPs

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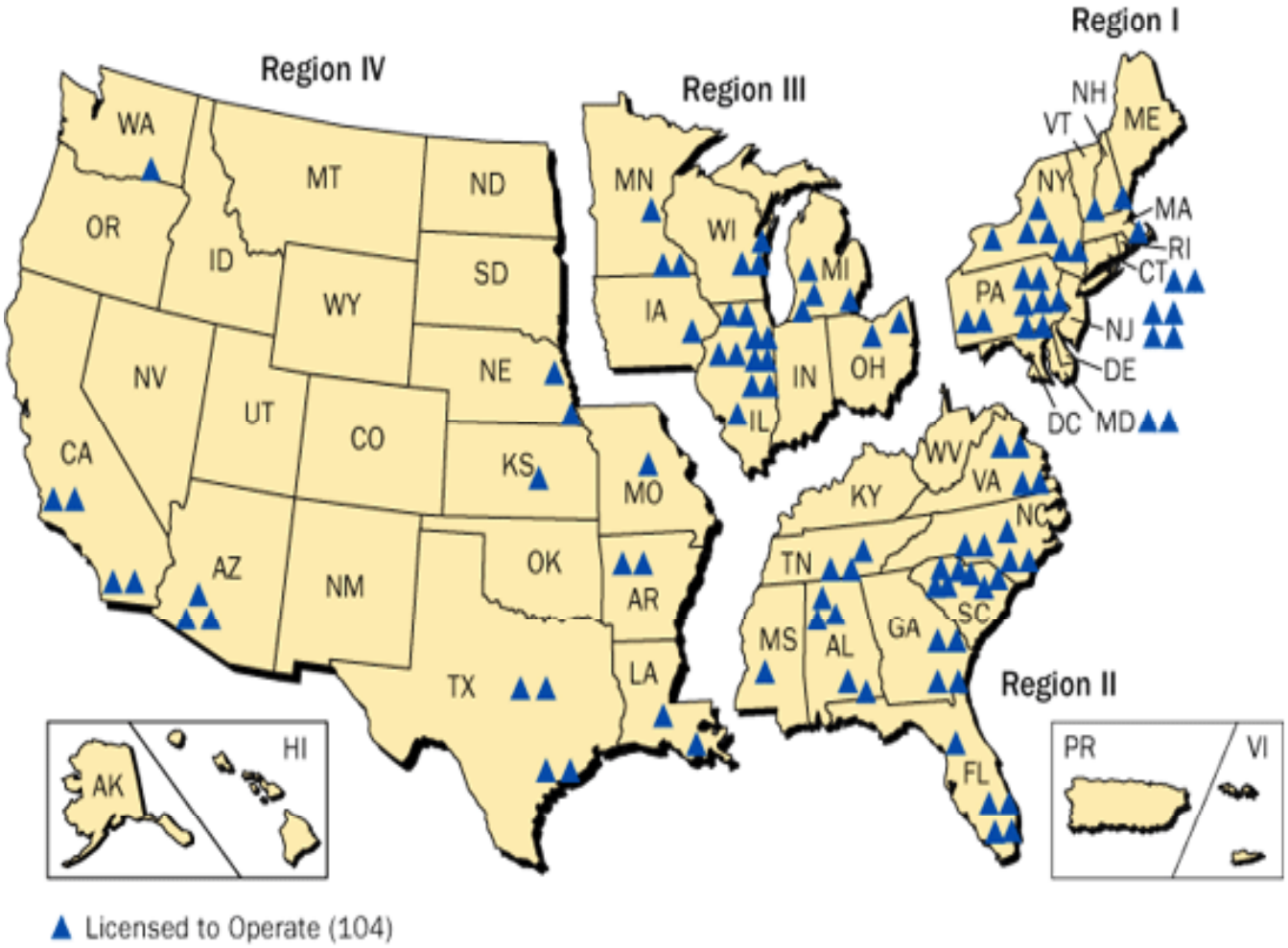
# Map of Operating Nuclear Power Reactors



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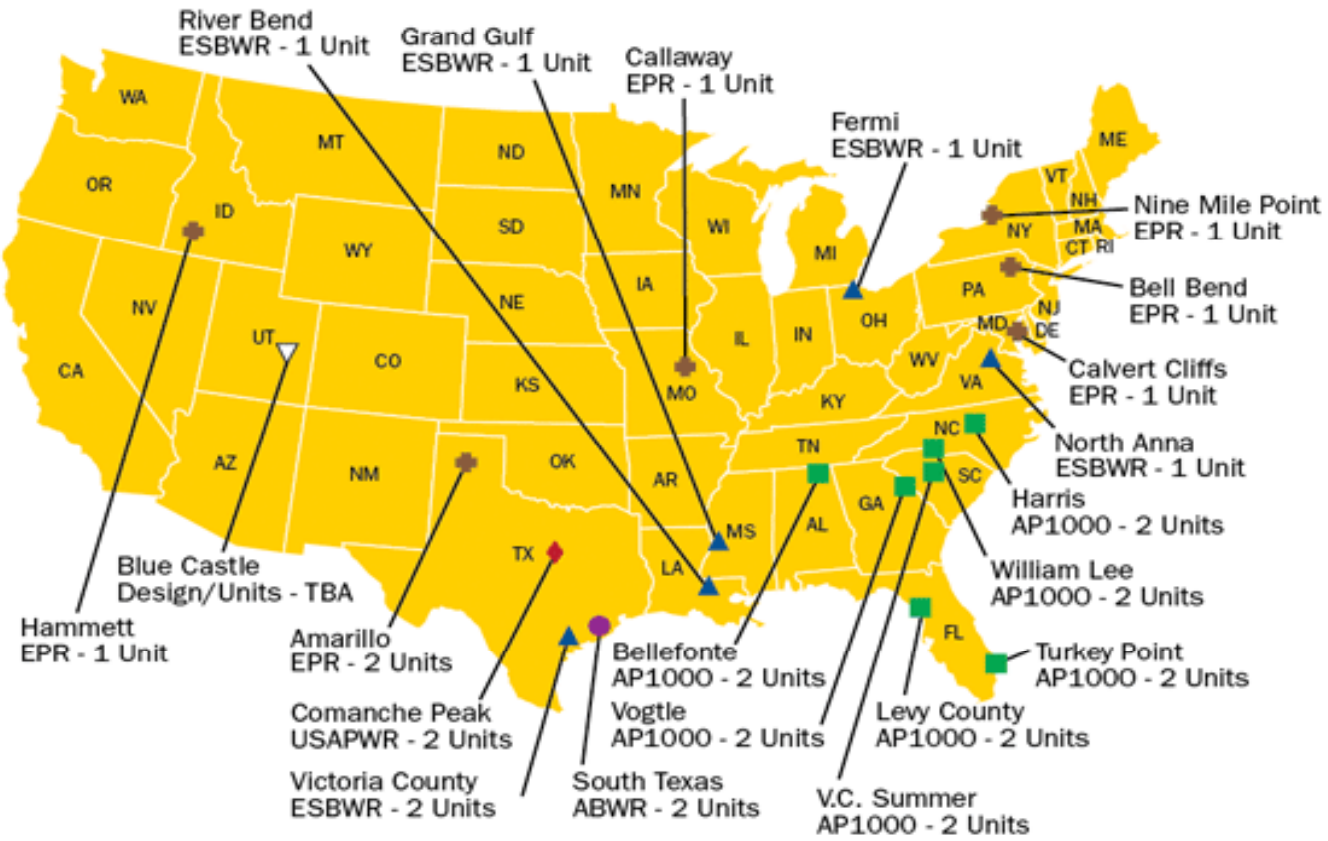
# Map of Proposed New Nuclear Power Reactors



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# General Facts



- 104 units at 65 sites in 31 states
  - 20% of Nation's electricity
  - 70 have undergone license renewal
  - New designs and operating licenses under review
- Among the most hardened commercial facilities in the world
  - Including robust guard forces
- Designs are based on a defense in depth concept
  - Internal and external hazards

# Defense in Depth

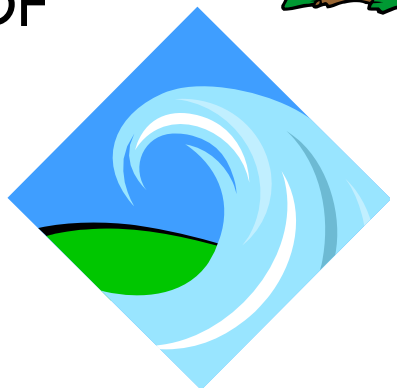


- Multiple independent and redundant layers of defense to compensate for hazards, failures or errors so that no layer is exclusively relied on
  - protection, mitigation and emergency preparedness
- Protection against internal, external and security related events
- Mitigation- hardened safety systems
  - Robust containment structure
  - Post 9/11 requirements
- Emergency preparedness
  - Evacuation plans
  - Sheltering/Potassium Iodide (KI)
  - Return criteria

# External Hazards

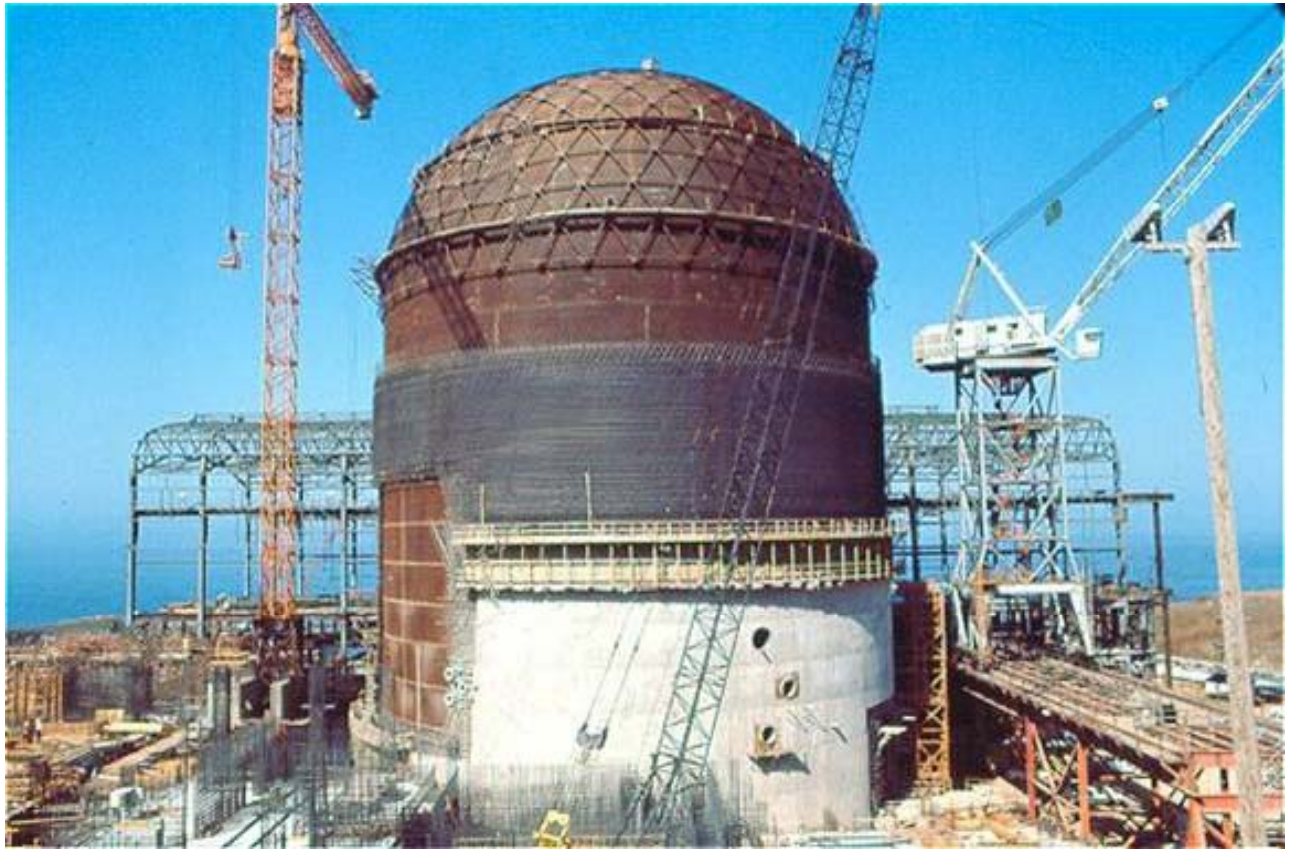


- Natural phenomena suited to the specific site
  - Floods, seismic, tsunami, seiches, hurricane, tornado
  - Maximum historical values (deterministic)
  - Additional margin
- NRC is now using PRA
  - Seismic design basis ground motion determined so that 1E-6 CDF



# Wolf Creek Containment Construction





# Trojan and Ginna Containments



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# Beyond Design Basis Considerations



- Use of PRA has resulted in additional requirements
  - Low frequency/high consequence events
  - Loss of all ac power (station blackout, SBO)
  - Anticipated transient without SCRAM
  - Severe accident management strategies
  - Hydrogen control
  - Aircraft impact - extensive damage mitigation

# PRA and Consequences



- WASH-1400
  - Published in 1975
  - First application of PRA to NPPs
- NUREG-1150
  - Published in 1990 (just internal events)
  - LCF individual ~2E-9 within 10 miles; absolute prompt fatalities ~10
- Sandia Siting Study
  - Published in1982
  - To support rulemaking
  - LCF individual ~1E-7 within 10 miles; abs. prompt fatalities ~100
- State of the Art Consequence Analysis
  - Public comment expected in December 2011
  - Best estimate
  - LCF individual ~1E-10 within10 miles ; absolute prompt fatalities ~0
    - Return modeled

# Fukushima Dai-ichi

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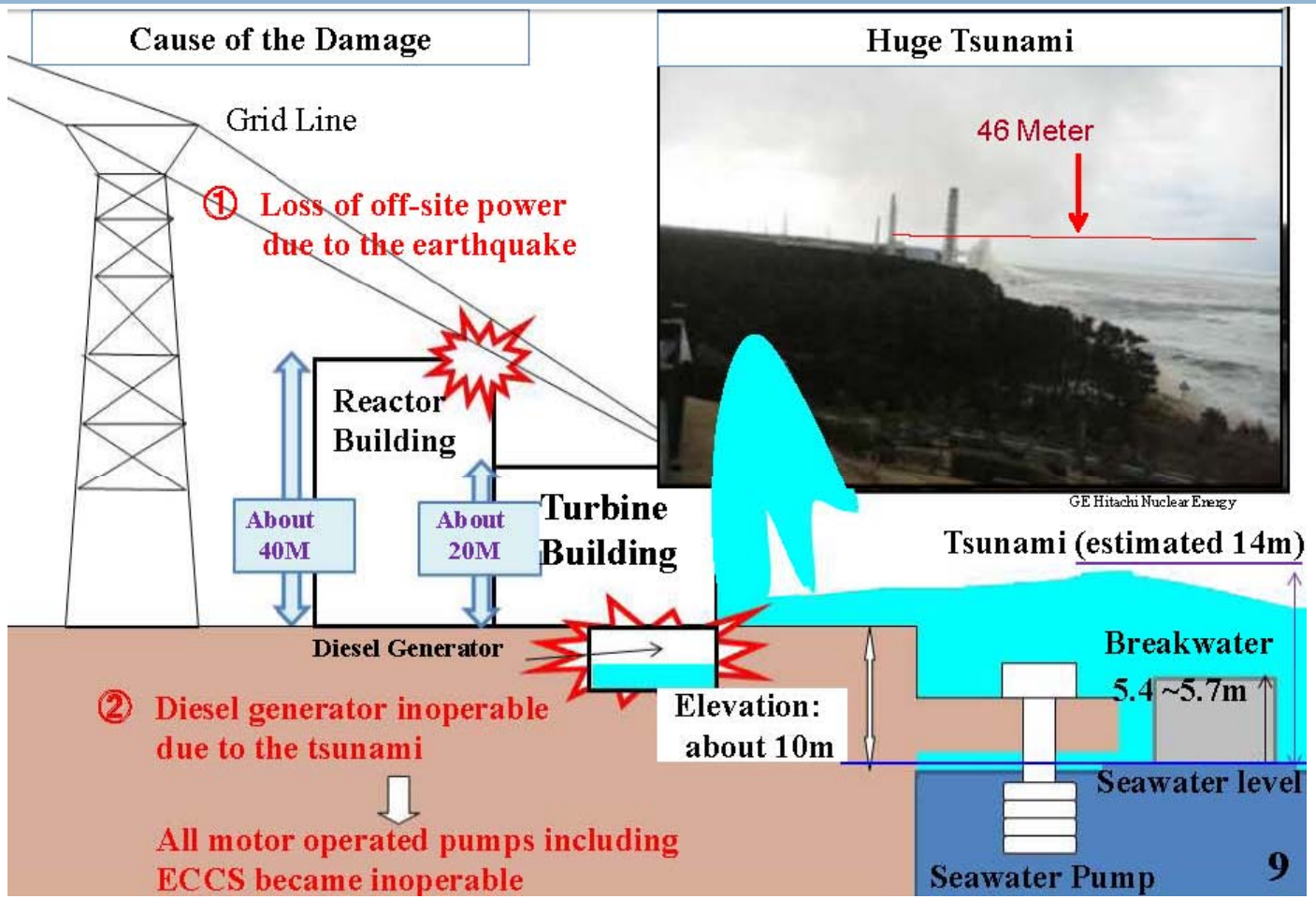
# Sequence of Events

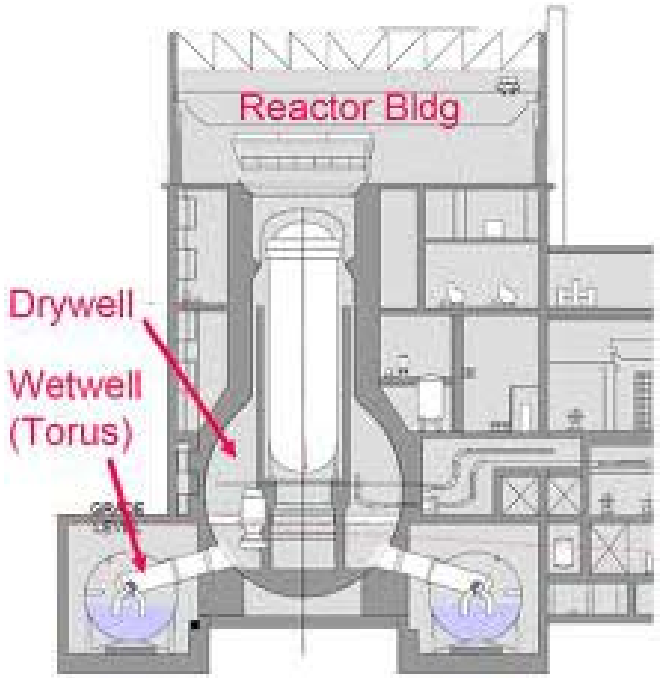





www-pub.iaea.org/MTCD/meetings/PDFplus/2011/cn200/documentation/cn200_Final-Fukushima-Mission_Report.pdf

# Fukushima Unit 4





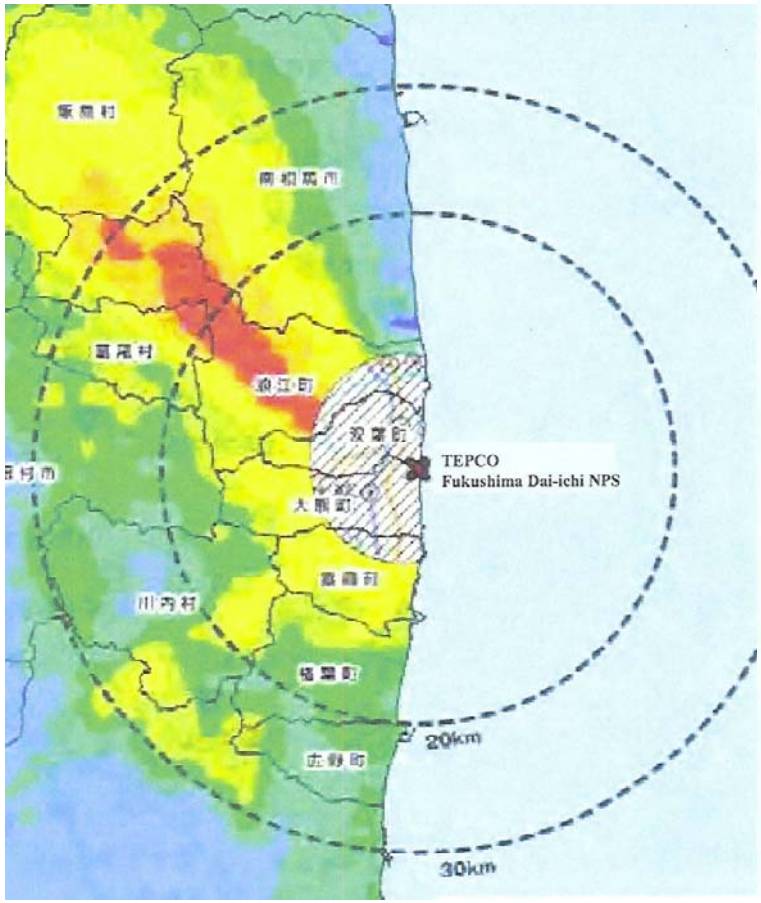

# Radioactivity Releases



- Dai-ichi Emergency Worker Dose Limits
  - 200 milliSieverts (mSv) = 20 Rem
- Plant workers
  - Six people exceeded the dose limit
  - 250 mSv = 25 Rem
  - Occupations
    - Operators
    - Engineers
- No health consequences have been noted
- LNT 2.5% above LCF background

# Dose Rate Map






**explanatory note**

**Air dose rate over 1 meter above ground level (μSv/hr)**
**[Converted into the value as of july 2]**

19.0 <
9.5 - 19.0
3.8 - 9.5
1.9 - 3.8
1.0 - 1.9
0.5 - 1.0
0.2 - 0.5
0.1 - 0.2
< 0.1

**Areas where readings were not obtained**

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# NRC Actions

# NRC Response to Events in Japan



- NRC conducted a methodical and systematic review
- Near-term actions
  - Conducted additional inspections regarding coping measures
- Near Term Task Force Report
  - 12 Recommended Actions
    - 2 for NRC
    - 6 for industry
    - 4 Longer-term actions

http://pbadupws.nrc.gov/docs/ML1118/ML111861807.pdf

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# Recommendations Summary



- No imminent risk from continued operation and continued licensing activities
- NRC's regulatory framework could be enhanced
- Additional requirements and nuclear power plant improvements for low probability, high consequence events, would reduce risk even further

# Interim Actions



- The near-term actions identified are the following:
  - Seismic and flood hazard reevaluations
  - Seismic and flood walkdowns
  - Station blackout regulatory actions
  - Equipment covered under Title 10 of the *Code of Federal Regulations* (10 CFR) 50.54(hh)(2)
  - Reliable hardened vents for Mark I containments
  - Strengthening and integration
    - emergency operating procedures,
    - severe accident management guidelines, and
    - extensive damage mitigation

# Next Steps



- Notation vote paper due October 3, 2011
  - Reflect regulatory actions
  - Implementation challenges
  - Technical and regulatory basis
  - Additional recommendations
  - Schedule and milestones for stakeholder engagement and Advisory Committee on Reactor Safeguards review

# Summary



- Nuclear power plant landscape
- Robust infrastructure
  - Defense in Depth
  - Design for internal and external hazards
- Fukushima Daiichi event
- Task Force Recommendations

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# QUESTIONS

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