

# Assessing and Managing the Risk of Nuclear Power: Impact on California



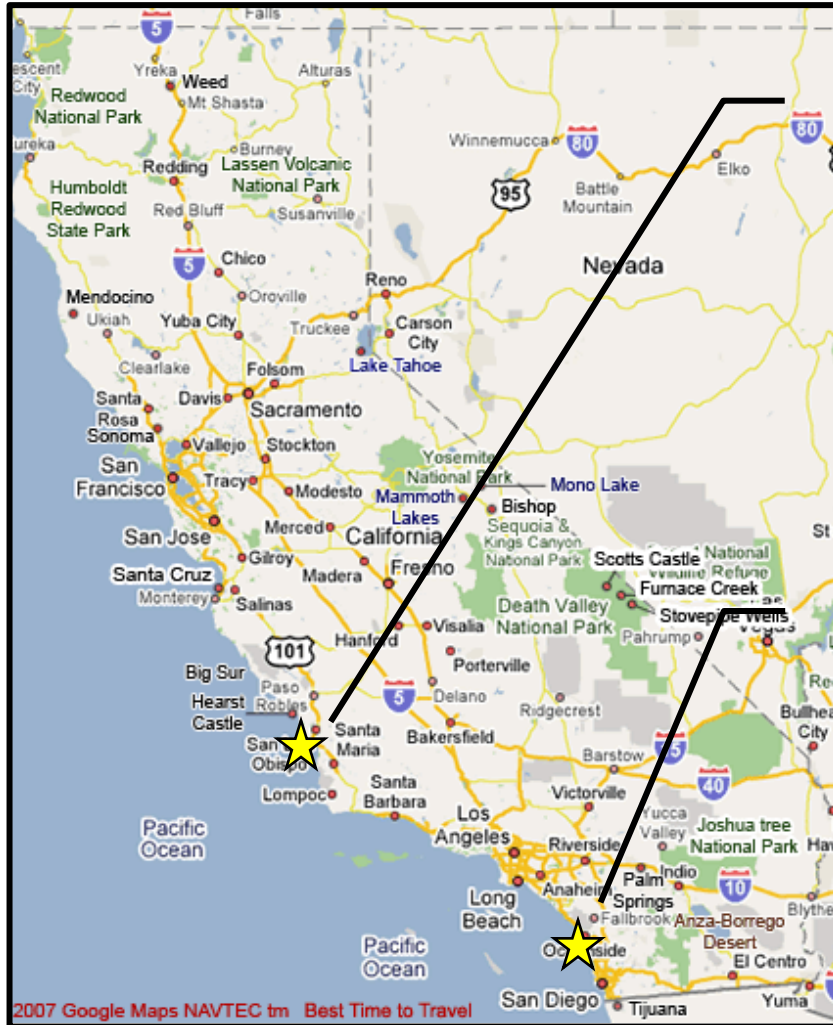
California Council on Science and Technology  
Meeting on “Risk, Uncertainty and Trust in Scientific Data and Analyses”

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# Nuclear Power in California



## Diablo Canyon Power Plant (DCPP)

- 2 X 4-Loop Westinghouse PWRs (1,100 MWe each)
- Unit 1 commissioned in 1985 and Unit 2 commissioned in 1986
- Owned and operated by PG&E

## San Onofre Nuclear Generating Station (SONGS)

- 2 X 2-Loop CE PWRs (1,100 MWe each)
- Unit 2 commissioned in 1983 and Unit 3 commissioned in 1984
- Owned and operated by SCE



# Three major policy questions arise from the Sendai tsunami and the nuclear accident at Fukushima

- How should the nuclear accident at Fukushima affect our policies for existing reactors?
  - Policies for regulating safety (e.g., lessons learned)
  - Policies for license renewal (e.g., should existing nuclear plants be shut down before, or after, existing coal plants?)
- Are the new, Generation III reactor designs sufficiently safe to be built, considering lessons learned from the Fukushima accident?
- Are there broader lessons for protecting public health and safety?
  - The Japanese tsunami early warning system saved many lives
    - » compare the 2004 Sumatra tsunami, 230,000 fatalities, with Sendai ~28,000
  - The U.S. west coast from northern California to Alaska has thrust faults that can generate similar tsunamis



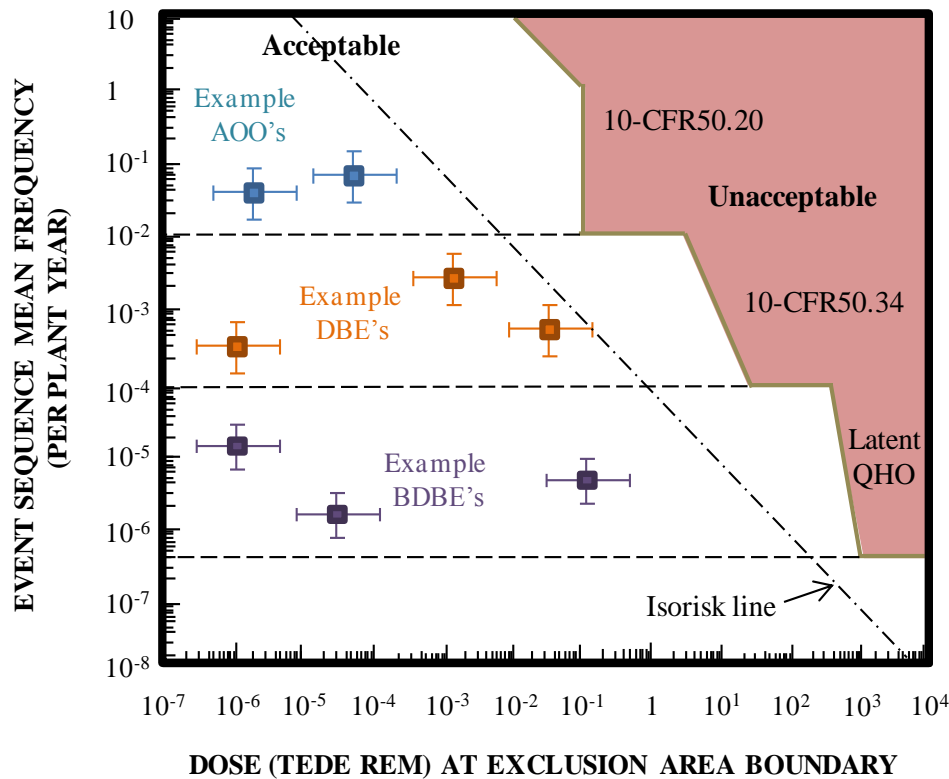
# The U.S. Nuclear Regulatory Commission published safety goals for nuclear power in 1986

- “The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of one percent (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.”
- “The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of one percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes.”

**No comparable requirements exist for fossil fuels**



# The USNRC safety goals can be displayed on a frequency/consequence chart



Anticipated operational occurrences

Design basis events

Beyond design basis events



# Deterministic vs. Risk-informed vs. Risk-based



**USNRC relies heavily on Defense-in-Depth philosophy where an appropriate balance between protection, mitigation, and emergency preparedness must be established**

# The United States response to Fukushima

- Major ongoing activities:
  - US NRC Task Force 90 day review
  - DOE reviewing critical nuclear installations
  - INPO independent review
  - US NRC and DOE monitoring situation in Japan and providing support



# Major questions raised surrounding risk analysis and management of current fleet

- Is there adequate protection from natural phenomena within the design basis?
- Is there sufficient consideration of natural phenomena that falls outside of the design basis?
- Are US nuclear facilities adequately prepared for mitigation for long-term station black outs?
  - Multiple unit sites?
- Do US nuclear facilities have adequate emergency preparedness measures?
- Does the US NRC have adequate programs in place to deal with similar issues?



# Recent US NRC findings at DCPD and SONGS

- NRC inspectors focused on what licensees were doing with respect to the capabilities and strategies they had to respond to large fires/explosions, station blackout events, and flooding events
- No major safety-related findings but examples of findings:
  - Lack of a written agreement for fuel oil supply to support emergency diesel generators when operation was required for more than 7 days (SONGS)
  - Extension cords used to connect power from portable generator to plant equipment were not re-verified to be of an adequate length (SONGS)
  - Licensee identified that the memorandum of understanding was not in place with the California National Guard for the contingency to supply diesel fuel to the site when the main road is unavailable (DCPD)

**Cannot overstate the importance of having effective self-assessment and corrective action program**



# The accident at Fukushima provides important lessons learned

- Severe natural events are possible
  - U.S. west coast is likely underprepared for protecting coastal residents from tsunamis
  - The nuclear accident at Fukushima is an important contributor to the overall costs of the disaster
    - » Likely greater than \$100 billion from a total cost of ~\$300 billion
    - » But public health impact from accident is much smaller
- The most important lesson for managing beyond-design-basis events in existing infrastructure is to have planned ahead
- Some key remaining questions:
  - Ability to cope with multiple unit accidents
  - Clear line of command (less of an issue in the United States)
  - Mutual aid agreements



# Backup Slides



# Station Blackout: Assessing Coping Time

“The reactor core and associated coolant, control, and protection systems, including station batteries and any other necessary support systems, must provide sufficient capacity and capability to ensure that the core is cooled and appropriate containment integrity is maintained in the event of a station blackout for the specified duration.”

Based on four factors:

1. The redundancy of the onsite emergency ac power sources;
2. The reliability of the onsite emergency ac power sources;
3. The expected frequency of loss of offsite power; and
4. The probable time needed to restore offsite power.

*In summary, the US NRC evaluates the overall design of onsite and offsite electrical system reliability and determines an appropriate coping time*

*- Coping time varies from plant to plant and can range from 4 to 36 hours*

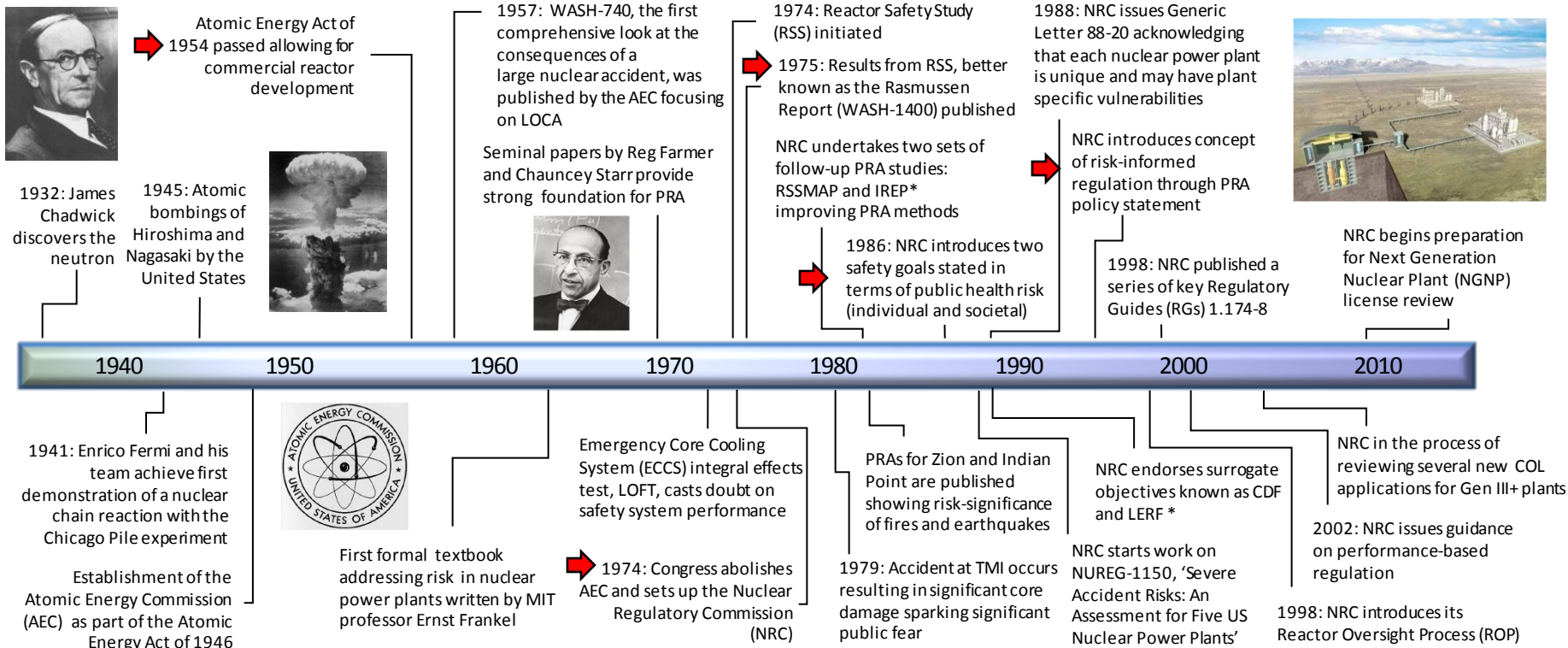


## February 2002 USNRC Order: Section B.5.b

- Following 9/11, USNRC developed strategies that required plant licensees to “maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with loss of large areas of the plant due to explosions or fire”
- Originally intended for coping with fires and explosions, NRC contends strategies would help protect against natural hazards such as severe earthquakes and floods
- USNRC will review adequacy of B.5.b strategies for dealing with non-security severe events by end of 90-day review



# History of PRA in the nuclear industry



RSSMAP = Reactor Safety Study Methodology Application Program  
IREP = Interim Reliability Evaluation Program

CDF = Core Damage Frequency  
LERF = Large Early Release Frequency



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