

How did Individual and Organizational Use of Probability and Risk Assessment at TEPCO Contribute to the Fukushima Accident?

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Overview

- * TEPCO experts postulated the tsunami
- * Results were shared with corporate and site managers
- * Results were shared with regulator and industry experts
- * Limited action resulted

Presentation Outline

- *Background of tsunami design basis and expert's calculations
- *How probability and risk factored in to actions taken
- *Enterprise Risk assessment
- *Lessons Learned

Background



- * Tsunami design basis was reevaluated at least five times
- * Actions were taken twice to modify the plant

Tsunami Design Basis



- * Initial design basis was sea level + 3.1M – 1960 Chilean earthquake and tsunami
- * In 2002, increased to sea level + 5.7M
- * In 2009, increased to sea level + 6.1M
- * Seawater pumps were raised in response to both increases
- * Note: Units 1 – 4 site grade is sea level + 10M

Postulated Tsunami

- * Japan Society of Civil Engineers (JSCE) standards
- * Academic study of AD 869 Jogan earthquake and tsunami
- * Headquarters for Earthquake Research Promotion (HERP) predicted a magnitude 8.2 quake anywhere along the east coast Japanese Trench
- * TEPCO experts, in 2008, postulated a 9M tsunami (using Jogan study and a magnitude 8.4 quake)
- * They also postulated a 15.7M tsunami (using the tsunami wave model from a 1896 magnitude 8.3 quake)

Shared Results

- * Corporate executives
- * Site leaders
- * Nuclear and Industry Safety Agency (NISA) in Sept 2009 and March 2011
- * Asked JSCE to review tsunami wave model from the Jogan study

Geological Studies

- * Core borings at five locations in 2009 and 2010
- * Three sites, no tsunami deposits were found
- * One site, 0.5M tsunami from Jogan earthquake
- * Remaining site, 3-4M tsunami was confirmed
- * Area and site topography not susceptible to tsunamis
- * No tsunami stones in the area

TEPCO Actions

- * Geological studies were completed
- * Calculations were shared with regulator and industry experts
- * Recognized potential damage to sea water pumps
- * Formed a countermeasures group in 2010
- * Did not recognize potential damage to plant, no walk downs were performed
- * Enterprise risk assessment focused on lost generation
- * WANO flooding SOER was deemed not applicable

Probability

- * Calculations were viewed as very conservative
- * Hypothetical in nature
- * Geological data did not support calculations
- * More review was required
- * Larger concern was the potential for a large earthquake and tsunami off the coast of Tokyo

Earthquake March 11, 2011

- * Larger magnitude, 9.0, and more fault lines and source area, and difference location than assumed in calculations
- * Forty-one minutes later, a series of tsunamis approximately 15M high
- * Destroyed sea water pumps, various tanks & facilities, and flooded reactor & turbine buildings thru open doors & ventilation louvers
- * Total loss of AC and DC power to units 1-5 (unit 3 retained limited DC)

Tsunami Inundation



Lesson Learned

An organizational culture is needed that:

- * Accepts an extreme external event can occur and rigorous preparations must be made
- * Promptly assess current capabilities to mitigate an event when new information is received that challenges current design assumptions
- * Reviews risk and possible consequences of changes in design bases assumptions