

NPRE 457: HW 41

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1 Fukushima Summary

Japan got hit with an earthquake of magnitude 8.9-9.0 on the Richter scale. This earthquake had a magnitude 2.5 times higher and 15 times as energetic as the earthquake the plant was designed against. The accident began with a the earthquake, which caused a Station Blackout. There was a transformer station 10 km from the plant that was destroyed causing all off-site power to be lost from the plant. In addition to loss of off-site power, the earthquake caused a tsunami that flooded the basement of the station. The basement of the plant was flooded because the seawall built to prevent tsunamis from reaching the station was shorter than the manufacturer specified to save on costs. The low seawall let the tsunami waters flood into the containment building basement, which caused all the feed-water pumps and the backup diesel generators to flood. The flooding of the backup generates with the loss of off-site power from earlier left the station in a total station blackout. After power was lost, the plant workers began to do whatever they could to prevent the cores from melting down – they used a naval vessel to pump water into the cores, they hooked up their car batteries to the control station, and they waded through radioactive water to connect electrical cables. However, this was in vain as three units of the reactor experienced hydrogen buildup that resulted in an explosion.

2 Reactor Accident and Characteristic Matching

Accident	Characteristic
Fukushima	Equipment Flooding
Chernobyl	Positive Power Reactivity Coefficient
Three Mile Island	Small Break LOCA
SL-1	Steam Explosion
Browns Ferry	Insulator Fire
Windscale, Sellafield	Wigner Energy Annealing
Fermi-1	Flow Blockage

3 The Flooding of Fukushima and Fort Calhoun

The flooding that affected Fukushima and Fort Calhoun were both relatively extreme events. However, the tsunami at Fukushima was substantially more destructive and absolutely extreme compared to the Missouri River flooding. Overall, both plants were surrounded with water, but Fukushima also experienced a total station blackout.

4 Fukushima Reactor Unit Analysis

Unit	Event	Time	Observation
1	The flooding reached the basement and disabled the electrical supplies. The cooling system for Unit 1 was unable to start. After the 55% of the core melted down, the operators vented the containment structure and caused a hydrogen explosion.	Saturday, March 12, 3:36 PM	At the same time as the explosion, a white smoke was observed over the plant.
2	The decay-heat removal ran on batter power for 24 hours until the batteries providing power were depleted. After the decay heat was not removed, the unit experienced a 35% partial core meltdown. This meltdown caused a hydrogen explosion.	Tuesday, March 15, 6:10 AM	The pressure of the vessel was lowered after a steam release. The effective dosages of 20-30 cSv/hr in the Unit 2 water.
3	The decay-heat removal ran on batter power for 24 hours until the batteries providing power were depleted. After the decay heat was not removed, the unit experienced a 30% partial core meltdown. This meltdown caused a hydrogen explosion. Three plant workers connected an electrical cable to a pump in the basement of the turbine building and waded through radioactive water.	Monday, March 14, 11:01 AM	The containment vessel may have been damaged. Also, there was likely a coolant pipe was damaged in the earthquake.
4	The reactor was shut down for a routine maintenance before the accident and all active fuel was transferred to a spent fuel storage pool. An explosion and fire damaged the building the fuel was in. The fuel storage may have gone partially dry.	Tuesday, March 15, 9:38 AM	Initially, there were no observed reactor coolant leaks inside the reactor.