

Advisor

Earthquake Impact on Japan's Nuclear Plants



In response to the magnitude 9.0 earthquake just offshore Japan's northeastern coast, eleven reactors at four sites in closest proximity were automatically or manually shut down per seismic emergency procedures.

A fire was detected at the Onagawa plant following its shutdown, but was extinguished in short order and did not involve the plant's reactor containment structure.

Five reactors at two sites in the Fukushima prefecture have declared emergencies due to loss of normal site power and backup emergency power. The emergency diesel generators that would normally power plant cooling and circulating equipment in the event of an offsite power outage have failed soon after initial operation due to tsunami flooding, and backup batteries were only temporarily able to keep pace with the post shutdown heat rate of the reactors. The Japanese government has declared a state of emergency and ordered the evacuation of all residents living within a twenty kilometer radius of plant 1 (Daiichi) and a ten kilometer radius of plant 2 (Daini) – though these largely overlap as the plants are within 11 km of each other. It is also distributing iodine tablets to persons in the vicinity. Iodine blocks the absorption of radioactive elements by the thyroid, and thus help prevent certain long term health effects. Both Fukushima facilities are operated by Tokyo Electric and Power Company (TEPCO).

At the Fukushima Daiichi plant in unit one – the oldest (1971) and smallest (450 MWe) unit – caused the most immediate alarm due to fast rising temperature and pressure. The Japanese Nuclear Safety Agency authorized steam to be manually vented to atmosphere through a specialized filter to relieve pressure that might otherwise have caused structural damage to the containment vessel. Hydrogen created by the reaction of water with high temperature fuel

element zirconium cladding was vented along with this steam, and an explosion ensued, injuring three workers who have since been evacuated. Government reports state that the steel liner was not damaged, and that plant personnel have begun the process of filling the containment vessel with borated seawater to maintain cooling. The boron acts as a neutron absorber and can slow any remaining nuclear reaction. A TEPCO spokesman has reported that regulators and plant operators are assuming that some core damage has taken place, as exterior monitors have detected trace amounts of Cesium. The amount of radioactivity released is believed to be modest and the prevailing winds have carried steam releases toward the sea to this point.

There was an explosion at Unit 3 at site 1 (Daiichi) – (a 746 Mw BWR commissioned in 1976) on Monday after possible fuel damage in this reactor as well. The larger megawatt size and the presence of Mixed Oxide (MOX) Fuel increases the potential radiological impact of this reactor incident. MOX fuel was developed as a means of converting post cold war stores of plutonium into useful reactor fuel – thus reducing the world's stockpile of weapons grade material. Venting was taking place in a controlled manner to reduce containment pressure, but hydrogen from the same zirconium reaction caused an explosion similar to that at unit one. Government reports state that this reactor containment vessel is also now being filled with seawater.



At the nearby Fukushima 2 (Daini) plant, three reactor units shut down by the earthquake have also lost emergency power and declared emergencies. TEPCO has stated in a press release that it has been authorized to conduct pressure releases (venting) as needed to prevent containment breaches. Emergency mobile diesel generators have been delivered to both sites to provide limited power restoration, but earthquake damage has created challenges in providing backup power.

One news agency reported that the cooling system has failed at the Tokai No. 2 Power station, an 1100 MWe BWR that was commissioned as Japan's first large scale power plant in 1973. Unlike the other reactors, Tokai 2 is operated by Japan Atomic Power Company and is located in the Ibaraki Prefecture (approximately 75 miles from Tokyo). Later news reports claim a diesel generator has been restored to service at this facility and is providing adequate power for reactor cooling.

Evacuees are being monitored for the presence of contamination (discrete radioactive particles on clothing or skin) and a number have been identified for decontamination. When needed, this is accomplished with sponges, soap and water. The Japanese media have reported that three operators at the Fukushima Daiichi plant have signs of radiation sickness – possibly

those who were charged with manually opening vent valves in the absence of an electrical power supply.

The nuclear plants affected by the earthquake represent 18% of Japan's electricity producing capacity, and it is likely that recovery will be a lengthy process. Units 1 and 3 at Daiichi will be total losses due to the use of seawater for cooling and the likelihood that fuel elements have sustained damage. If damage can be contained, they will likely be placed into SAFSTOR mode as is the case with Three Mile Island unit 2, and decommissioned well into the future in concert with the remaining site units. It should be noted that it required ten years and over \$1 billion to take this unit from post accident state to SAFSTOR status. In any event, all eleven reactors affected face a long road back to service. Reactors damaged in the last Japanese earthquake were taken offline for a protracted period to allow detailed mechanical testing and inspections.

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