

Nuclear Power, Earthquakes, and HT³R

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Japan Earthquake/Tsunami

A series of large earthquakes have recently occurred off the northeast coast of Japan along the so-called “ring of fire.” The earthquakes caused no damage to Japan’s nuclear reactors as they automatically shut down as designed. At that point electrical power generators started operating emergency cooling pumps to maintain the reactor core temperature at safe levels. However, less than an hour later, an ensuing tsunami (that was twice the designed “worst case” height of 5 meters) struck the same region and knocked out all emergency electrical power generators for the cooling pumps of three reactors operating at Fukushima Daiichi, leaving only batteries (rated for an 8-hour life) to maintain safe shutdown conditions. However, as these batteries ran out of power, their ability to adequately cool the reactors declined. The reactors then suffered serious damage through extreme overheating and hydrogen explosions which led to the subsequent release of radiation.

The precise nature of the problems that have occurred in Japan over the past few days since the earthquake, and subsequent tsunami, will not be known for some time due to the confusion on the ground that is present in most such catastrophic events. However, we do know 1) the situation at the Fukushima-Daiichi reactor site is extremely serious and 2) these reactors are near the epicenter of the major earthquake that occurred on March 11, 2011. When this event is concluded, the world-wide nuclear industry will most certainly incorporate the “lessons learned” into new reactor designs and operating procedures.

If we look back to the accident at Three Mile Island (TMI) there was also an apparent lack of transparency and unreliable information primarily because of inadequate instrumentation. However, in the end, the conservative containment design at TMI worked. If someone were standing at the “fence” of the facility when the accident occurred, they would have received a **smaller radiation dose** than if they were standing next to the United Nations building in New York City (because it is made of granite which contains a naturally occurring and slightly radioactive isotope of Potassium). However, it is never good to have accidents!

The Japanese government and nuclear industry have continued to make official information releases to the international community every since the tsunami/earthquake occurred. Their transparency has dramatically improved the situation compared to Three-Mile Island. The international (including the US) nuclear industry is supporting Japan as they work through all the technical issues resulting from this devastating event.

It is internationally accepted that the United States Nuclear Regulatory Commission (NRC) remains the “gold standard” of the world in regulating nuclear energy. And in fact, the NRC has

seismic standards for reactors in California that exceed the effects of the recent gigantic earthquake off the coast of Japan. Further, new earthquake data is periodically reviewed by the NRC to ensure continued safety in the US. However, the failures in Japan are directly attributable to their tsunami design standards which may not be as severe in the US because most major faults on the west coast are beneath land rather than the ocean (and tsunamis are generally caused by violent upward shift of geological formations beneath the ocean).

How about the HT³R?

In the shadow of this tragedy, one important passively safe nuclear reactor design needs to be moved to the forefront of future nuclear power reactor options: the high-temperature gas-cooled reactor (HTGR) like that planned for the HT³R (High-Temperature Teaching and Test Reactor) facility. This HT³R facility is being proposed by the University of Texas of the Permian Basin and Los Alamos National Laboratory, to be located near Andrews, Texas as a prototypical “test and qualification” reactor for this nuclear reactor technology. It would provide design data needed to help usher in this advanced concept.

Since before 2000, China (HTR-10), Japan (HTTR), and others have been exploring HTGR nuclear reactors that are designed to operate at high temperatures (up to 1500° F) and are cooled by an inert gas (Helium) that cannot decompose like superheated water in the presence of zirconium to create explosive concentrations of hydrogen. These HTGR’s are much more tolerant of high temperatures and are classified as “passively safe” by the industry because they do not require “active systems or human intervention” to safely shut down if they overheat. Rather, they automatically shut down and conduct away the remaining heat without damage to the reactor. Further, the maximum temperature the reactor core could reach is several hundred degrees lower than any temperature that would damage the reactor or fuel components.