

Where the fault lies

Earthquakes have been around a lot longer than nuclear reactors. **Laurie Wiegler** asks if they can ever be a safe mix



On 11 March a subduction zone earthquake of magnitude 9.0 rocked Japan, with huge aftershocks rippling through the northeastern segment of the country. Even a month later, one scientist just south of Tokyo told *tce* that aftershocks occurred every two hours or so.

Of the tidal wave that followed, the US National Oceanic and Atmospheric Administration's (NOAA's) tsunami modeling team estimated the wave height to have been approximately 8 m at *Fukushima Daiichi* and roughly 7 m at *Fukushima Daiini*.

Could such a large quake and/or tsunami happen elsewhere in the world? And, if so, are the world's nuclear reactors – such as those in the UK, France, India and the US – prepared to take the hit? The answer is... yes and no.

According to the US Nuclear Regulatory Commission (NRC), the quake that rocked Japan is particular to that region of the world. As a subduction zone quake, a tectonic plate was literally shoved underneath another plate – much like one pushes a dinner plate underneath the top plate in a stack. These types of earthquakes are also required to produce the kind of massive tsunami seen in Japan, the NRC reported on 19 March.

The United Nations Office for the Coordination of Humanitarian Affairs* published a paper with map in 2007 that details the history of seismic activity around Asia. The UN states that 90% of all the world's earthquakes occur in the area called the Pacific Ring of Fire, which grazes Japan before jutting down to Papua New Guinea and the Solomon Islands. The 'ring' is a consequence of plate tectonics and collisions of crustal plates.

on shaky ground?

Yet the Pacific isn't the only problematic seismic area. In view of the Japan earthquake and tsunami, most countries are rethinking the locations of their nuclear plants, even if the integrity of reactors and their cores may be sound. Of particular concern is a reactor that lies on or near a highly seismic area.

On its website the NRC shows that in the US the most vulnerable nuclear plant is not Diablo Canyon or San Onofre in California – areas commonly considered highly seismic – but in Richmond, Washington, at Energy Northwest's Columbia generating station. Even here, the NRC asserts, there isn't nearly the type of danger as exists in the aforementioned area of Japan. Simply, although it is the only US nuclear plant near the country's most worrisome seismic area, where the Juan de Fuca plate meets the Pacific plate in the Cascadia subduction zone, it sits a fairly safe 362 km from the coast.

Further, ground motions estimated at the plant are far lower than those seen at Fukushima, "so the distance precludes the possibility of a tsunami affecting the plant," according to the NRC.

The US regulator has its detractors, though, especially when it comes to trusting information around plant renewal time. The nuclear business is a profitable one and plant owners make a good case for renewals, even buying up ad space in newspapers and launching major public-relations campaigns.

However, because of the industry's current spotlight on earthquakes, it's becoming good politics at the very least to appease a worried public. For example, German Chancellor Andrea Merkel famously ordered the shuttering of the country's seven oldest reactors, all of which were built before 1980.



The Fukushima Daiichi plant in better days

a 'fateful day' for nuclear power

Indeed, according to Paul Norman, a nuclear professor from the University of Birmingham, UK, Germany's response was nothing more than politics... a 'knee-jerk' reaction.

"It was very interesting - I feel almost like the sort of Jonah bad-luck-type person, [because] I was actually out there in Germany at the time, at a German university, on the day they shut them all down. It was a fateful day for nuclear power," said Norman.

He said the older German nuclear plants are shut down pending a review. "What will happen following that we don't really know."

Of course, the Sendai quake and tsunami could not have come at a worse time for proponents of nuclear energy.

For example, while the US has 104 operating nuclear reactors - a number that hasn't budged since *tce* reported on a so-called 'nuclear renaissance' in America back in 2009 - American sentiment is notoriously divided when it comes to nuclear power. The liberal Greenpeace environmental group is only one among many activist organisations fighting nuclear industry inroads in the US just as conservatives and many scientifically minded liberals support a nuclear programme.

Other countries also have their doubts but Japan isn't yet prepared to scrap nuclear power - at least according to one Japanese scientist residing south of Tokyo, who asked to remain anonymous. He said the Fukushima Daiichi and Daiini lapses caused caution in some, but so far it's impractical to completely give up the notion of nuclear power.

"On Twitter, about 50% of people are still in support of nuclear power, which is quite surprising in light of the situation," he said.

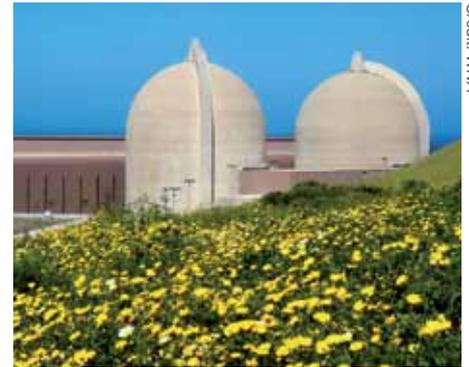
"I think one reason people continue their support is the problem we had up until about two weeks ago in the metropolitan area, where there were long periods of continuous blackouts. The fear of radioactivity is not visible, but the fear of losing electricity for three hours is quite visible and affects our lives," he added.

India is also more likely to worry about keeping the lights on than extinguishing its nuclear plants, even Nomura, which lies the closest to a fault line along the Indo-Chinese plate. The region is historically shaky - after all, the Himalayas were formed 70m years ago when the Arabian plate collided with the Eurasian plate, just north of India.

Technical writer Sachi Mohanty, of Gargaon, India, said: "The power cuts that happened in post-tsunami Tokyo are a daily and commonplace occurrence in India and aren't newsworthy. In fact, just today (21 April), the leading English newspaper, *Times of India*, had a report about how this summer has been less fierce than the last. This means



Chubu Electric Power's Hamaoka nuclear power plant, Japan



Diablo Canyon nuclear reactor at Avila Beach in San Luis Obispo, California

lower demand for air conditioners. Since the demand for power has been less than expected, the power cuts too have been less than expected."

Even so, Mohanty said that every office and some homes in India come equipped with a back-up power generator.

"And the generator is not meant for use in some sort of a once-in-a-lifetime emergency. The generator is the lifeline without which companies would be unable to function. India cannot afford to indulge in academic debates about the problems related to the long-term storage of nuclear waste."

manufacturers, spent-fuel pools at fault?

With so many countries such as India and Japan just scrambling to keep the power on, a partial reliance on nuclear power is not surprising, even in the shakiest of locations. But since part of that reliance has meant trusting the suppliers and manufacturers tasked with keeping a Fukushima Daiichi or Daiini or a Hamaoka humming - even if the country's primary energy comes from oil; or as in the case of Japan, largely gas and coal - the relationship can be shakier than the region.

GE Hitachi Nuclear Energy supplied most of the boiling-water reactors (BWRs) to Fukushima at graduated intervals, beginning approximately 40 years ago with a Mark 1 containment system, in an age that has been widely criticised in light of the explosions following the tsunami. Fukushima Daiichi 6 is relatively young, and was provided a Mark 2 containment system before it started operation in 1979. The boiling-water technology was even designed by GE along with the Idaho National Laboratory back in the mid-1950s, and is now the second-most popular type of nuclear reactor after the pressurised-water reactor.

A spokesperson for the UK-based World Nuclear Association (WNA), Ian Hore-Lacy, who pointed out that at least five of the six

Fukushima units were designed in the 1960s, said that any criticism of these BWRs of GE's at Fukushima is "unjustified."

Hore-Lacy defended the fact that a lot of other things that are still in use today were also designed several decades ago: "There are cars, planes, oil refineries, you name it, that are not up to today's standards. So I think that's a fairly unreasonable point to make against GE."

He said that the design of the reactors at Fukushima "is a good design by 1960s standards. They were built and they've held up well under the circumstances. Yes, a new reactor would be better, but that's true of any technology."

In the early 1980s, GE recommended seismic enhancements to the Mark 1 containment vessel, and while Tepco did not return *tce's* e-mail request for an interview, Hore-Lacy stands by US-based GE. "I don't have details on enhancements, but I understand by talking to GE people that possibly most of the recommendations were made."

Even so, there are other concerns related to the reactors. What troubles Lynn Sykes, Higgins professor emeritus at Lamont-Doherty Earth Observatory, Columbia University, is the location of the spent fuel in Japan.

"GE reactors - of which all those at Fukushima are of that design, as well as about one third of reactors in the US - have spent-fuel pools up at the top of the building. This is really dangerous if you need to pump water up there and you don't have water available."

A better nuclear-plant model includes a pressurised-water reactor (PWR), according to Sykes, because this provides for spent-fuel pools at the ground level. He says these are "far safer" and are exemplified by the Westinghouse type. However, some PWRs do store the spent fuel in an auxiliary building. In the US, all spent fuel is stored on site - largely because volatile and opposing political forces have kept Yucca Mountain, Nevada, on hold.

“possibly a bigger role in assessing nuclear-reactor safety along fault lines or anywhere is how well managed the plant is”

cosy bedfellows

Yet, when it comes to concerns about nuclear-reactor safety, the mechanics are just one part of the equation. By some accounts, possibly a bigger role in assessing nuclear-reactor safety along fault lines or anywhere is how well managed the plant is, whether the government or the company has control, and how much the people can trust the information they are being fed.

It's not news anymore that Tepco and the Japanese government were cosy, at least prior to the quake and tsunami. Since 11 March, though, Tepco has drawn fire and ire for obfuscating the facts and being slow to even release muddy information.

The aforementioned scientist outside Tokyo said: “Tepco has a long history of being quite secret about the information [regarding their reactors' safety] and I don't think it was disclosing as much information as necessary. One of the most visible [bits of] evidence pointing to the fact that the company is being secret is that it is showing the pictures of the broken reactors on the English website, but not on the Japanese website!

“So most of the data that should be released is only shown on the international website,” the source said. “And most Japanese people are not very fluent in English.”

But is the nuclear industry in control elsewhere around the globe, particularly where faults lie? It certainly isn't in the US, where the NRC is tasked with citing failures of companies such as PG&E or Entergy to properly inspect their plants. The NRC, in its reading room online, gives clear updates on inspections of its 104 plants. They are rated in severity according to colour.

overreaction to reactors?

The NRC doesn't publish all the information it has, though, so journalists must formally request more classified documents via the Freedom of Information Act in order to tease out the less-than-favourable aspects of an NRC report.

Bad press has centered around Buchanon, New York's Indian Point nuclear plant. Since the Japan quake, New York media especially have swarmed around a story that some say



Some of the damage caused by the tsunami at the Fukushima Daiichi nuclear power station

has been hyped, even though at least one very vocal scientist disagrees.

Indian Point, which lies north of Manhattan along the Hudson River in an area more known for snowstorms than earthquakes, has two fault lines actually running underneath it – fault lines only discovered years after the plant was erected. Since the plant lies so close to a dense metropolitan area, the danger is obvious, or so goes the logic.

Sykes told *tce* that “the plan for Indian Point 1 was made in the late 1950s and the earthquake assessment was one page. It was a person [spending an] afternoon of consulting who said: ‘This is a quiet area; it's not like California, Alaska and Japan.’ And that's true – but Indian Point (reactors) 1, 2 and 3 were not built to withstand very large earthquakes. They were built nominally for quakes of about 5.2.”

Of course, Indian Point is defended by the energy company that owns the operating reactors there. Numbers 2 and 3 are owned by Entergy while reactor 1 was shuttered in 1974 by its owner at the time, Consolidated Edison, after the water-cooling system on this PWR failed.

“In fact, Indian Point (both units) is designed to withstand an earthquake 100 times greater than the largest ever recorded in the area,” Entergy spokesperson James Steets told *tce*.

Further defending Indian Point is the WNA's Hore-Lacy, who said that all the Indian Point bashing is a lot of “hype.”

regulation matters

Norman points out that reactors along fault lines, like all nuclear reactors, have to be approved by the regulator. “The regulator would take into account the specific location and likely worst-case scenario in terms of

how big a quake you would get. That differs at different locations around the globe.”

Currently, the US NRC is making a very public case for its thoroughness in inspecting reactors and, as of 25 April, the International Atomic Energy Association (IAEA) is posting near-daily updates on its oversight of the world's reactors. *tce*

As tce was going to press, the NRC issued a very rare red safety citation against nuclear plant Browns Ferry, near Athens, Alabama. The citation was issued for problems with its emergency cooling system. Plants included in this article have been issued with green and yellow citations.

Laurie Wiegler (lauriewiegler@aol.com) is a freelance science reporter

further reading

*Map of tectonic plates and faults in Asia Pacific: www.swccd.edu/~lltr/Lshare/esl/Yamamoto/ESL295-%20FA09/S&R/History/OCHA_ROAP_Tectonics_v3_070615.pdf

WNA white paper on nuclear power plants and earthquakes:

www.world-nuclear.org/info/inf18.html

Map of US nuclear reactor sites:

www.nrc.gov/reactors/operating/map-power-reactors.html

other reading

www.nrc.gov/NRR/OVERSIGHT/ASSESS/pim_summary.html

www.euronuclear.org/info/encyclopedia/n/nuclear-power-plant-world-wide.htm

www.nrc.gov/japan/faqs-related-to-japan.pdf

www.westinghousenuclear.com/news_room/nuclear_terminology.shtml