Nukequake: The Columbia Generating Station Is a Seismic Timebomb

By Gar Smith, June 18, 2014

The landscape in eastern Washington State is deceptively tranquil — a rural pastiche of vineyards, farms, scrub grass, ridges and windmills. But what appears peaceful and settled in the moment, has proven restive and violent over geologic time. Beneath the glacial trough of the Puget Lowland, and extending east through the Cascades to the Columbia Basin, lies a hidden landscape of geomorphic rubble — broken basalt, vast shards of continental rock, volcanic ash, and layers of ancient sediment.

Part of the sprawling Hanford complex along the Columbia River.

Like a picnic blanket spread over a minefield, the Columbia Basin's flat meadows and rolling hills veil an oft-times explosive past. Much of this geological record was buried beneath an epochal slurry of soil released when a massive ice dam repeatedly burst from 1,000,000 to 13,000 years ago. More than 40 great Missoula Floods have inundated this region.

By the time the first white pioneers rolled into the territory that was to become Washington State, there was little evidence to suggest the record of turmoil buried deep beneath the soil. The first non-native settlers to arrive in southeastern Washington's Pasco Basin encountered a seemingly tranquil vista of grass-fringed hillocks framing the region's valleys. They gave these landmarks colorful names — Rattlesnake Ridge, Saddle Mountain, Horse Heaven Hills. The first geologists (who arrived much later) initially assumed the rills and ridges were relatively benign — home to little more than shallow faults that posed no great hazard to the farmers and ranchers who came to populate the area.

From the air, however, planes equipped with remote-sensing LIDAR (Light Detection And Ranging systems that use laser range finders to scan the ground surface) would eventually reveal a series of previously unrecognized fault scarps associated with the east-west linear ridges now known as the Yakima Fold and Thrust Belt (YFTB). And there were other clues: strikingly dissimilar kinds of rock cohabiting on adjacent sides of an exposed scarp; deposits of “colluvium,” layers of soil turned topsy-turvy by ancient tremors.

Then there was the mystery of the region’s roads. In 1979, geologists began to notice that the highways crossing Oregon and Washington State were rising ominously — at the rate of one to two millimeters per year.

Not the best place, you might think, to build a nuclear power plant.

The History of the WPPSS reactor

The Columbia Generation Station (CGS), Washington’s only remaining commercial reactor, sits inside the Department of Energy’s Hanford Nuclear Reservation, a former nuclear weapons production site that spreads over 586 square miles. The CGS facility, which extends over 1,089 acres (1.7 square miles), is the sole survivor of a planned five-reactor complex proposed by the Washington Public Power Supply System (WPPSS). Powered by a General Electric Mark II boiling water reactor, CGS (originally dubbed the Washington Nuclear Power Unit 2, or WNP-2) began operating in December 1984, a mere 15 miles north of Richland, Washington.

Top Ten Reasons the CGS Should Be Shut Down

To recap: Terry L. Tolan's update of new seismic data, based on a survey of 30 years of research, reveals:

1) The epicenter of the region's largest historic earthquake was erroneously placed 180 miles from the CGS nuclear plant when the epicenter actually was 99 miles from the reactor site;

2) While six major faultlines were identified prior to the design and construction of the CGS plant, the region is now known to contain 12 major faults;

3) The closest of these active faults runs a mere 2.3 miles from the CGS nuclear plant;

4) New ground motion studies for the DOE's Waste Treatment Plant found a potential for ground motion forces more than double what the CGS nuclear plant was designed to withstand;

5) Local faults have turned out to be much longer than previously known — increasing the potential for more powerful earthquakes;

6) Faults previously thought to be "uncoupled" now are believed to be connected--thereby increasing the potential for larger earthquakes;

7) The faults are now known to be "younger" — indicating more recent and frequently occurring earthquakes;

8) Some of the faulting extends more than 10 miles deep, into the basement rock below basalt layers--which can greatly increase the force of large quakes;

9) Surface faulting on Umtanum Ridge, which extends within 6.2 miles of the nuclear plant, shows signs of more recent activity than previously suspected — increasing the likelihood of earthquakes; and finally,

10) Energy Northwest's 2010 updated "hazards report" to the NRC failed to acknowledge any of the concerns cited above.

Projected to open in five years at a cost of just under $400 million, construction actually took more than 12 years and racked up a total cost of around $3.2 billion. When the reactor finally started churning out power, its electricity was priced at 6.2 cents per kWh — triple the preferred rate for the average Bonneville Power Authority utility. (From 2000 to 2010 CGS reactor provided just five percent of the Pacific Northwest's electricity. In 2011, it provided even less, owing to a six-month shutdown for repairs. By 2013, CGS's contribution to the power grid of the entire Pacific Northwest region had declined to just 3.9%. Meanwhile, the market price of electricity in the Pacific Northwest has fallen to the point that the CGS reactor no longer produces power at a profit — a fact that bolsters the call for closing the reactor and replacing the lost power with electricity from renewable energy installations). In December 2013, Robert McCullough, a leading utility consultant, released an extensive report on the reactor's economics. McCullough's investigation showed that it cost $418 million to operate the reactor while the plant produced only $218 million worth of market-rate power.

The fact that only one reactor was actually built suggests why the power system's initials came to be pronounced "Whoops." After WPPSS declared bankruptcy and defaulted on its bonds during a $2 billion financial meltdown (at the time, the largest municipal bond default in US history), "Whoops" was enshrined as an official entry in the Barron's Financial Dictionary. On November 19, 1998, an understandably embarrassed WPPSS Executive Board voted for a name-change, rebranding its operation as "Energy Northwest." CEO Vic Parrish rushed to assure a skeptical public that: "We are not trying to run from our past, but run toward our future." Either way, a troubled history and a questionable future clearly had the company's management on the run.

In 2009, eleven years after its name-change, the industry-funded Institute of Nuclear Power Operations ranked CGS as one of the country's two reactors "most in need of improvement." Out of the 75 unplanned shutdowns (or "scrams") that hobbled the US commercial nuclear fleet that year, CGS accounted for five. Even Brad Sawatzke, Energy Northwest's Chief Nuclear Officer, was forced to concede, in an April 29, 2011 interview with a Seattle TV station, that "our one Northwest nuclear reactor has the worst shut down history in the country." But, he hastened to add, "most [of the scrams were]… associated with the turbine side of the house and not nuclear."

Of course, whenever a turbine fails, the entire nuclear plant stops generating electricity and becomes an economic liability. No surprise then, that Energy Northwest's initial 2013 draft ten year budget included funds for a new turbine and a new steam generator. However, in an apparent move to keep costs down, Energy Northwest removed those costly purchases and others, $150 million in all, from its printed budget. As a result, the current budget lacks funds to replace these two critical pieces of equipment.

Quake and Break

Today, the Columbia Generating Station has become the focus of a growing national debate over the safety of nuclear reactors built in seismic trouble spots. The published studies of seismic lore available to the engineers who designed the WNP-2 only ran from 1974 to 1981. It wasn't until after construction of the 1,170-Mw atomic reactor was completed that a new generation of geologists began to uncover the region's uncharted seismic history.

One sign that this might not have been the perfect spot for a nuclear power plant came in the very first stages of construction. As Energy Northwest explained in a September 2013 press release: “Columbia’s built-in safety margin began with preparation of the new construction site in the 1970s. The soil at the site was removed to a depth of 65 feet and replaced with structural backfill soil — soil specially engineered… to meet stringent density requirements.”

In this same press release, Energy Northwest misinformed the public about what really occurred when three GE-designed Mark I reactors melted down at the nuclear power complex in Fukushima, Japan. While Fukushima’s reactors “safely survived the March 11, 2011 earthquake,” the company writes, “the facilities were not designed to withstand the effects of the tsunami.” In fact, the earthquake knocked out the outside power needed to keep the reactors from melting down. Without off-site power, emergency batteries can only run the cooling systems protecting the reactors and radioactive waste storage pools for a matter of hours.

In addition, earthquake-caused damage to piping and other critical safety systems at Fukushima Daiichi Unit 1 may very well have triggered the first meltdown, even before the tsunami hit. On May 15, 2011, the Tokyo Electric Power Company (TEPCO, the plant’s operator) quietly conceded there might have been some pre-tsunami quake damage to key facilities and critical pipes.

In his 2007 book, *TEPCO: The Dark Empire*, Katsunobu Onda both predicted and explained the mindset behind the official post-meltdown evasions of 2011: “If TEPCO and the government of Japan admit an earthquake can do direct damage to the reactor, this raises suspicions about the safety of every reactor they run.” This kind of industrial/political collusion should concern everyone living in the Pacific Northwest for the simple reason that the CGS Mark II reactor was designed by General Electric, the same company that designed and built the Fukushima Daiichi reactors. Fukushima’s Unit-6 building houses a GE Mark II reactor, a BRW-5 design that began operating in 1979. The US Nuclear Regulatory Commission has determined that the Mark II containment is subject to the same danger of catastrophic hydrogen explosions that occurred with the Mark I reactors at Fukushima. (On September 20, 2013, Japan’s Prime Minister Shinzo Abe ordered TEPCO to decommission the Mark II reactor.)

Faulty Assumptions

The classic caveat for great undertakings has long been: “Don’t build your castles on sand.” The modern equivalent of this warning could well be: “Don’t build atomic reactors in earthquake zones.”

When the CGS reactor was originally designed, geologists thought earthquakes were largely consigned to the sea-facing portion of Washington, west of the Cascades. They believed the faults beneath the inland ridges of the Columbia Basin were inconsequential and “uncoupled” — short and shallow fractures that, because they were believed to be unconnected, posed little in the way of risk. It wasn’t until the 1980s that geologists (and the public) began to get a glimpse of the extent of the dangers buried beneath their feet.

An additional wake-up call occurred in 2009 when a swarm of more than 1,000 quakes shook the eastern half of the sprawling Hanford Nuclear Reservation — a complex dotted with radioactive waste storage tanks. While the Hanford quakes were no larger than magnitude 3.3, they struck close to the surface and produced a significant peak ground motion. This activity suggested that the nearby Yakima Ridge Fault actually extended into the Hanford Reservation all the way to the Wooded Island in the Columbia River — a finding that raised concerns about the safety of the CGS reactor, as well.

When CGS was designed, geologists were only aware of six local faults — Umtanum Ridge-Gable Mountain, Rattlesnake Ridge-Wallula Alignment, Horse Heaven Hills, Rattlesnake Hills, Yakima Ridge, and Saddle Mountain. After the nuclear reactor was constructed, another half-dozen faults were identified — Frenchman Hills, Manastash Ridge, Toppenish Ridge, Columbia Hills, Hog Ranch-Naneum Ridge, and the Hite Fault. By 2011, three new faults east of the Cascades had been identified. All were assessed as “more active” than would previously have been expected. Casting a worried eye toward Hanford’s shuttered nuclear facilities and waste-storage tanks, seismologist Annie Kammerer observed: “Frankly, it is not a good story for us. The plants were more vulnerable than they realized.”

In 2013, the Washington and Oregon chapters of Physicians for Social Responsibility (PSR) hired geologist Terry L. Tolan to conduct a survey of the region’s seismic research. While geologists had become aware of several newly discovered faultlines, no one had considered how these findings might apply to the CGS reactor. Tolan’s review reiterated that the CGS site is surrounded by at least 12 significant faults that are more numerous, much longer, far deeper and potentially more destructive than anything imagined when the reactor was first designed. These known faults have the potential to rattle the reactor with forces double those the CGS reactor was designed to survive. Two faults identified after the CGS was built actually bracket the reactor to the north and south. The southern fault, identified by the recent earthquake swarm, runs within 2.3 miles of the nuclear core.

Most of the concern in Washington State, however, has concentrated on just three fault systems, some of which have importance in considering the risk to the CGS nuclear reactor.

The Yakima Fold and Thrust Belt.

This formation, located east of the Cascade Range, is part of a tectonic region that is far more seismically active and interconnected than once believed. The Yakima Fold courses through the sagebrush flats of central and eastern Washington, a stretch of territory that includes the Hanford Site. The Yakima Fold-Thrust Belt (YFTB) consists of a series of generally parallel ridges running west-to-east. The result of tectonic compression, each of these ridges is cored by a major fault system.

In the mid-2000s, the US Geological Survey (USGS) found historic evidence that the YFTB had produced at least seven magnitude-7 earthquakes that created ground motions exceeding the CGS reactor's design limits. Another troubling discovery: The Rattlesnake Hills-Rattlesnake Mountain structure has registered a significant surface rise — having moved upwards at a rate of 60 to 72.5 meters per millennium. (In more familiar terms, that would be around 197 to 238 feet per 1,000 years or about 20 to 24 feet every century.)

The Seattle Fault.

In 1999, USGS scientists Robert Bucknam and Brian Sherrod reported finding physical evidence that the 44-mile Seattle Fault that traverses metropolitan Seattle was still active. LIDAR mapping confirmed the existence of a Holocene-era fault scarp at the point where the Seattle Fault crosses Bainbridge Island.

A reverse fault beneath Seattle caused a major magnitude-7 earthquake between A.D. 900-930. Another quake along the reverse fault that projects through Tacoma, violently rearranged the ground surface between A.D. 770 and 1160.

Given this history, the Seattle Fault now is considered to pose a major seismic hazard to the city of Seattle. This shallow “thrust variety fault” is not a single crack but a series of eight fault strands that extend east and west over a five-mile path between downtown Seattle and Vashon Island. The Seattle Fault zone also contains three or more south-dipping thrust faults.

The South Whidbey Island Fault.

The region’s most dangerous surface fault is believed to be the South Whidbey Island Fault (SWIF). A USGS study revealed the fault’s hazards in the mid-1990s. Unlike most faultlines, which parallel coastlines and mountain ranges, the SWIF actually crosses southeast through the Cascade Range, reaching as far as the Tri-Cities in southeast Washington.

The SWIF initially was estimated to run 40 miles through the southern portion of Whidbey Island but the USGS has discovered that the SWIF actually is composed of a complex band of fractures extending 50 miles. With a greater fault track running 200 miles from Vancouver Island to the Cascade foothills, the SWIF is one of the largest fault systems in the region — second only to the offshore Cascadia fault in terms of size and risk. Geologists have uncovered evidence of four sizable shakes along the SWIF over the past 16,000 years. They set the most recent at around 2,700 years ago.

We now know that the Seattle Fault is not isolated. It is, in fact, part of the SWIF. Together, they form a system of faults that extends southeast across the Cascade Range and as far as the Hanford Reservation. A 2011 USGS report traced the Umtanum Ridge fault to the west and found that it extended through the Cascade Range and linked with the active Seattle and SWIF fracture zones in the Puget Sound area. The USGS research nearly doubled the length of the Umtanum fault — from around 77 miles to 124 miles. Evidence now suggests the faults and folds of the Umtanum Ridge extend northwestward through the Cascade Range where they merge with the Seattle and South Whidbey Island faults near Snoqualmie Pass — 22 miles east of Seattle.

“The faults don’t just end in Puget Sound,” USGS research geophysicist Rick Blakely noted. “Our hypothesis is that many big faults in Eastern Washington go through the Cascades.” Blakely’s research suggests that the active faults west of the Cascades actually extend 250 to 300 miles from the Olympic Peninsula and through the Cascade Range where they merge with the basalt formations of Eastern Washington, at least as far as Pasco — a town located about 20 miles southeast of the CGS reactor.

The discovery of “tectonic connections” between the seismically active Puget Lowlands and the basalt that underlies the Hanford Nuclear Reservation is alarming. As the Pacific Northwest National Laboratory (PNNL) noted in a 2012 report, larger faults can produce more slippage, which can generate larger quakes and more intense ground motion. PNNL emphasized that long faults — especially those with a longer “recurrence rate” — are an even greater threat since they can generate higher-magnitude seismic events “due to long-term build-up of stress.”

“What we’re dealing with is a system of faults that we think are linked,” says USGS geologist Brian Sherrod. “But if you have a fault system that’s 200 kilometers long and you rupture half or a third of it, that’s a big earthquake. That’s a magnitude 7.5.”
PNNL scientists have determined that tectonic stress on the YFTB is being released by geophysical rotation, folding, fracturing, and faulting. So far, thanks to a favorable alignment, the YFTB has been able to handle the offshore Cascadia Subduction Zone’s growing pressures as the submerged Juan de Fuca rock plate pushes its way beneath the continental plate at the rate of 1.6 inches per year. The relentless east-northeast pressure forces fractured elements of the Pacific Northwest lithosphere to slowly grind together and rotate in a clockwise direction. Imagine a massive shovel (the Juan de Fuca plate) being slowly rammed beneath a gargantuan 50-to-155-mile-thick paving stone (the North American plate).

There was another surprise awaiting the geologists. Contrary to long-held opinion, the faults beneath central Washington were not shallow. Instead, they were found to originate deep within the crust, extending more than 12 miles below the surface. “The faults that formed the ridges are much more dangerous than anyone realized,” Sherrod summarized. “It’s a fundamental rethinking of the seismic risk over there.”

The Seattle Fault, the SWIF and a Geological “Train Wreck”

Even without an earthquake, the Pacific Northwest is in constant motion, moving about half-inch per year. And, with every creeping millimeter of movement, the pressures continue to mount inside the offshore Cascadian Subduction Zone, the Seattle Fault, the Tacoma Fault, and the South Whidbey Island Fault. It is estimated that, since 1700, the Northwest coast has moved more than 25 feet closer to Japan.

USGS scientist Ray Wells has created an ingenious laminated map with movable sections that demonstrate how the puzzle-pieces of the region's geology engage in a vast and complex contest of slow-motion collisions. As Wells puts it: "It's a train wreck on a geological scale."

If it is a train wreck, then the "locomotive" would be the Pacific Plate, which continues to chug implacably northward at a rate of two inches per year, pulling much of California along for the ride. As California bumps into Oregon from the south, the Juan de Fuca Plate continues to ram into Oregon from the west as it dives eastward beneath North America. Rotating under strain and pushed northward, Oregon continues to press into Washington. Unfortunately Washington's northward progress is blocked by the unyielding bedrock that underlies inland British Columbia. Pushed from the south and blocked by the north, Wells explains, the Evergreen State "crumples like a line of box cars slamming into a mountain."

It is this unremitting pressure that created the Seattle, Tacoma, and South Whidbey Island faults. "They are all driven by this north-south compression," Wells says. "Ditto for the rumpled ridges and faults of the YFTB in Central and Eastern Washington. The Puget Lowlands are being compressed by about a quarter of an inch a year. That adds up to more than 20 feet of crunch since the last time the Seattle Fault fired off. Central and Eastern Washington are being squeezed at a slightly lower rate. Inexorably, the pressure is accumulating, loading the Seattle Fault and its associates like springs. The squeeze on the Puget Sound region is enough to produce a magnitude-7 quake every 500 years."

A Whole Lot of Shakin' Going On

Global climate change also effects tectonic activity. The land surface of our planet is a study of elements in motion. The original singular supercontinent called Gondwana began to break apart more than 180 million years ago. The individual continents that resulted have been in motion ever since. As the globe warms, polar ice melts, sea levels rise. As pressures on surface and subsurface tectonic plates shift, earthquakes can become more frequent. One Australian study of more than 386,000 earthquakes between 1973 and 2007 shows seismic activity increasing fivefold over a 20-year span. According to Tom Chalko, the scientist who conducted the survey: “The most serious environmental problem we face . . . [is] rapidly and systematically increasing seismic, tectonic, and volcanic activity.”

A “History of Megaquakes” compiled by Safer Coastlines lists just three superquakes (measuring magnitude 7.9 or more) in the entire 18th century and only two in the 19th century. By contrast, there were ten megaquakes in the 20th century and just the first 12 years of the 21st century have seen seven megaquakes (all ranging between magnitude 8 and magnitude 9).

It is important to note that the earthquake records from the 17th and 18th centuries are spotty and incomplete. Still, the first decade of the current century has seen an unusual number of super-quakes — a magnitude 9 quake in Sumatra in 2004 caused a tsunami that killed 227,898; a magnitude 8.8 quake in Chile in 2010 killed 521; a magnitude 7.0 quake that left more than 300,000 dead in Haiti; a magnitude 7.0 quake in New Zealand in 2010 was followed by a magnitude 6.3 aftershock in 2011; the magnitude 9.0 megaquake that hit Fukushima in 2011 (the fifth largest quake in the past 110 years) was followed by a magnitude 7.3 quake in October 2013. All of these monster quakes have occurred along the “Ring of Fire,” the seismically active zone that rings the continents facing the Pacific Ocean.

Despite this appearance of a troubling trend, USGS geophysicist Andrew Michael insists that “overall, the pattern is random.” Tom Parsons, a USGS geophysicist at the Pacific Coastal and Marine Sciences Center in Menlo Park, California, agrees. “Based on the evidence we’ve seen,” Parson says, “we don’t think that large, global earthquake clusters are anything more than coincidence.”

The International Atomic Energy Agency (IAEA) estimates that 20 percent of the world’s reactors are currently operating in regions of known seismic activity. In 2008, growing concern with “beyond design basis” accidents prompted the IAEA to create the International Seismic Safety Centre. (A “beyond design basis event” refers to any incident that generates greater stress than a nuclear plant was designed to withstand.)

More troubling news. One earthquake can trigger another and small quakes can unleash seismic monsters. It can also work in reverse. Some scientists speculate that the ferocious quake that struck Japan in 2011 also set off small tremors in Nebraska.

Marine geologist Chris Goldfinger, however, contends “the chances of stress transfer triggering a major quake [over great distances] are low if not nonexistent.”
On the other hand, Goldfinger has noted: “We’re in the middle of a global cluster of megaquakes…. Everybody’s noticed it. There are seismologists who say it’s not statistically significant. But it’s happening. The reason it’s downplayed is that nobody’s figured out a mechanism — how and why they’re happening now.”

Canadian seismologist Dr. John Cassidy has noted that large earthquakes can trigger smaller earthquakes and smaller tremors can trigger larger quakes. Case in point: some geologists believe a magnitude 7.7 quake that struck British Columbia’s Graham Island in October 2012 may have been linked to a magnitude 7.5 quake that struck off Alaska nine weeks later. In any event, Cassidy concludes: “The potential is there. The same plate movements are happening today as happened 100 years ago and 1,000 years ago…. The energy is being stored for more earthquakes in the future. We know that they’ll happen, we just don’t know when.”

Terry L. Tolan, the consulting engineering geologist hired to assess existing studies that evaluated potential seismic hazards at the CGS site, notes that, despite these troubling discoveries, “No seismic structural upgrades have been made at the [CGS] over the past 30 years, which has dramatically increased the seismic risk.”

Planning for the “Expected” Not the “Unexpected”

The CGS reactor was not designed to survive a specific magnitude earthquake. Instead, it was built to withstand a particular amount of “ground shaking” that would be produced by the largest “expected” quake. This phenomenon is measured in “g” (or “gravity”) forces — a function of the magnitude of the quake at its epicenter and its attenuation over distance. (A small quake happening nearby could produce the same force as a much larger quake occurring farther away.) Determining the “g” factor requires two critical bits of information: knowing the location of any surrounding faultlines and understanding the potential forces that could be unleashed during a “maximum credible earthquake.”

The CGS facility was designed to shrug off a “Safe Shutdown Earthquake” with a ground motion of 0.25g (i.e., one-fourth the force of gravity). As a matter of industry practice, nuclear reactors are supposed to include an additional “margin of safety” beyond the established “g-factor.” The NRC, however, leaves it up to the plant’s engineers to determine the appropriate “margin of safety.” According to the Nuclear Energy Institute, the margin of safety is supposed to handle a threat “greater than the largest earthquake and flood ever known for the region.” (The NRC claims that, under some circumstances, the CGS design should be able to handle a ground motion of 0.6 g.)

Unfortunately, the geologists who advised CGS’ engineering team in the 1970s, lacked the knowledge about new, longer, deeper faults recently unearthed by a new generation of quake hunters. Newer, meaner faults notwithstanding, CGS’ ancient Mark II reactor just isn’t as safe as its operators proclaim. As Princeton University physicist and former White House advisor Frank N. von Hippel told the *Los Angeles Times*: “These first generation boiling-water reactors have the least margin of safety of any reactor design.”

A Note on Richter Readings

While the Richter scale is the most familiar means of ranking earthquakes, its value is limited since it only references the total amount of energy produced by a quake. Local ground acceleration is the effect that really matters. That’s why the NRC does not require nuclear facilities to be built to survive quakes of a given magnitude. Instead, they are required to withstand a particular level of ground motion at the site. This threat level is referred to as a “Safe Shutdown Earthquake.” As the NRC explains, when a SSE strikes, “all structures, systems, and components important to safety are designed to remain functional.”

This standard may seem a bit wishful. It not only links three incompatible concepts — i.e., “safe,” “shutdown,” and “earthquake” — it further seems to presume that there will never be such a thing as an “Unsafe Shutdown Earthquake.”

The Richter Scale was devised by Cal Tech professor Charles F. Richter in 1935. Richter’s iconic instrument traced the effects of ground tremors using needle-like pens that recorded resulting amplitudes on reels of paper rolling off the drums of seismographs. The science has since gone digital. Today, geologists commonly gauge quake activity in terms of Moment Magnitude — a direct measure of the energy released based on the strength of the rock that ruptures, the area of the fault and the average amount of slippage.

Like the Richter Scale, the Moment Magnitude Scale is logarithmic, with each full step of the scale representing a ten-fold increase in ground movement — i.e., a magnitude 7 quake would be ten times more powerful than a magnitude-6 event. This force can be expressed as the explosive equivalent of a chemical detonation. Let's compare two recent examples. The magnitude 7.0 earthquake that devastated Haiti in 2010 packed the wallop of 480,000 tons of TNT. The magnitude 9.0 Tohoku-Oki quake that unleashed a tsunami on Japan in 2011 released a force equal to the detonation of 480,000,000 tons of TNT — one hundred times more powerful than the Haiti quake. While Moment Magnitude is useless for assessing small, short-duration quakes, it also fails to fully account for the force of larger quakes that can roil the ground for much longer periods. A better scale would simply measure the energy released by the quake. In this case, however, each step up the magnitude scale would mark not a ten-fold increase in earth-rattling force but a thirty-two-fold increase.

Misplaced Epicenters: Grounds for Concern

When the CGS atomic plant was still on the drawing boards, there were only two known historic temblors that drew concern — one in 1936 and a larger one that struck in 1872. In 1872, one of Washington's largest quakes rumbled into the Cascades with a force of magnitude 6.5 to 7.4 and sent massive landslides tumbling into the Columbia River. More recently, a window-cracking magnitude 5.7-to-6.1 quake in 1936 snapped brick chimneys and created 200-foot-long fissures in the soil of the Walla Walla Valley along the Washington-Oregon border.

The location of the larger jolt became a matter of serious debate. For those who wanted to see the CGS reactor built where it now sits, it was better to site the 1872 quake as far from the Hanford Site as possible. Reactor advocates pinned the epicenter of the 1872 quake in the North Cascades, 180 miles away. With the more troubling 1872 shaker conveniently pushed to the far horizon, WPPSS' engineers would only need to focus on potential impacts of the smaller 1936 "Milton-Freewater" quake, whose epicenter had been placed 55 miles southeast of the Hanford Site. Looking back, University of

Washington geologist Eric Cheney reflected: “It would have been comical if it wasn’t so serious.”

The NRC ultimately had to intervene to settle the dispute over the location of the 1872 quake and appointed a mediator named Howard Coombs to resolve the conflict. Coombs, however, wasn’t a totally disinterested player. He had previously served as a paid consultant for numerous nuclear power projects. Under Coombs’ direction, the parties ultimately agreed to locate the quake’s epicenter close to the Canadian border — a decision that pleased WPPSS and simplified the engineering challenges. As Cheney observed, Coombs “found a place to park it where it wouldn’t be a problem and everyone was happy.”

The NRC gave the green light for the reactor’s construction based on the risks associated with the smaller 1936 quake. (The USGS rated the 1936 event as magnitude 5.9 quake with an estimated ground acceleration of 0.22 g.)

The next step was to estimate the “potential seismic risk” from any unknown faults that might lie within a 16-mile radius of the planned reactor site. An assessment was performed and it produced an assumption of “potential” risks. From this, an analysis was derived. It was this analysis that was used to assign a “Safe Shutdown Earthquake” target for the CGS, which was set at a peak ground motion of 0.25 g (or one-fourth the force of gravity).

The State of Washington’s Geology

In wasn’t until after the CGS reactor went operational in 1984 that scientists began to discover that Washington’s seemingly placid landscape masked a troubling and rambunctious past. As A.C. Rohay and S.P. Reidel, two Pacific Northwest National Laboratory scientists, explained in 2006:

“The Columbia River Basalt Group forms the main bedrock framework of the area. These rocks have been folded and faulted over the past 17 million years, creating broad structural and topographic basins separated by anticlinal ridges of the YFTB. Sediment of the late Tertiary has accumulated in some of these basins. The Hanford Site lies within one of the larger basins, the Pasco Basin…. Bounded on the north by the Saddle Mountains and on the south by Rattlesnake Mountain and the Rattlesnake Hills. Yakima Ridge and Umtanum Ridge trend into the basin and subdivide it into a series of anticlinal ridges and synclinal basins. The largest syncline, the Cold Creek syncline…, is the principal structure containing the U.S. Department of Energy (DOE) waste management areas and the Waste Treatment Plant (WTP).”

In essence, the DOE's WTP — and much of the Hanford Reservation — sits precariously atop a layer-cake of sediments dating from the Miocene, covered with vestiges of the Pliocene Ringold Formation, topped with Missoula Flood gravels, infiltrated with sands and silt of the Pleistocene's Hanford Formation and capped by more recent deposits accumulated during the Holocene. This stacked-card-deck of sediments can act to amplify the slipping and shaking "ground motion" during a large magnitude earthquake.

Washington State, it turns out, is even more seismically compromised than California. The Evergreen State stands at risk from three distinct forms of quakes: shallow, deep, and mega. Geologist Bill Bakun offered a dire assessment of Central Washington: "It's all riddled with faults," he said. "It wouldn't surprise me to have a magnitude 6.8 quake anywhere in that region, including near Hanford."

In 2002 (some 27 years after Howard Coombs' panel issued its verdict), Bakun and several scientific colleagues uncovered clear evidence that the disputed 1872 quake was not located 180 miles away but actually involved a shallow fault on the southern end of Lake Chelan, a mere 99 miles from the CGS — nearer by half.

Bakun also set the magnitude of the quake at 6.8 — noting that the margin of error would range from 6.5 to 7. Other seismologists have placed the force of the quake at magnitude 7.4.

The Lake Chelan quake rattled residents all the way from Eugene, Oregon, to British Columbia. It was a large rumble that affected at least 151,000 square miles and may have been felt as far north as Alaska. The USGS concluded the damaging impacts of the resulting ground acceleration extended to the southeast, well beyond the Hanford nuclear site. This ground motion acceleration likely would have produced seismic forces greater than the CGS reactor was built to handle.

Clearly, had the CGS existed when the Lake Chelan quake occurred, it most likely would have sustained moderate to severe damage.

Energy Northwest insists that its reactor — though built to withstand a "very strong" to "severe" 6.5 magnitude quake — could handle a "violent" 6.9 magnitude event "based on conservative practices in design, manufacturing, fabrication and installation, plant structures, systems and components." But dealing with a magnitude 7.5 quake — eight times more powerful than a 6.9 quake — would be a different matter.

Second Thoughts

In 1983, the year before CGS reactor was placed in operation, the NRC decided to question the plant's seismic safety. WPPSS had assured Washington that all of its planned reactors were engineered to ride out, if not the worst possible, at least the worst "likely" earthquake. But this time, the NRC (an enforcement agency that routinely invites its licensees to provide their own safety assessments and compliance recommendations) decided to seek a "second opinion." USGS scientist Tom Heaton was hired to review Energy Northwest's seismic research. After plowing through a "decade's worth of seismic studies," Heaton was astonished at "how little was really known about earthquake risks in the Northwest."

"WPPSS reviewed the historical records, which went back 150 years," Heaton reported. And they reached "the logical conclusion: What's past is prologue. The middling quakes since settlers arrived in the mid-1880s were what the region could expect in the future." Drawing on the limited geological knowledge at the time, the WPPSS had assured the NRC that "surface faulting is not a factor in the design of the plant" and that there was no evidence that any "capable faults" existed within a five-mile radius of the proposed reactor site. (The NRC defines a "capable" fault as one that has produced near-surface ground motion at least once in the past 35,000 years or "movement of a recurring nature" within the past 500,000 years.)

The WPPSS survey acknowledged the existence of several new "potential" seismic sources but concluded they would most likely produce little more than an magnitude 4 to 6 quake, with an outside chance of a rare magnitude 6 to 7 earthquake.

The NRC reviewed the findings but issued no new safety requirements. (In 1988, the NRC invited all reactor operators to assess their potential risk from earthquakes beyond the parameters of the hypothetical "Safe Shutdown Earthquake." Again, no seismic upgrades were made to the CGS plant, then in its fourth year of operation.)

Taking License

In 2011, during the CGS's relicensing process, the NRC signaled its concern that Energy Northwest was still relying on dated seismic studies from 1994, rather than the most recent (and more alarming) research. But the NRC let the operators slide. Despite protests from environmental organizations and citizen's watchdog groups alarmed by the spectacle of similar GE reactors reduced to smoking rubble by the Fukushima quake and tsunami, the license-renewal process remained on track.

Hoping the Fukushima catastrophe would provide impetus for heightened safety concerns, a coalition of Northwest activist groups petitioned the NRC on April 14, 2011, asking that the Columbia Generating Station's relicensing application be placed on hold pending an assessment of the new findings of longer, more active and linked faults in the area surrounding the reactor.

The NRC deliberated and announced it was rejecting the citizens' petition because it raised "issues that are outside the narrow scope of the NRC's safety review for license renewal." According to the NRC's ruling, the only issues of concern during the relicensing process were those "limited to managing the effects of aging on certain passive structures, systems and components." Seismic reviews, by contrast, "are part of the ongoing regulatory oversight process."

This seems an odd standard. Not permitting an evaluation of new earthquake data during a relicensing process seems as irresponsible as not allowing the submission of new evidence during a murder trial.

There was another oddity about the relicensing process. The CGS's operating authority was not set to expire until the end of the reactor's original "design lifetime" — in 2023. Yet the NRC allowed Energy Northwest to apply for a new, extended operating license in 2007, 16 years early. Five years and 2,200 pages later, the NRC approved Energy Northwest's renewal application on May 23, 2012.

John Pearson, a retired physician and president of Oregon Physicians for Social Responsibility, notes that, out of nearly 200 applications, the NRC has only denied one reactor operating license. In the case of CGS, Pearson argues: "What we received was a rush job, 10 years before it was due, that did not consider all the evidence."

The NRC's decision seemed akin to the Department of Motor Vehicles granting a license allowing a car built in 1979 to compete in a road race that's scheduled to start in 2023. Picture, if you will, Energy Northwest arriving at the starting gate steering a dilapidated vehicle operated by a steam pressure cooker pumping 14.7 million pounds of steam per-hour, exerting 1,005 pounds-per-square-inch at 547 degrees F., and powered with more than 500,000 pounds of nuclear fuel that keeps the engine constantly revving — all day, all week, all year.

Hazards at Hanford: A Double Standard for CGS?

Ten miles northwest of the CGS, the Hanford Reservation's $12.2 billion Waste Treatment Plant (WTP) hunkers over 65 acres in the Pasco Basin, several miles below a bend in the Columbia River. The controversial project is supposed to process 56 million gallons of Hanford's radioactive and chemical wastes and encapsulate the toxic residue in a glass-like state for storage inside stainless steel canisters. The plant, dogged by costly design problems, has been under construction for more than 12 years. The WTP project continues to experience delays, missed deadlines and shutdowns. With federal budget cutbacks looming, DOE has announced plans to start laying off construction crews in 2014.

While the NRC seems content with the situation at the CGS, the Department of Energy was quick to take action after three USGS studies published in 2007 revealed a history of larger-than-expected quakes that had battered the Hanford region over the past millennia.

What the 2007 USGS studies uncovered was deeply troubling: there were more faults than previously known and they all ran longer and plunged far deeper than suspected. Instead of lying a mile or two beneath the ridge, the faults extended more than ten miles into the Earth's crust. The deeper the fault, the greater the potential shock when it moves.

Faults that were thought to be unconnected with other, nearby faults, were found to be part of a larger, common fault structure.

The report also warned that the size of many local faults had been underestimated. Faults that were thought to run 40 miles turned out to extend more than 100 miles. The

Umtanum Ridge structure, once believed to extend 77 miles, was found to continue more than 124 miles.

“Based on the length alone,” USGS paleoseismologist Brian Sherrod told the Seattle Times, “you would estimate that some of the faults out there are capable of producing magnitude 7.5 earthquakes.”

As recently as November 2013, Energy Northwest’s website was insisting the CGS reactor was built to survive a magnitude 6.9 quake. Energy Northwest has offered no seismic, scientific or engineering data to substantiate this claim. In any event, this discussion of plant safety and “magnitudes” is immaterial because the NRC grants operating licenses based solely on the ability of a reactor and its safety systems to survive the effects of ground motion and g forces and (as earthquake scientists and the NRC will tell you) you can’t translate ground motion into magnitude.

Although Hanford’s WTP is located fairly close to the CGS, its design-basis earthquake safety margin (a ground motion of 0.5 g) was twice as great as that required for the CGS nuclear reactor. Construction on the WTP began in 2002 but the Defense Nuclear Facilities Safety Board (DNFSB) called a halt to work in 2005 and the project remained shut down for a year pending new seismic studies. As Tolan noted: “The maximum vibratory ground motion for this area has been dramatically increased based on the WTP studies [and] … the presence of more (and longer) capable faults.” This raises a question: Given the elevated concern for the WTP site, why was the CGS, located just 10 miles away — and with older seismic qualifications — not shut down as well?

When a new seismic response analysis for the WTP was delivered in 2007, it warned of an increased level of seismic hazard — including the “violent” shaking and “heavy” potential damage that could result from a magnitude 6 to 7 earthquake. The DNFSB consequently recommended raising the ground-motion requirements at the WTP 30 percent to 0.6 g – or more than double the 0.25 g SSE design-basis protection level set for the CGS reactor.

Hanford’s WTP is now being constructed to survive a quake that would rank 9 on the USGS 10-point earthquake scale. Meanwhile, a 2011 USGS survey concluded that the probability of large (magnitude 7 and greater) quakes could be much more likely in eastern Washington. The fault associated with the Umtanum Ridge structure was found to plunge deeply into the Columbia River's "basement rock," a clear sign that future ruptures could produce much larger quakes than previously predicted. Tolan called the latter discovery a "big revelation that has kind of shaken everything up…. These faults appear to extend into the basement; they're not just in the rug."

In Tolan's assessment, "Energy Northwest needs to develop a CGS site-specific model for ground motion response spectrum based on borehole vertical seismic profile data from the ground surface to the top of the Columbia River basalt. They then need to integrate this data with the WTP shear wave velocity data for the Columbia River basalt/Ellensburg Formation." Once that is accomplished, Tolan adds, Energy Northwest would still need to "reevaluate the maximum credible earthquakes … that the revised model of the Yakima Fold can potentially generate." This new seismic model would also need to incorporate the latest findings on coupled faults, frequencies, length and depth.

With questions about new seismic dangers gaining more media attention, Energy Northwest's posted a bold assertion on its homepage: "Columbia Generating Station exceeds the Nuclear Regulatory Commission's robust seismic design requirements, and is capable of withstanding a massive earthquake." The posting makes no mention of specific findings (of new faults that are longer, deeper and connected). Instead, it refers only to a single study that is still in progress — an investigation by Pacific Northwest National Laboratory that Energy Northwest is co-sponsoring and funding.

In a letter to the Oregon/Washington chapters of Physicians for Social Responsibility (OWPSR), the NRC stated "All of the issues raised in the letter from OWPSR are known and are being evaluated as part of the seismic hazard reevaluation being conducted by DOE and Energy Northwest" as part of the earthquake planning report that is due at the NRC in March 2015.

The DOE's next "seismic hazards analysis" is scheduled for 2014. Meanwhile, the DOE has required the entire Hanford site to provide an up-to-date earthquake hazard evaluation as part of a ten-year review. This reassessment is currently underway. Ivan Wong, a board member at the Earthquake Engineering and Research Institute, is one of the scientists who believe the record will show the seismic hazard in Eastern Washington has probably been underestimated.

The DOE's concern is not matched at the NRC, however. "The licensee conducted a full probabilistic seismic hazard analysis for the region around the CGS plant, including an evaluation of earthquake activity… including the Yakima fold belt and the Cascadia subduction zone," the NRC recently reported. No cause for alarm, the NRC continued, since "the licensee evaluated the seismic capacity or ruggedness of the CGS plant and determined that the risk of core damage from a seismic event is very low (0.00005 per year)."

The NRC insists, "there is no immediate safety concern at CGS" and, come March 2015, the NRC has only promised to review the "evaluations conducted by Energy Northwest for *potential* regulatory action." (Emphasis added.)

Even if Energy Northwest's "re-evaluation hazard evaluation" reveals additional, heightened dangers, that does not guarantee the NRC is prepared to adopt the Precautionary Principle. If new ground acceleration estimates are found to "exceed the original design level," the NRC has indicated it will simply require plant operators to "conduct a seismic probabilistic risk assessment." What happens if the risk is found to exceed margins of design safety? "The NRC *may* determine that the plant must perform modifications to strengthen equipment or anchorage based on the new higher ground motion." [Emphasis added.] And if the NRC does decide to act, it still would not deny a license to operate. It would simply require that "a new ground motion level would be added to the licensing basis of the plant."

On its website, Energy Northwest has actually promised to be more diligent than its supposed federal regulator: "Should the new PNNL analysis determine changes are appropriate," Energy Northwest states, "we will certainly make them."

The disturbing element of this slow, bureaucratic approach is the issue of timing: While you can schedule a safety review for March 2015, you can't schedule an earthquake.

The Risk of Hanford Blowback

Once the pride of the Pentagon's Cold War atom bomb program, the Hanford Nuclear Reservation now resembles a "retirement community" for atomic artifacts — the home of nine retired military reactors, four reprocessing plants, 53 million gallons of radioactive wastes, and toxic ponds of hazardous chemicals stored in aging buildings, concrete basins and underground tanks. In an assessment dating from 1999, the DOE identified more than 1,600 waste sites at Hanford and slightly more than 500 facilities built to store these wastes.

For more than 12 years, the DOE and its highly paid contractors (Bechtel and URS) have been struggling to determine how to safely process and store the radioactive waste produced by Hanford's military reactors. The still-unfinished $12.3-billion Waste Treatment Plant has been plagued with design problems, delays and cost overruns and its fate remains uncertain.

The history of Hanford has not been pretty. Dumping of radioactive waste in the past was not exactly always done according to procedure…

More than 100,000 plutonium-filled used fuel rods from Hanford's closed reactors are stored in two shallow pools filled with about 1,000,000 gallons of water. Hanford's ancient tank farms (which contain enough plutonium to fashion 70 nuclear bombs) were built in the 1950s with an anticipated lifetime of 20 years. Nearly seven decades on, these containments are beginning to fail. If the pools were to crack and drain, the exposed material could quickly ignite, creating a fallout hazard that would spread far beyond the reservation.

In the 1990s, one of the pools was found to be releasing toxic sludge into the ground only 300 feet from the Columbia River. In February 2013, inspectors reported that six of Hanford's 177 underground tanks were leaking. In October 2003, the DOE reported that 67 of the tanks "have leaked or are suspected to have leaked" a million gallons of radioactive liquids into the ground. In 2013, six more tanks were found to be leaking and the DOE now fears as much as 1.5 million gallons of contaminated water may have been spilled into the surrounding soil.

But these pools are not just leaking radioactive fluids into the earth. On March 16, 2013, a series of hydrogen gas releases were reporting escaping into the atmosphere from a radioactive waste holding tank. Washington's KING 5 News reported the releases "lasted for several days, much longer than usual." Plant operators were reportedly concerned that "a single spark could have set off an explosive release of radioactivity." Hanford's Waste Encapsulation and Storage Facility (WESF) holds 1,936 stainless steel, 20-inch-long capsules containing 130 million curies of radioactive cesium and strontium (plus their decay products) in water-filled pools. Opened in 1979, the WESF now holds the largest concentration of strontium-90 and cesium-137 on Earth. Over the years, these deadly wastes have been left to simmer in an aging pool, beneath 13-feet of water, with no overhead containment and no safety backups in the event of an earthquake. In June, 2012, prompted by the Fukushima meltdowns, workers inside the WESF's cement-and-cinder-block warehouse were ordered to carefully rearrange the spacing of more than 800 cylinders to reduce the chance of overheating.

Part of the Hanford nuclear reservation.

The Hanford Nuclear Reservation holds two-thirds of the country's stored high-level nuclear wastes — some 330 million curies of radioactivity that could be released in part or in toto by a severe earthquake or an on-site accident. The release of even a portion of these stored wastes could render the site a no-man's land that could make recovery impossible and could compromise the safe operation of the nearby CGS plant, as well.

After a series of unusual hydrogen gas releases occurred at one of the Hanford storage tanks in March 2013, KING 5 TV News reported that "State and federal officials have long known that hydrogen gas could build up inside the tanks at the Hanford Nuclear Reservation, leading to an explosion that would release radioactive material."

The Defense Nuclear Facilities Safety Board immediately called for additional monitoring and ventilation of the tanks. A major radiation release, whether the result of an earthquake, a storage failure or human error, would require the evacuation and relocation of approximately 300,000 people living within 50 miles of the CGS and the Hanford site.

It wouldn't even require a nearby earthquake to take out Hanford. If an earthquake (or a terrorist attack) were to rupture the Grand Coulee Dam, a 65-foot-high wall of water could inundate the nearby town of Richland and multiple disasters would befall operators at the Hanford Reservation and CGS. (And it's not just the Grand Coulee: there are seven other dams on the Columbia between the Grand Coulee and the Hanford Reservation.)

Meanwhile, at the same time the DOE is struggling to find a way to safely isolate the military's nuclear wastes, the CGS reactor has quietly churned out an additional 3,200,000 pounds of fresh nuclear waste — with a payload of 360 million curies. According to nuclear expert Robert Alvarez, the amount of curies of radiation from the atomic wastes at the CGS now surpass that of the toxic nuclear leftovers from nuclear weapons production stored on the Hanford site.

Full Speed Ahead

Despite the Pasco Basin's shaky geography and Hanford's hellish hazards, Energy Northwest continues to push ahead, arguing that there is no significant danger associated with operating a power plant that has undertaken no structural safety improvements for nearly 30 years. While the company has agreed to attend to more than 100 internal up-grades demanded by NRC inspectors (i.e., reinforcing pipes, strengthening tie-downs, upgrading equipment), Energy Northwest has undertaken no structural/foundation modifications in response to the seismic hazards analysis. A former CGS employee (who has requested anonymity) believes it would be "virtually impossible to upgrade the foundation to meet the standards that we now know the plant should have." Moreover, the former employee confided, "it would be impossible to upgrade the piping."

In 2012, a coalition of citizens concerned about nuclear-safety asked the NRC to provide the most recently completed Probabilistic Seismic Hazard Assessment for the CGS reactor. The response was somewhat startling. "Currently, no probabilistic seismic hazards assessment exists for Columbia Generating Station," the NRC replied. The NRC confirmed the "the original design of the facility" had not been changed in 30 years. However, as part of the NRC's "Post-Fukushima Daiichi Lessons Learned" response, an "update to the seismic hazards assessment is in progress." The review and recommendations will be provided, not by the NRC or by independent investigators, but by the plant operators themselves.

In the meantime, don't hold your breath: This review will not be due until March 2015. But there should be no cause for concern, the NRC's Lara Uselding offers, since "the NRC knows of no significant changes to possible seismic hazards of the region."

Antinuclear watchdogs are left to wonder why the NRC remains willing to wait four years before even beginning to assess the depths of North America's potential "Fukushima" problem. Can we afford to wait?

Imagine, if you can, the spectacle of an earnest entertainer heedlessly tap-dancing atop a barrel of dynamite. The NRC's position seems to be that such an activity can proceed since it is statistically without any great, provable risk. But if you happen to be a member of the audience, your appraisal might be somewhat different. Given the potential for a serious disaster, why bother taking the risk in the first place?

The Channel-control Blade Problem

Another seismic safety issue involves the channel-control blades that help moderate the atomic reaction inside the tightly packed fuel assemblies that power Boiling Water Reactors. (In BWRs, these cruciform metal blades are inserted upwards from the bottom of the reactor while in Pressurized Water Reactors, control rods are inserted from above.) Designed to slide up and down between clusters of four fuel assemblies, the blades are used to moderate the chain reaction and are essential to conducting an emergency reactor shutdown (a "scram").

The problem is that it might not be possible to shut down a BWR by fully inserting control rods into these straight narrow channels while the reactor is undulating during an earthquake. The channels may bow, bulge or twist, altering the clearance that allows the control rods to move freely.

In a September 3, 2010 notification letter to the NRC, GE Hitachi Nuclear Energy (GEH) noted that its previous “engineering evaluations… [did] not address the potential impact of a seismic event on the ability to scram.” Furthermore, in the event of an emergency shutdown, “scram capability is expected to be affected due to the added seismic loads,” especially at low reactor pressures (i.e., below 900 pounds-per-square-inch gauge). GEH notified the NRC that it had sent an alert to operators of 35 reactors in more than a dozen states that the critical control rods could fail in an earthquake. One of the potentially at-risk reactors was the Columbia Generating Station.

After “evaluating” the problem for more than a year, GEH sent an email on September 26, 2011 advising the NRC of its findings. The news was not good. GEH reported it had “determined that the scram capability of the control rod drive mechanism in BWR/2-5 plants may not be sufficient to ensure the control rod will fully insert in a cell with channel-control rod friction at or below the friction limits specified….”
GEH stated the expected impact of a Safe Shutdown Earthquake (SSE) on Mark I reactors “may result in control rod friction that inhibits the full insertion of the affected control rods during a reactor scram.” Similarly, Mark II reactors like the CGS, when faced with either a Loss-of-Coolant Accident or a Safety Relief Valve problem during an earthquake, might not be able to “fully insert” quake-damaged control rods “to perform the required safety function.”

When GEH first notified the NRC in 2010, it took the position that the control-blade issue was not a “Reportable Condition.” In the 2011 update, however, GEH was compelled to admit that “a Reportable Condition… exists.”

Meanwhile, on October 11, 2013, the Nuclear Engineering Institute reported a related problem. The fuel channels through which the control blades are supposed to slide can be affected by bending and bowing, owing to the compounding impacts of heat, pressure and radiation. The NEI reported: “More than half of the 35 BWRs in the United States have reported control blade interference due to channel distortion since 2000…. Channels manufactured by all major BWR fuel suppliers have been affected.” According to a December 2010 GHE evaluation report filed with the NRC, the CGS was one of the plants warned about the possibility of blade failures during earthquakes.

These components were subjected to even greater stress in the 1990s, after the NRC (bowing to the wishes of the nuclear industry) effectively permitted reactor operators to double the amount of time nuclear fuel could be irradiated in their reactors. This “high burn-up” policy also increased the percentage of uranium-235 contained in the fuels.

While this increased the profitability of old reactors, it also increased the stress on the components inside the aging plants — including the critical control rods.

In September 2011, headlines broke the news that 35 of GE’s US reactors “may not shut down properly during an earthquake.” GEH cautioned that, while “there is no discussion of a recall of any control rods at this point,” it recommended testing to determine “whether any modifications are necessary.” GEH admitted it had become aware of the control rod problem “several months” before the Fukushima disaster and the company now recommends that defective control rods be replaced when its reactors are shut down for refueling. According to Energy Northwest’s FY 2014-16 Strategic Plan, the company expects to begin preparations for replacing control blades in 2014, with the actual work scheduled for 2015 and 2016.

But what if an earthquake strikes before the next refueling cycle? The position of GEH and the NRC seems to be that running a reactor with defective control rods constitutes a reasonable risk. For someone living near one of these reactors, however, the more reasonable assessment might be the following: “If you can’t safety stop a reactor you shouldn’t be allowed to start a reactor.”

The NRC Raises a Few Questions

On January 19, 2010, Energy Northwest presented the NRC with its application to renew the operating license for the CGS reactor. On July 13, 2010, the NRC (following up on the 2007 reevaluation of the WTP’s vulnerability) sent a letter requesting that Energy Northwest address concerns that CGS’s 15-year-old seismic risk study failed to foresee the dangers uncovered at the WTP site.

The letter had been preceded by an urgent conference call on June 28, 2010 in which the NRC repeated its continuing concern that Energy Northwest had relied on old seismic hazard estimates to measure ground movement. (Energy Northwest has persisted in relying on two earlier findings — the 1981 WPPSS and 1994 Geomatrix studies. The NRC has called both studies “incorrect and flawed.”) Citing the USGS and PNNL studies of earthquake hazards that forced the DOE to make structural improvements at the WTP, the NRC asked Energy Northwest to “assess whether consideration of the more current” earthquake discoveries might “impact the results” of the company’s Severe Accident analysis.

In response, Energy Northwest expressed concern that the impact of newer geological studies “could not be addressed quantitatively.” Energy Northwest also insisted that basalt and sediment bedrock at the WTP site were different from the geology beneath the CGS. While it is true that there are different “soil structures” at the two sites, this does not get the CGS off the seismic hook. As geologist Terry Tolan concluded in his report on “Earthquake Risk Factors at the CGS,” the WTP and CGS sites are “geographically and geologically linked and similar.”

In a follow-up letter, the NRC suggested that Energy Northwest’s failure to incorporate the latest information about the location, size, and frequency of local faults was a significant shortcoming.

The 1994 Geomatrix models assumed the faults in the Yakima Fold were “uncoupled” and, thus, likely to produce only smaller magnitude 5 to 6 quakes. (In the Columbia Basin, an uncoupled “thin skin” fault only penetrates the region’s surface basalt. It does not extend downwards through the sedimentary layers and into the depths of the crystalline basement.) By 2009, however, new data from deep hydrocarbon exploratory drilling had produced what scientists at the USGS, the PNNL, the American Geophysical Union, and the Geological Society of America concluded was “compelling” evidence the YFTB’s major faults were, in fact, coupled, “thick skin” faults.

As USGS geologist Richard Blakey noted: “Generally speaking, long faults are potentially more dangerous than short faults, and the through-going faults proposed here would pose significantly increased seismic hazards if they would prove to be active along their entire lengths.” USGS studies published in 2009 and 2011 also revealed the eastward extension of the Umtanum Ridge-Gable Mount and Yakima Ridge faults actually placed two “active” faults approximately 6.5 miles north of, and 2.3 miles south of, the CGS reactor.

Energy Northwest Offers a Reply

Two months later, on September 17, 2010, Energy Northwest restated its position that increased concerns about the earthquake safety of the WTP plant should have no bearing on the CGS reactor. Energy Northwest continued to claim that there were "distinct" geologic differences between the two sites and touted CGS's "increased distance from nearby seismic sources." Company officials insisted its predictions of peak ground motion were actually more conservative than required.

Energy Northwest's fixation on dated data also freed the company to argue that any faults near their atomic reactor were much farther away than the faults encroaching on the Hanford's troubled WTP. (This ignores the 2011 USGS finding that the reactor is bracketed by two previously unknown "active" faults, one located only 2.3 miles to the south.)

Still, the NRC appeared mollified. No new seismic structural upgrades were ordered at the CGS.

A Litany of Shortcomings

On March 10, 2011, just a day before the Great Tohoku-Oki quake sent a tsunami sweeping over Japan's eastern coast, Energy Northwest received the latest in an ongoing ebb-and-flow of letters related to its license renewal application. This NRC missive challenged the sufficiency of the math the company had employed to assemble its cost-benefit analysis of earthquake impact mitigations. The letter was in response to several previous Requests for Additional Information ("RAI" in NRC-speak) all stemming from a July 1, 2010 NRC request to review the company's Severe Accident Mitigation Alternatives (SAMA) planning for the CGS site.

Energy Northwest provided a partial response on September 17, 2010. The NRC then sent two additional RAIs asking for clarification. Energy Northwest's January 28, 2011 reply also left the NRC wanting. After months of back-and-forth correspondence, the NRC fired of a letter on March 10, 2011 citing a litany of shortcomings in the renewal application, including faulty tables, quantitative lapses and apparent inconsistencies. The NRC asked the company to justify the calculations it had used to determine the cost-benefit analysis of its earthquake preparations. The NRC noted that Energy

Northwest's tables on fire and earthquake risks and remedies were unclear. A table on handling severe accidents failed to "provide an analysis." In an important section on earthquake risks, "Neither seismically-induced failures nor random failures appear to be addressed." In three tables addressing "internal, fire, and seismic events," the NRC pointed out that "the percentage contributions presented… total to much less than 100%." In another section of the application, the NRC criticized an assumption that "could result in an underestimate of the estimated risk reduction for [Severe Accident Mitigation Alternatives]."

An NRC 'Walkdown' Stumbles across Some Problems

In the summer of 2011, faced with the spectacle of three out-of-control GE reactors in Japan spewing radiation into the planet's oceans and atmosphere, the NRC announced it was "requiring all power reactor licensees [to] reevaluate the seismic hazard and, if necessary, update the design basis to protect against the updated hazards."

On April 29, 2011, the NRC ordered all US reactor operators to provide updated Seismic Reevaluations. But what looked like a swift response to a global tragedy was undercut by the NRC's timeline. Reactor operators were informed the reports would not be due until March 12, 2015 — four years and a day after the Fukushima disaster.
In the meantime, the NRC directed its "resident inspectors" to complete post-Fukushima safety surveys of all US reactor sites. The NRC's initial inspection report on the CGS was released on May 13, 2011. It noted a number of lapses, including a finding that the Emergency Response Facilities, fire protection systems, floor drain isolation valves, sump-valve switches, and the Tower Makeup "were not seismically qualified." (The "makeup" tower is designed to provide additional water to the cooling system to offset any losses from evaporation, leaks or cooling system discharges. In the case of CGS, this "make-up" cooling water must be drawn from the Columbia River, some three miles away. Earthquakes would pose an additional threat to the pipes that carry CGS reactor's critical coolant more than 15,840 feet from river to reactor.)

The NRC also dispatched earthquake and flooding specialists to join resident inspectors for post-Fukushima "walkdown" surveys of plant safety nationwide. (The "walkdown" involves close physical inspections to determine if plant equipment is in good repair, properly installed, and positioned to withstand damage during an earthquake. Walkdowns are followed by less-rigorous "walkbys," which rely on simple visual inspection of the facilities.) The CGS Walkdown Report was completed on November 20, 2012 but the NRC refused to release the findings, citing "public security concerns."

Under pressure from local activists (and other members of the public who had their own "security concerns"), the government relented and released the report.

Out of 120 walkdowns conducted at the CGS, the NRC inspection documented "35 potentially adverse seismic conditions." Additional "walk-by" inspections of 55 "unique areas" identified 74 "potentially adverse seismic conditions." (Remember, all of these risk assumptions were based on the increasingly dubious 30-year-old premise that the peak horizontal ground motion from a seismic shock was unlikely to top 0.25 g.)

Among the problems discovered during the inspections were:

• Missing concrete anchors from a surface-mounted support plate (only three of four bolts installed);
• Improperly installed concrete anchors (crooked, with visible gaps between bolt heads and plate surfaces);
• Bolts found missing nuts and washers;
• Serious corrosion on bolts and concrete anchors;
• Missing support clamps and bent flanges at bolted interfaces;
• Missing clamps on instrument tubing.

In a subsequent public relations blog dated July 31, 2012, the NRC gave some examples of how the walkdowns worked to ensure that "protective features" were in place to deal with earthquakes and floods. But, in at least one case, the inspectors appeared to redefine a problem as a solution. "[C]onsider a watertight door protecting against a flood," the NRC blogged. "If a window two feet above the door could allow floodwaters in, *the site has two feet of available physical margin*." [Emphasis added.] (This odd approach to flood safety seems as ill-advised as installing a window in a seawall — on the theory that no waves would ever rise high enough to reach it.)

The History and Current Status of the CGS Reactor

Over the years, the CGS (like every other nuclear plant) has continued to experience maintenance difficulties — some of which could prove problematic in the event of a serious earthquake.

In 2001, the plant's employees replaced 22 Westinghouse electric circuit breakers with an incorrect model. Reporting on this slip-up more than a year later, an NRC inspection report noted: "Sixteen of the breakers had important functions to play in power circuits that operated four different safety systems at the plant, including emergency diesel generators, standby service water pumps and emergency core cooling system pumps." The miss-matched breakers went undetected for nearly six months because, the NRC reported: "No one noticed that the new breakers did not have the same dimensions as the old breakers and didn't fit properly in the power circuits."

During an inspection in October 2002, the NRC was startled to find a seven-foot-tall "man-lift" (a movable work platform similar to a cherry-picker) parked unattended near the reactor vessel and a few feet from some control panels. The inspectors wrote that the device "could have tipped against sensitive control room panels during a seismic event" damaging the panel's circuitry and necessitating an emergency reactor scram.

In March 2004, NRC inspectors discovered the nuts, studs or latches on 14 breakers governing the plant's safety systems were not properly secured and CGS's operators were cited for failure to verify "that all seismic restraints were properly configured." The NRC also expressed concern that CGS workers had missed several opportunities to discover and correct the breaker errors between 2001 and 2004.

During a visit in August 2011, NRC inspectors found the control room was being used to store rolling metal ladders, maintenance carts, unsecured bookcases and two 55-gallon barrels, which were positioned dangerously close to a high-pressure core spray pump. The barrels posed an "overturning hazard" that could have disabled the pump, which is essential in handling the consequences of an earthquake. (The NRC called this an example of one-of-many "long-standing issues" at the CGS reactor plant. Additional instances of unsecured equipment found stored next to critical safety systems were recorded in 2007, 2009 and 2011.)

And yet, as Paul Koberstein reported in the *Cascadia Times*, despite this history of repeated, unattended and uncorrected errors, the NRC continued to permit Energy Northwest to operate the CGS "at full power, under their clearly inadequate original licensed earthquake standards."

To Vent or Not to Vent

Fukushima also underscored the fact that the containment structure surrounding the CGS Mark II reactor was too small to contain the buildup of extreme heat, pressure and explosive hydrogen gas in the event of an incident. The NRC has acknowledged that the Mark II containment capacity is only one-sixth the size of standard containment structures in pressurized water reactors — like the PWR that suffered a partial meltdown at Three Mile Island. (Note: The GE Mark I containment structure is even smaller.)

Surprisingly, the NRC has been aware of this serious design flaw for more than 40 years — long before the Fukushima disaster – and these concerns eventually prompted the NRC to recommend design modifications. In a February 1992 report on “Generic Safety Issues,” the NRC expressed concern about the country’s Mark I and Mark II containments. “Reactor pressure is anticipated to increase during a severe accident, releasing steam and non-condensible gases into containment,” the report stated. With this in mind, the NRC recommended the installation of hard pipe vents as a means of “reducing risk” and avoiding “the probability of core-melt” in the event of a station blackout.

On March 19, 2013, in response to the potential threat of hydrogen gas explosions in US-based Fukushima-style Mark I and Mark II containment structures, the NRC ordered the operators of all 23 GE Mark I and eight Mark II boiling water reactors to install “hardened” vents to help relieve internal pressures. Unfortunately, the NRC failed to take the extra critical step of requiring radiation filters on these vents. While the NRC’s own engineers recommended adding filters, the plan was opposed by nuclear operators, who cited cost concerns.

The cost of adding filters to protect the public was estimated at $15 to $40 million per reactor. “Given the added stress this places on the incumbent portfolio,” UBS Financial Services concluded in a February 29, 2013 report, “the effort does not meet the usual rigor of a quantitative cost-benefit analysis used to justify such investments.”

Paul A. Gunter of Beyond Nuclear, a Maryland-based nuclear watchdog group, called the NRC’s decision not to require filters “would ‘firehose’ radioactive releases from an accident into the local community and be a de facto violation of their own requirements that all nuclear power plants have viable containment buildings” to protect public health and safety against the uncontrolled release of radioactivity. The NRC’s General Design

Criterion specifically requires “an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment.”

With this in mind, Beyond Nuclear called on the NRC to “shut down all GE BWR reactors with Mark I and Mark II containments,” including Washington State’s CGS. Under the NRC’s current rules, any future buildups of radioactive gases and “hot” particles can be discharged into the atmosphere — and over downwind communities. The containment design problem has been resolved by eliminating the requirement that containment structures must actually contain explosive gases and nuclear radiation.

It’s something like promising to build an “escape-proof” prison and then overcrowding it with rowdy inmates. When internal pressures threaten to erupt into a riot, prison authorities rush to protect the prison structure by ordering the installation of escape hatches for the prisoners.

NRC Commissioner Allison Macfarlane explained why she cast the lone vote to require filters to keep radiation from pouring into the outside winds: “My decision reflects, in part, my experiences during a recent trip to the Fukushima Daiichi plant in Japan. The visit to the reactors required travel through deserted villages, full of abandoned homes and businesses overgrown with weeds, and past fallow fields, and unused industrial buildings, roads and railroad tracks, all of which emphasized the impact of the accident from a nuclear plant that was over 10 kilometers [6.2 miles] away.”

In March 2013, the NRC ordered plant operators to install hardened vents at 31 US reactors. The cost to Energy Northwest was estimated to range between $25 and $30 million. Energy Northwest says it plans to install the vents during the next fuel outage in 2015 or in 2017. The new vents will not have filters.

“It (Most Likely) Can’t Happen Here”

On March 12, 2012, the first anniversary of the Fukushima disaster, the NRC issued an Order to Modify Licenses that required all nuclear plant operators to prepare plans and safety improvements to deal with “Beyond-Design-Basis External Events.”

“The events at Fukushima Daiichi highlight the possibility that extreme natural phenomena could challenge the prevention, mitigation and emergency preparedness defense-in-depth layers,” the NRC wrote. This meant “additional requirements must be imposed to mitigate beyond-design-basis external events." But in the next breath, the NRC decreed "continued operation does not pose an imminent risk to public health and safety." The NRC then declared: "additional requirements are needed to provide adequate protection to public health and safety." These statements stand in apparent contradiction.

The NRC attempted to resolve the conundrum thusly: "A sequence of events such as the Fukushima Daiichi accident is unlikely to occur in the US. Therefore continued operation and continued licensing activities do not pose an imminent threat to public health and safety."

Former NRC Chair Gregory Jaczko took exception to this approach during an October 10, 2013 conference on the Fukushima catastrophe. "[Fukushima] is telling us that severe accidents can and most likely will happen at some point." Jaczko warned. "Society does not ultimately find it acceptable to evacuate hundreds of thousands of people, to have areas of land permanently contaminated, to spend half-a-trillion (or more) dollars to deal with the aftermath of an accident at a facility that is simply designed to generate electricity. For nuclear power plants to be considered safe…, power plants should not be able to create accidents like this."

The NRC concluded its March 12 memo by trumpeting the Commission's "fundamental regulatory objectives" — to wit: "Reasonable assurance of adequate protection of the public health and safety." [Emphasis added.] When it comes to protecting the public from hydrogen explosions, core meltdowns and panicked evacuations to avoid clouds of radioactive fallout, is "reasonable" and "adequate" assurance the best the NRC can provide? One would hope the NRC's overriding "regulatory objective" would be to guarantee absolute assurance of the best protection of public health and safety.

The NRC ordered CGS's operators to provide a list of strategies "to respond to extreme natural events resulting in a loss of power" by February 13, 2013. Energy Northwest's plans remain a mystery since the NRC has withheld the report from the public citing "security reasons." The Oregon and Washington PSR chapters have filed a Freedom of Information Act request to gain access to this plan.

CGS and GE's Forgotten History of Fraud

On April 3, 2013, an investigative team at *Cascadia Times* produced a stunning report on “The Long Tragic Trail of Failed General Electric Nuclear Reactors.” The investigation unearthed evidence of corporate cover-ups that extended as far back as the 1950s. The article was based, in part, on court records from a 1985 lawsuit that charged GE with intentionally selling boiling water reactors that GE knew contained critical design flaws. Specifically, the reactor’s undersized containment shell was too weak to prevent an explosion of hydrogen gas that might build up during a Loss of Coolant Accident.

In 1985, four different nuclear operators sued GE for fraud, misrepresentation and breach of contract, accusing the company of selling flawed reactor designs the company knew were unsafe. One of the litigants was the Washington Public Power Supply System and the reactor at the heart of its lawsuit was the Columbia Generating Station. WPPSS sought $1.2 billion in damages.

During the disclosure process, GE was forced to turn over evidence that revealed the company had been aware of potentially fatal flaws in the Mark I and II designs for at least 10 years — and possibly since the very start of its reactor program dating back to 1958.

The evidence came in the form of numerous memos from GE’s own engineers who repeatedly expressed concern that the reactors’ pressure containment shells were likely to fail during an accident, leading to explosions that would pour dangerous clouds of radiation over nearby lands and waterways. GE admitted it had a problem in 1974 when officials confided to the industry journal *Engineering News-Record* that its Mark II containment vessel “could be subjected to ‘newly discovered’ physical loads that could structurally damage the steel containment and the equipment inside it.”

Documents disclosed during the trial revealed that GE had been assigning engineers to try to fix the design problems since 1958. All the while, GE continued promoting sales of its reactors to companies in the US and around the world.

How could General Electric justify such a practice? According to the *Cascadia Times*, GE officials apparently assumed they would eventually find a way to fix the problematic reactors. And, when they did, “the utilities would have to hire GE to fix them.”
Federal Judge Alan A. Anderson presided over the Washington State trial. After

reviewing the evidence, Anderson concluded that GE "hid serious doubts" about the safety of the reactor it sold to WPPSS.

"The concealment constituted bad faith and nullified [a] contract provision limiting GE's liability," Judge Anderson concluded. "The Court can only view [GE's policies] as a fairly sophisticated form of Russian roulette."

The initial lawsuit ended in a mistrial, with Judge Anderson ruling that WPPSS could file a subsequent complaint against GE charging "negligent misrepresentation" rather than "fraud." In 1992, GE opted to settle out-of-court with an offer of $134.9 million in "goods and services." To sweeten the deal, GE offered to provide WPPSS with $16.5 million worth of extra electricity per year. And how would GE provide this bonus power? By increasing the power output of its flawed CGS reactor by 50 megawatts.

Thirty-seven years after GE's quiet, in-house admission to *Engineering News-Record*, the very disaster its engineers had predicted, took place inside three GE reactors at Fukushima.

Taking it to the NRC

On March 12, 2012, with the Fukushima disaster clearly in mind, the NRC requested that all nuclear plant operators provide detailed "Mitigation Strategies for Beyond Design Basis External Events." Energy Northwest was ordered to deliver an Overall Integrated Plan by February 28, 2012. When the deadline came around, Energy Northwest informed the NRC that its strategies were "preliminary," "not yet finalized," and "subject to change as strategies, procedures, and modifications are finalized and equipment is procured." Energy Northwest promised to advise the NRC of any "significant changes to the plan or the proposed schedule" in "subsequent status reports."

So what plans did the company develop to prevent a Fukushima-scale disaster from occurring at the CGS? That remains unknown because, as A. L. Javonik, Energy Northwest's Vice President for Engineering, informed the NRC: "Energy Northwest believes that this submittal contains some information that should not be made publicly available." The company therefore requested that its plans for handling a Beyond Design Basis challenge "be withheld from public disclosure."

In an earlier letter dated October 25, 2012, Energy Northwest assured the NRC that the "implementation" of its order would be completed prior to the reactor's restart following a refueling outage scheduled for May 1, 2015 — more than four years after the Fukushima meltdowns.

As previously mentioned, on March 21, 2013, Beyond Nuclear, the Oregon and Washington PSR chapters, and 22 other citizens' groups filed a citizens' petition with the NRC demanding the revocation of operating licenses for all fatally flawed GE reactors with Mark I and Mark II containments. It seemed a reasonable request. The NRC's Japan Lessons Learned Task Force had already concluded that the GE reactors were prone to "early containment failure" in the event of "a severe nuclear accident."

The first petition review board hearing was held on May 2, 2013.

At that meeting, a delegation of anti-nuclear experts filed a complaint that the NRC had "rejected its own staff cost benefit analysis that the filtered containment vent was justified." (They also let the hearing officer know that their documentation had been forwarded to the Office of the Inspector General.)

On June 17, 2013, the Petition Review Board announced that it saw no need to entertain the call to revoke the licenses of North America's 31 Fukushima-model GE Mark I and Mark II reactors.

An Appeal to Macfarlane

On July 4, 2013, PSR's Oregon and Washington chapters sent a letter to Commissioner Macfarlane outlining their concerns about heightened earthquake risks at the Hanford Nuclear Reservation and the potential implications for the CGS reactor.

The concerned activists were hopeful of a positive response, given some of Macfarlane's recent press statements. On March 19, 2013, Macfarlane criticized a cost-benefit analysis because NRC staff "did not include the potential costs of offsite releases similar to those experienced by Japan after the Fukushima accident." On another occasion, Macfarlane observed: "We don't know everything about how the Earth behaves, and we must factor this into how we approach nuclear safety."

Even more remarkable, according to a *New York Times* report, Macfarlane marked Fukushima's second anniversary with a speech on March 12, 2013, in which she declared "the current generation of reactors has already outlived the theory of geology that was prevalent when their sites were chosen…. They predate wide acceptance of the theory of plate tectonics — the view that the Earth's crust is made up of plates that rub and slip against one another."

Three months later, on October 1, Macfarlane sent a reply. In her letter, she simply noted that the NRC "continues to conclude that CGS has been designed, built, and operated to safely withstand earthquakes likely to occur in its region." The PSR chapters were naturally disappointed that Macfarlane failed to address the issue of troubling geologic data, "some of which has been widely known to Washington state geologists for over a decade."

(It's not as if the NRC doesn't realized the dangers. In an email dashed off to colleagues four days after the Fukushima quake, Brian Sheron, head of the NRC's Office of Nuclear Regulatory Research, referenced some of the alarming findings about new fault hazards in Central and Eastern Washington. This data, Sheron wrote, demonstrated the NRC "didn't know everything about seismicity…. And isn't there a prediction threat the West Coast is likely to get hit with some huge earthquake in the next 30 years or so? Yet we relicense their [nuclear] plants.")

On November 23, 2013, Beyond Nuclear Director Paul Gunter reached out to Washington State Representative Gerry Pollet to support a request for a formal inquiry into the safety of the CGS plant. Pointing to the same "containment vulnerability responsible for multiple catastrophic failures at Fukushima," Gunter warned of a pattern of pro-nuclear "regulatory protectionism" that pervades both Tokyo and Washington and "places the public at undue and unacceptable risk."

In written testimony to the NRC, Charles K. Johnson, director of the Joint Task Force on Nuclear Power for the Oregon and Washington chapters of PSR, laid out a number of critical concerns. These included:

(1) "Demonstrably inadequate containment structures" that had contributed to the ongoing radioactive calamity in Japan. The meltdown of three GE-designed reactors provided proof that continued operation of the flawed CGS plant violates the NRC's

obligation that licensees guarantee “an essentially leak-tight containment against the uncontrolled release of radioactivity.”

(2) An earthquake-triggered accident at the nearby Hanford Nuclear Reservation would spawn a cloud of radioactive fallout that could spread to the CGS, causing the site “to become so radioactively hot that operators might be at immediate health risk.”

(3) Failure of the Grand Coulee dam, due to a quake, would flood the region and cut power to the reactor site. Flood damage to the reactor’s water-intake systems and access roads would amplify the dangers and complicate the ability to respond. (The CGS is one of 34 reactors — one third of the US fleet — at risk from the collapse of upstream dams. A 41-page study that revealed the danger was suppressed by NRC officials. It only came to light after two NRC whistleblowers leaked the report. In September 2013, Public Employees for Environmental Responsibility sued the NRC to force release of agency studies on the risks of dam failures. PEER argued that the probability of a massive dam failure destroying a US nuclear plant “is higher than the probability of the Fukushima tsunami.”)

(4) The failure to consider new seismic data during the May 2012 relicensing hearings constituted another example of the NRC’s ongoing standard of lax “regulatory oversight.”

(5) The NRC’s decision to ignore the “lessons of Fukushima” and the advice of its own staff by requiring reactor operators to add hardened vents to Mark I and Mark II containment structures but not requiring that the vents include filters to trap radioactive gases and particles. Hardened vents equipped with filters have become the new post-Fukushima standard in Finland, Germany, Japan, Switzerland, Sweden and Taiwan.

Refusing to be rebuffed, Beyond Nuclear, the PSR chapters and the other petitioners subsequently utilized the NRC’s Management Directive 8.11 to gain one further opportunity to argue its case. The NRC has yet to reply to the request.

Meanwhile, on December 14, 2013, the NRC announced that it would grant critics calling for the shutdown of the CGS reactor the right to hearings as part of a formal petition process before the NRC’s Petition Review Board.

The “breakthrough” was a necessary-but-not-sufficient step forward. “We didn’t ask for a petition,” one activist lamented, “We asked for a shutdown based on the earthquake information.” So, instead of a proactive response to a potentially grave threat, “the NRC has decided to put us into a slow petition process.”

But if it’s a slow process to challenge the safety of a flawed and aging reactor built in the midst of an earthquake haven, it’s another matter when it comes to expediting the continued operation of the same facility.

NRC Relicenses CGS for another 30 Years

On May 22, 2012, the NRC relicensed the nearly 30-year-old CGS reactor to continue operating for another 30 years. The new license was granted despite the fact that the plant’s seismic evaluation was still in the works. Meanwhile, news coverage of Fukushima’s three nuclear meltdowns provided a stark reminder of what fate might have in store for the CGS General Electric Mark II reactor.

What was not reported in the media’s coverage was the fact that anti-nuclear activists in Japan had repeatedly warned of the specific dangers posed by the Fukushima reactors. Their complaints eerily foreshadowed the very problems that have given rise to concerns about the CGS. Aileen Mioko-Smith, the director of Green Action, Japan’s leading anti-nuclear organization, noted that TEPCO’s reactors were “operating on 1978 earthquake-resistant guidelines” and ignoring more recent studies that revealed greater31 than-imagined seismic dangers. “Tokyo Electric’s analysis of the earthquake magnitude potential at the Daiichi site was unscientific and grossly underestimated,” she charged.”The study’s main technique considered fault lines as short and separate threats when they were clearly parts of a much larger system.”

At CGS, as at Fukushima, the facility was designed to store dangerously radioactive spent fuel rods in a pool placed near the top the structure, 100 feet above the ground. Pointing to the trouble-plagued Fukushima cleanup, Steven Gilbert, a toxicologist and president of Washington’s PSR chapter, underscored the parallel risks at the CGS: “If an earthquake cracked that spent-fuel facility, we could have a Fukushima-like scenario on our hands.”

A collapse of the spent fuel pool atop Fukushima's damaged Unit 4 building could spill 1,500 new and used fuel rods. The ignition of Unit 4's 400 tons of radioactive fuel assemblies could release 15,000 times the amount of radiation produced by the atomic bomb that destroyed Hiroshima. All told, there are more than 11,000 fuel assemblies scattered about Fukushima. Former DOE official Robert Alvarez estimates these fuel assemblies contain more than 85 times as much lethal cesium as was released at Chernobyl.

The CGS has 27 steel and concrete casks to store used nuclear fuel on site. Each cask holds 68 fuel assemblies. The water-cooled spent fuel pool high up in the CGS containment building was designed to accommodate 2,658 fuel assemblies. As of 2013, the storage pool was reported to be two-third full. This would total more than 1,700 fuel assemblies — more than are at risk at the Unit 4 site in Fukushima.

Unfortunately, the massive, ongoing (and still-uncontrolled) radiation spills seeping and venting from the damaged Fukushima reactors appears not to have prompted an "excess of caution" from officials at the NRC or Energy Northwest. In October 2013, Dave Swank, vice president of engineering at Energy Northwest, assured the media: "I don't have any concerns." Echoing the NRC, Swank explained there was no cause for undue alarm because the "odds" of a major quake were low. Swank also quoted from Macfarlane's letter to PSR in which she maintained "the NRC continues to conclude that CGS has been designed, built and operated to safely withstand earthquakes likely to occur in its region."

Unfortunately, these reassuring words don't hold up when you look beneath the surface — which is exactly what a team of citizens and scientists have done. On October 31, 2013, John Pearson, MD and Steven G. Gilbert, PhD, fired off an eight-page letter to Macfarlane on behalf of the Oregon and Washington chapters of PSR.

"We need to know what data you are using as the basis for your conclusion," they wrote. "From what we can gather from your letter, the NRC, under your leadership, has no intention of independently evaluating readily available geological evidence about the increased seismic potential of the CGS-Hanford site until after receiving Energy Northwest's report."

“All of this evidence leads us to urge you to fulfill your mandate as nuclear regulators and put the safety of the public… above the utility’s interests,” Pearson and Gilbert wrote. They concluded by calling on Macfarlane to shut down the CGS reactor “until it can be shown that it meets adequate earthquake standards.”

New Discoveries about Historic Megaquakes

It turns out the geology of West Coast of the US has something uniquely in common with the East Coast of Japan: The potential for massively destructive “megaquakes.” Japan’s 2011 quake was triggered by an offshore “subduction zone.” In tectonic terms, “subduction” takes place when one vast stretch of crustal plate suddenly thrusts forward, shoving itself beneath another massive plate.

It takes a subduction zone to produce a “megathrust” earthquake. There is only one subduction zone along the continental US, and it is located off the coast of Washington, Oregon and California.

For eons, Washington State has been an earthquake campground — a convention center for tectonic convulsions. The NRC was aware that shallow quakes were widely distributed over Washington State, while deep earthquakes were mainly felt in western parts of Washington and Oregon, but the possibility of a catastrophic magnitude-9 megathrust quake was not suspected until 1984 — the very year the CGS reactor began operations.

“The interface where rocks jerk past each other in an earthquake, called the ‘rupture zone,’ is immense,” notes PSR’s John Pearson. How immense? In her book, Full Rip 9, Seattle Times science reporter Sandi Doughton notes: “A magnitude 9 subduction-zone quake can rupture an area bigger than the state of Maine” — i.e., 35,385-plus square miles. This could be an ominous portent for the CGS: The state of Maine is 190 miles wide, which is nearly the distance between the ocean and the CGS’s reactor core.
In Japan, there had been a historic warning of the 2011 quake. A similar megaquake had hit the same area in 869 AD. The 8.8 Sanriku quake struck the northern coast of Honshu, causing major devastation across and region. And it would turn out that a similar foreshadowing event had occurred along the West Coast.

A ‘Ghost Forest’ Haunts the Northwest

On January 26, 1700, a violent realignment of the 740-mile-long Cascadia Fault triggered a 9-magnitude quake that shoved the West Coast several feet closer to Asia. The upheaval sent a monster tsunami powering across the Pacific. Ten hours later, it crashed into Japan, destroying farmlands and flooding warehouses stocked with rice. The cataclysm was caused by the relatively tiny Juan de Fuca plate pushing eastward and plunging below the North American continental plate. While transform faults like California's San Andreas can generate severe quakes as strong as 8.1, only subduction zones can muster the size and length needed to trigger megaquakes.

The Cascadia monster-quake was unknown to the engineers who designed the nuclear reactors on the California coast and inland in Washington State.

Like many scientific discoveries, the 1700 megaquake was revealed by chance. In 1984, a USGS researcher named Brian Atwater was paddling a canoe along the shoreline of Willapa Bay, just north of the Oregon-Washington border. On this particular day, an especially low tide had exposed an odd expanse of mud bristling with hundreds of weathered stumps. Atwater correctly suspected the half-buried trunks were the remains of a "ghost forest" that had been destroyed by an ancient flood. Tree-ring evidence placed the date of the disaster in 1700 — the same year the massive tsunami struck the coast of Japan.

Atwater's discovery was soon reinforced by a report by Eric and Kanamori Heaton in the Bulletin of the Seismological Society of America. The Heatons proposed that the Cascadia Subduction Zone (CSZ) was capable of generating incredibly strong quakes. Geologists quickly connected the geomorphic dots and deduced that the towering seawaves that struck Japan in 1700 had been spawned by a massive earthquake along the CSZ. The same event that ravaged Japan's coast first obliterated the Willapa Bay forest, dropping the continental plate several feet in a few cataclysmic seconds and causing a Pacific Ocean tidal wave to flood the region. (And, remember, when we say "dropping a tectonic plate," we're talking about a plate that can be 50 miles thick.)

The Heaton report spurred a flurry of new research into the seismic history of the Pacific Northwest. By 1995, at least 86 new studies reported evidence that an active CSZ existed offshore — running more than 700 miles from the top of Vancouver Island and south to California's Cape Mendocino.

Other scientists subsequently discovered that the devastating megaquake, while unknown to the country's best academic minds, was well known among the communities of Indigenous peoples living in the Pacific Northwest. The cataclysm was firmly embedded in the oral tradition of the Makah people. The story of the battle between Thunderbird and Whale had been passed down over 15 generations. The tales told of the night when the oceans vanished, only to return and surge halfway up the mountain slopes.

In 2012, the USGS published a report by Oregon State University's College of Earth, Ocean, and Atmospheric Sciences that documented a history of 19 major earthquakes (ranging from magnitude 8.7 to 9.2) that rocked the CSZ over the past 10,000 years. In addition, examination of seafloor drilling cores uncovered evidence of 23 magnitude-8.0-and-above quakes occurring in just the southern section of the fault. The study's lead author, OSU professor Chris Goldfinger noted: "If they happened today, [such earthquakes] could have a devastating impact."

Patrick Corcoran, a hazards outreach specialist with OSU's Sea Grant Extension program, found the discoveries troubling. "We in the Pacific Northwest have not had a mega-quake since European settlement," Corcoran said. "And since we have no culture of earthquakes, we have no culture of preparedness…. Now that we understand our vulnerability to megaquakes and tsunamis, we need to develop a culture that is prepared at a level commensurate with the risk."

Previous research had concluded CSZ megaquakes (capable of causing devastation from Vancouver Island to California) occurred about once every 500 years but OSU's 13 years of research also revealed that major earthquakes tend to strike along the Cascadia every 240 years or so. While four so-called "Full Rip 9″ megaquakes are known to have hit the Pacific Northwest between 2000-0 BC, the period from 0-1700 AD registered five 9.0-plus megaquakes.

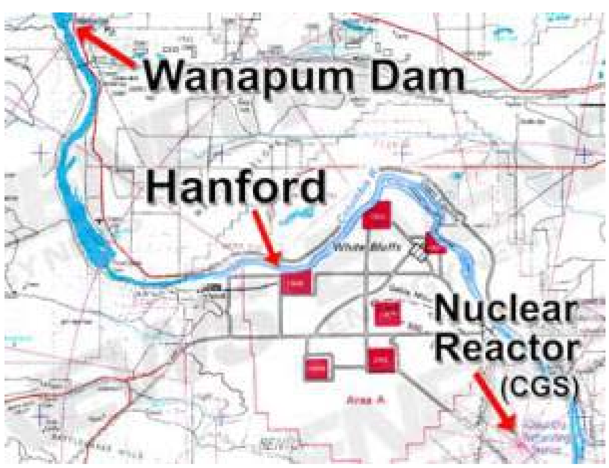
The OSU team predicted there was a 40% chance a major quake could strike southern Oregon before 2062. "It has been longer than that since it last happened," Goldfinger, observed. "Frankly, it is overdue for a rupture." (Note: The 250th anniversary of the 1700 mega-quake fell in 1950.)

According to Jay Patton, a co-author of the OSU report, if the region is not hit by a Fukushima-style megaquake by 2060, “we will have exceeded 85 percent of all the known intervals of earthquake recurrence in 10,000 years.” The odds are that any child born after 1990 and still living in the Pacific Northwest will become either a victim or a survivor of the region’s next monster quake.

The past decade has seen an increase in progressively larger tremors along the CSZ. Even so-called “slow slip events” can put added strain on nearby sections of blocked faultline rock and this could eventually trigger larger quakes. A computer model created by Stanford Geophysics Professor Paul Segall suggests that it may well be one of these “tiny” quakes that triggers the next magnitude-9 catastrophe.

And when it happens, some estimates warn that the pressures backed up behind the North American plate will cause the Pacific Northwest to suddenly lurch 57 feet to the West at the same time the coast drops three to six feet.

The impacts of such a large earthquake would be extensive and long-lasting. While the worst damage would occur in the cities west of the Cascades, the impact of such a monster quake would be felt far inland. Over a wide region, high-voltage electric transmission lines, natural gas supplies, gas and fuel shipments would be disrupted for months. It could take up to three years to rebuild damaged electricity transmission lines. Recovery would be slowed by the fact that many damaged roads and bridges would need to be rebuilt. The loss of reliable offsite power and fuel would cripple operations at the CGS, compromising the safety of the reactor and stored fuel rods.



While a megaquake could send a tsunami racing up the Columbia River, it would be unlikely to advance more than a half-dozen miles. More troubling would be the danger that ruptured dams upriver could release a deluge in the direction of the Hanford Nuclear Reservation

Even at a distance, the resulting ground motion would rock the CGS reactor with a force that could damage pipes, threaten the containment structure, or crack the stored fuel pools, causing them to drain and ignite. Any of these failures could lead to a Fukushima-style core meltdown and a hydrogen explosion.

NRC's Fukushima Response: "Lessons Learned" but Not Applied

One month after the Fukushima quake and tsunami, it was clear that TEPCO and the Japanese government had lied to the public about the scale and the dangers of the disaster. For weeks, government officials and TEPCO spokespersons issued a string of false assurances to mask the fact that four badly damaged reactor buildings were not stabilized and that three nuclear cores had gone into meltdown.

After a six-month Parliamentary investigation, Japan's Fukushima Nuclear Accident Independent Investigation Commission concluded the disaster "was the result of collusion between the government, the regulators and TEPCO." The Commission issued a stern recommendation: "Japan's regulators need to shed the insular attitude of ignoring international safety standards."

The official 660-page report prepared by the Japanese Diet also contained a finding that cast a pall over every GE Mark I and Mark II reactor still in operation: At least one of the damaged reactors at Fukushima Daiichi (Unit 1, the first to fail) succumbed to the forces of the earthquake, not to the floodwaters of the tsunami.

It was subsequently reported that Units 1 through 4 all showed evidence of so-called "Euler strut bulges," which are clear indications of seismic damage.

Despite the warnings from Japan, however, the NRC continues to insist "the newest seismic data suggest that, although the potential seismic hazard at some nuclear power plants… may have increased beyond previous estimates, all operating nuclear plants remain safe *with no need for immediate action*." (Emphasis added.)

Japan’s six-month investigation into the causes of the Fukushima disaster concluded that the crisis was a “profoundly man-made disaster that could and should have been foreseen and prevented.” Let’s hope this is never said about the Columbia Generating Station.

Originally posted at http://safeenergy.org/2014/06/18/nrc-denies-earthquake-petition/.

A condensed version of this article is available at http://www.earthisland.org/journal/index.php/elist/eListRead/washingtons_columbia_generating_station_is_a_seismic_timebomb.

Some comments from that posting:

Comments

It is interesting to note the author’s reference to the Fukushima Nuclear Accident Independent Investigation Commission report.

That report also includes this:

“If NISA had passed on to TEPCO measures that were included in the B.5.b subsection of the U.S. security order that followed the 9/11 terrorist action, and if TEPCO had put the measures in place, the accident may have been preventable.” (p. 16)

By John Dobken on Mon, May 12, 2014 at 1:31 *pm*

The power company TEPCO and the Japanese government have been lying about the actual amounts of radiation from the beginning of the disaster that they allowed to happen and they have been lying to this very day! You cannot ever trust anything they put out to the media for the people. When the internet company zeolite dot com offered both TEPCO and the Japanese Government a 100 percent FREE full shipping container load of the medical grade radiation detox mineral called zeolite that could have safely removed radiation from thousands of peoples bodies. They refused the free zeolite.

By Barry on Sun, May 11, 2014 at 4:40 *am*

Even Brad Sawatzke, the plant's chief nuclear officer, conceded in an April 2011 interview that "our one Northwest nuclear reactor has the worst shutdown history in the country."

This was actually a quote from Gerry Pollet - not Brad Sawatzke - I hope the author will make the correction.

By John Dobken on Mon, May 05, 2014 at 3:57 *pm*

The Pacific Northwest National Laboratory in Richland, Wash. is currently conducting a seismic study of the area where Columbia Generating Station is located.

That study is due to the NRC in 2015 and will help inform Energy Northwest and the NRC about any modifications that need to be made.

If you want to know the facts about Columbia Generating Station's seismic capabilities, visit:

http://www.energy-northwest.com/ourenergyprojects/Columbia/Pages/Seismic-Safety.aspx

By John Dobken on Mon, May 05, 2014 at 3:51 *pm*