

Safety reviews, not shutdowns, are ordered in the wake of Fukushima

The US, China, and France each have a considerable stake in the growth of nuclear power. But public opinion may have greater sway.

With the extent of the damage and contamination from the nuclear disaster in Japan still unknown weeks afterward, implications for the hundreds of reactors operating around the world are similarly unclear. But as Japanese workers continued efforts to bring under control the four crippled reactors at the Fukushima Daiichi plant and the associated spent-fuel pools, other nations launched fresh safety assessments of their nuclear generating plants, even while reassuring their populations that a repeat of the sequence of events in Japan was highly unlikely. With a few exceptions, the closure of operating facilities, or even the abandonment of nuclear energy altogether, was not among the responses being considered.

The US reaction

In the US, home to the largest number of commercial reactors, the Nuclear Regulatory Commission assembled a task force of senior managers and former staff experts within days of the 11 March temblor and charged the group with assessing whether operating and safety procedures need to be changed. After its 90-day review, the task force will recommend possible formal changes to NRC regulations.

Bill Borchardt, NRC executive director for operations, told a Senate hearing on 29 March that the commission has in recent years approved 20-year license extensions for more than half of the 104 operating US reactors. The Vermont Yankee plant, one of the 23 US units with the same GE Mark I boiling-water reactor (BWR) design as those damaged at Fukushima, was granted its extension on 21 March, just days after the accident. The Vermont reactor was commissioned in 1972 and, like other US plants, was initially licensed for 40 years.

Borchardt told members of the Energy and Natural Resources Committee that there is no reason to slow the relicensing process. Should a change to the design of a US plant be called for by lessons learned at Fukushima, he said, the NRC would, "without hesitation," order the change to be made outside the licensing process. Additional safety requirements at US nuclear plants should prevent a prolonged loss-of-coolant cri-

sis like the one that arose at the Fukushima Daiichi reactors. Following 9/11, the NRC undertook a review of the spent-fuel pool vulnerability issue specific to BWRs. As a result, measures to ensure that adequate water levels are maintained in the pools have been "greatly enhanced," Borchardt said.

Other NRC requirements during the past 20 years have mitigated the likelihood of power blackouts and hydrogen buildup that caused the explosions and radiation leaks seen in the Japan BWRs. Those requirements included the installation of radiation-hardened vent systems to release containment pressure and better positioning of batteries and other key pieces of equipment that would have helped operators at Fukushima to safely regain control of the reactors in the hours after the earthquake and tsunami struck, Borchardt said.

In the House of Representatives, longtime nuclear foe Edward Markey (D-MA) introduced a bill on 29 March that would suspend NRC licensing and relicensing activities until the adoption

of new safety measures that take into account lessons learned from Fukushima. "We should not wait for an American meltdown to beef up American nuclear safety measures," Markey said. But Nuclear Energy Institute president Marvin Fertel, representing the nuclear industry, issued a statement calling the legislation unnecessary in view of the NRC's safety reassessment process.

Markey's bill would also require US reactors to have available 72 hours of backup battery power and a much larger supply of fuel for diesel generators. David Lochbaum, director of the nuclear safety project at the Union of Concerned Scientists, told the Senate hearing that 93% of US reactors have only enough battery capacity to operate controls and pumps for four hours in a blackout. Markey's bill also would restrict the amount of spent fuel that reactor operators are allowed to keep in storage pools. Moving the spent fuel into dry casks after it has cooled for five years would reduce the number of fuel elements that could become exposed to the air during an accident that would lower the water

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A photo taken from a small, unmanned airplane on 20 March shows damage to the reactors at the Fukushima Daiichi powerplant in the wake of the 11 March earthquake and tsunami.

levels, as apparently occurred at Fukushima, Lochbaum and Markey argued. But Anthony Pietrangelo, Nuclear Energy Institute senior vice president, argued that five-year-old spent fuel produces very little heat or toxicity relative to fresh spent fuel.

China

Within days of the Japan quake, Premier Wen Jiabao suspended the review process for new reactor projects in China. The country's nuclear safety authority then ordered safety reviews for each of China's 13 operating plants, to assess contingencies for floods, earthquakes, and other natural disasters and to evaluate the reliability of their emergency power supplies. But various Chinese officials quoted in the state-controlled media insisted that the country's ambitious nuclear expansion plan remains on track. According to *China Daily*, Sun Qin, president of the China National Nuclear Corp, said, "China will not change its policy in developing the nuclear power industry." His remarks came during a 24 March visit to the Qinshan nuclear power plant, China's first power reactor.

"The safety of China's nuclear power facilities is guaranteed, and China will not abandon its nuclear power plan for fear of slight risks," Tian Jiashu, director of two nuclear safety centers under the Ministry of Environmental Protection, told the *People's Daily*. Yu Zusheng, an official of the Ministry of Environmental Protection, told *China Economic Weekly* that China should increase the use of third-generation reactor designs, such as Westinghouse's AP1000. The new designs include passively safe systems that don't require water pumps to cool the core in an emergency shutdown.

Of the 61 reactors now under construction worldwide, 28 are located in China, according to the nation's energy administration. Another 50 reactors are planned for China, according to the World Nuclear Association (WNA), which means that approvals and financing or major funding commitments are in place and that commissioning is expected within 10 years. An additional 110 reactors are proposed for China within about 15 years, according to the WNA.

Europe

Several European leaders reached a consensus quickly on a need for international nuclear safety standards. French president Nicolas Sarkozy, on a 31 March visit to Tokyo, said he will invite the Group of 20 developed nations to Paris in May to discuss the matter.

Few countries have a greater investment than France in the future of nuclear energy. Its 58 reactors produce more than three-quarters of the country's electricity needs—a greater proportion than any other nation. Also a net exporter of electricity, France sells more than €3 billion (\$4.3 billion) worth of power annually to its neighbors. And it is a major exporter of reactors and nuclear fuel and services, including reprocessing of spent fuel. The mostly state-owned Areva is the world's largest nuclear company.

European Union ministers met on 21 March and announced plans to carry out individual stress tests to measure the safety of the 143 operating reactors in EU member states. "Our first priority is to ensure that the highest standards are enforced in the European Union," Tamás Fellegi, the Hungarian minister who chaired the meeting, told reporters afterward. The voluntary tests should get under way by the end of the year and will assess seismic and flooding vulnerabilities, the adequacy of the reactor cooling and backup electric supply systems, and other factors. Neighboring non-EU countries that operate reactors will be invited to participate. Left unresolved, Fellegi acknowledged, is what action the EU will take in the event that a reactor fails its stress test. British Prime Minister David Cameron said the tests should be performed by "independent international regulators" and the results peer reviewed. German Chancellor Angela Merkel called for the results to be made public.

Noting that 14 of the EU's 27 member states have commercial nuclear plants, EU energy commissioner Günther Oettinger told reporters, "There are very few issues where national governments and parliaments have such a disparity of views as they do on nuclear energy." Italy, which closed the last of its four commercial reactors in 1990, had planned to build four new reactors, beginning in 2013. Now that plan has been delayed by at least a year as a result of the Japanese accident.

The German government has been considering whether to close its 17 reactors and abandon nuclear power. Within days of the quake, German authorities ordered immediate shutdown of the nation's 7 oldest commercial reactors, all commissioned before 1980. Restart will be contingent on the outcome of safety reviews, which were also ordered for the 10 German reactors that continue to operate.

In the UK, the office of the chief nuclear inspector has begun a six-month safety review of the 19 British

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commercial reactors. Thirteen reactors are planned or proposed for the UK, where nuclear energy accounts for 18% of electricity output, according to the WNA. In 2006 the UK's Labour government set a new national policy aimed at encouraging nuclear growth.

On 28 March International Atomic Energy Agency director general Yukiya Amano announced the convening of a nuclear safety conference in Vienna on 20–24 June. The agenda will include assessment of the causes and consequences of the Fukushima disaster and strengthening of nuclear safety and accident response measures.

US environmentalists' reactions

Environmental organizations were generally restrained in reacting to the Fukushima accident. The Natural Resources Defense Council urged that the NRC suspend its consideration of license extensions for reactors in highly seismic areas and recommended that it review existing extensions for reactors in such locations. The group also called on President Obama to order an independent inquiry into the safety of all US reactors in view of the Japanese events. "Review of the implications of this disaster should not be limited to the NRC assessing the adequacy of its own previous rules and decisions," council

president Frances Beinecke wrote in a letter to Obama. "This would be problematic for any entity, but is particularly the case for the NRC, which has long been seen as a weak regulator with insufficient independence from the industry it oversees."

Charles Ferguson, president of the Federation of American Scientists, urged Japan to reevaluate its growing reliance on nuclear power. The earthquake-prone nation had plans to increase its nuclear generation from about 30% of total electricity generation today to 41% in 2017, and to as much as 50% by mid-century. Instead, Ferguson urged Japan to adopt policies to stimulate greater use of renewable energy sources.

The longer term

It is too early to tell just what the impact of Fukushima will be on the renaissance that nuclear advocates had hoped lay ahead for the industry. Just one of the 62 reactors under construction globally is in the US—the second unit at the Tennessee Valley Authority's Watts Bar plant, whose completion is scheduled for 2013. Another 9 reactors are planned in the US, and 23 are proposed. President Obama has not altered his support for more nuclear power as one element of a plan to double the share of US electricity generated from "clean energy"

sources to 80% by 2035. But the building of new reactors will depend on the level of public acceptance and the availability of financing. And the capital markets have long been leery of the high costs, frequent overruns, and regulatory uncertainties of nuclear compared with natural gas and coal generation.

To help overcome the financing crunch, Congress authorized, and the Department of Energy has been offering, loan guarantees to nuclear utilities. In the first such deal, \$8.3 billion in guarantees was provided to Southern Co last year for construction of an AP1000 reactor to be located at a nuclear plant near Waynesboro, Georgia. Approval from the NRC is anticipated for that project. President Obama in February asked Congress for authority to issue up to \$36 billion in nuclear loan guarantees. But even guaranteed financing isn't always sufficient to seal a deal; last year Constellation Energy backed out of a joint venture to add a third reactor at its Calvert Cliffs plant in Maryland; company officials complained that the DOE's fee of \$880 million to guarantee \$7.5 billion of debt was too high. That left the other partner, Électricité de France, which operates all French reactors, to pursue the project alone.

David Kramer

For some, helium-3 supply picture is brightening

R&D efforts are beginning to pay off in reduced demand for the scarce neutron-detection isotope. But there is little relief for those requiring it outside the US.

A year after complaining that the tap on their helium-3 supply had been shut off, US users of the gas for scientific applications say the flow has resumed. But researchers abroad continue to face prohibitively high prices for it, when they are able to find it. Although the shortage of ^3He has spurred rapid advances in the development of alternatives for neutron detection, little progress has been made on adding new supplies.

The US inventory of ^3He has stabilized since shipments from the US stockpile for use in radiation portal monitors were halted early in 2009 and an interagency task force took over control of distributions (see PHYSICS TODAY, June 2010, page 22). By then, the Domestic Nuclear Detection Office (DNDO) had drawn an estimated 60 000 liters from the US reserve to equip the approximately 1300 ^3He -guzzling monitors that have been installed at US ports and border crossings. With that drain on supply plugged, and a modest new quantity of



Using tubes lined with boron-10, GE and SAIC have developed a plug-in replacement for the helium-3 neutron detectors in radiation portal monitors, used to scan cargo entering the US for the presence of nuclear materials. Portal monitors, which use large amounts of ^3He , were blamed for creating a worldwide shortage of the gas.