NUCLEAR SAFETY

Preventing the Next Fukushima

Weak authority and largely voluntary standards limit global institutions' impact on nuclear safety and security.

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While this year's disaster at Japan's Fukushima Dai'ichi plant, the worst since Chernobyl in 1986, was caused by the one-two punch of a huge earthquake followed by an immense tsunami—a disaster unlikely to occur in many locations—it revealed technical and institutional weaknesses that must be fixed around the world. If nuclear power is to grow on the scale required to be a significant part of the solution to global climate disruption or scarcity of fossil fuels, major steps are needed to rebuild confidence that nuclear facilities will be safe from accidents and secure against attacks (*1*).

It is too soon to draw all the lessons from the Fukushima disaster. But it is clear that the reactors' abilities to maintain cooling in the event of a prolonged loss of power and to vent dangerous gas buildups were insufficient, as were the operators' ability to respond to large-scale emergencies and the regulators' degree of independence from the nuclear industry (*2*). Operators and regulators around the world are reviewing their nuclear safety measures and responding to heightened public concerns. Governments' conclusions have ranged from China's plan to continue its massive nuclear construction effort to Germany's decision to phase out all nuclear energy by 2022.

But how are global institutions responding? The Chernobyl accident led to much of the current global nuclear safety regime, such as the Convention on Nuclear Safety (CNS) and other safety and liability treaties; an expanded safety program at the International Atomic Energy Agency (IAEA), including nonbinding safety standards and safety peer reviews carried out when states ask for them; and industry efforts such as the World Association of Nuclear Operators (WANO) that exchanges best practices and carries out peer reviews (*3*). But these institutions still leave primarily to each country the decisions about what nuclear safety and security measures to take, with only broad and largely voluntary international standards in place and weak authority for global institutions like the IAEA. Will Fukushima lead to new action to strengthen the global nuclear safety and security system?

So far, the signs are not promising. With competing proposals from several countries, little understanding of which ideas would help, and a lack of sustained leadership focused on building support for key initiatives beforehand, little consensus emerged at June's IAEA ministerial meeting, although the ministers directed the agency to prepare a suggested action plan. That plan, a 22 September United Nations conference on nuclear safety and natural disasters; reviews of the CNS; and the ongoing WANO effort to find ways to strengthen its operations all represent opportunities for progress.

Over the long term, new reactor designs with greater reliance on "inherent" safety measures, e.g., not requiring active pumps and valves to maintain safe operation, may reduce risks. But for the next few decades, most nuclear energy will be generated by the hundreds of reactors that already exist and those that will be built with existing designs. Hence, the near-term focus should be on upgrading safety and security for existing and planned facilities and building institutional approaches that can find and fix the facilities that pose the highest risks. We propose actions in six areas.

Higher Safety Standards

More stringent national regulations and international safety standards are needed, covering several issues. Reactor operators should be required to be better prepared for disasters such as floods and earthquakes, as well as for any events that cause a prolonged loss of electrical power, the key factor that led to the Fukushima disaster. These are the kinds of issues addressed in the "stress tests" the European Union is conducting and that regulators in other countries are pursuing.

The Fukushima earthquake and tsunami were both larger than the "design basis" Japanese plants were required to protect against, as was a 2007 earthquake near the Kashiwazaki-Kariwa nuclear plant. All regulators should reassess whether design bases reflect the spectrum of plausible disasters, requiring safety backfits where necessary, and should also require operators to plan responses to events beyond plants' design bases.

Operators should be required to install filtered vents, as some countries have done, which could greatly reduce the amount of radiation released if a dangerous pressure buildup in a reactor forces operators to vent gases, as occurred at Fukushima (*4*). Operators should also be required to put in place measures to prevent spent fuel from melting or burning if a spent fuel pool drains, such as installing survivable systems to spray the fuel in the pool with water. Ultimately, much of the fuel now stored in spent fuel pools should be moved to safer dry casks (*5*).

Institutionally, regulators must be wholly independent of those they regulate and have the authority, resources, expertise, and culture to be effective. For example, Japan has decided to separate its regulator from the ministry responsible for nuclear power.

The IAEA should recommend that states require steps such as these. The United States and other countries operating and exporting nuclear reactors, along with industry groups such as WANO, should press for these steps to be taken, in the interest of both public safety and the future of nuclear energy.

Higher Security Standards

There is a need for more stringent standards for protecting nuclear facilities against terrorist sabotage—a step both al Qaeda and Chechen terrorists have considered. Terrorists have also sought materials to make a crude nuclear bomb (*6*). Nuclear safety and security measures are in many ways mutually reinforcing (although they can sometimes conflict, as when safety might call for rapid emergency evacuation, whereas security might call for checking those who leave). A nuclear facility cannot be considered safe, in the sense of posing little risk to humans and the environment, unless it is also secure (*7*).

Yet today, security in place at many nuclear sites around the world is weak, and the IAEA security recommendations are much less specific than the agency's safety standards. Nuclear security, ignored at the June IAEA ministerial and in the EU stress tests, must be a fundamental part of the follow-up to Fukushima. States should adopt rules and practices that ensure that weapons-usable nuclear materials and major nuclear facilities, not just power reactors, are effectively protected

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against all plausible terrorist threats. The IAEA should issue recommendations to prevent a "security Fukushima," and the IAEA and the World Institute for Nuclear Security (WINS), the key operatrors' organization focused on security, should work with operators to ensure that nuclear security best practices are shared and implemented. Progress on these steps could build support for further action at the March 2012 nuclear security summit in Seoul.

Stronger Emergency Response

Nuclear operators and the institutions around them, e.g., local police, fire, and emergency departments, must put in place more effective emergency response plans and conduct regular and realistic exercises to make sure all the key players know what to do in a crisis. Operators should have redundant instrumentation and backup control centers, in case a reactor control room stops functioning (as also occurred at Fukushima). IAEA standards should call for each of these steps.

The IAEA response to the Fukushima crisis was often too little, too late, in sharp contrast, for example, to the World Health Organization's ability to respond quickly to disease outbreaks. The IAEA emergency response—from providing reliable independent information and analysis to helping the affected state—needs radical improvement.

Although difficult issues of responsibility and liability would have to be addressed, the industry should pursue the recommendation by James Ellis, president and CEO of the Institute of Nuclear Power Operations (INPO), who called for creation of an international emergency response team "with pre-staged equipment that is interoperable both domestically and internationally" (*8*). Such a team should probably be managed by the industry itself, with its capacity for rapid decision.

Strengthened and Expanded Peer Reviews

Every country operating major nuclear facilities should ask for an international team to review its nuclear safety and security arrangements. Reviews to check compliance with inadequate standards are not enough; these reviews should be based on the more stringent safety and security standards just described. WANO and the IAEA already provide safety peer reviews, using somewhat different approaches. But WANO reviews are organized by the industry and are kept confidential, whereas most reactors have never had a more transparent IAEA safety review or any international review of their security measures. The IAEA might select only a fraction of facilities for on-site reviews initially, to conserve resources (although WANO plans safety reviews at all reactors every few years), but the possibility of being selected would encourage other operators to upgrade standards.

Such reviews could help rebuild public confidence (as an IAEA review did after the 2007 earthquake at the Kashiwazaki-Kariwa plant) and identify issues that may have been overlooked. The largest nuclear operating and exporting countries should offer to accept such reviews at their civilian facilities and should work to convince others to do the same.

Legally Binding Requirements

Given the international consequences of a major release, there is a strong case to be made for more stringent global requirements, although states will insist on ultimate control over nuclear safety and security decisions. Treaties governing nuclear safety and security, such as the CNS and the Convention on the Physical Protection of Nuclear Materials and Facilities (with its 2005 amendment), express broad goals but include few specific requirements. States should negotiate specific, binding standards for both safety and security, although this is not likely to happen quickly, given the current lack of consensus (*3*, *9*). As Ellis put it, the world needs to find "the sweet spot between national sovereignty and international accountability" (*8*).

Expanded International Cooperation

There is a clear need for expanded international nuclear safety and security cooperation. The fact that the disaster revealed a range of inadequacies in nuclear safety in Japan, one of the world's wealthiest countries and among those with the longest experience in using nuclear energy, highlights the stringent demands for political and institutional stability, regulatory effectiveness, and sustained organizational excellence that today's nuclear technologies impose. Some nuclear countries, or countries now planning their first plant, struggle with regulatory ineffectiveness, corruption, and political instability. The IAEA, states and companies selling nuclear power facilities, and nongovernmental organizations must work together to help these countries put in place and sustain effective safety and security measures.

A Safer, More Secure Nuclear Future

A central lesson of Fukushima is that judgments that some events are so unlikely that they can be ignored may prove to be wrong. For example, new knowledge of the magnitude of historical tsunamis was not adequately incorporated into tsunami-protection rules, including rules for nuclear power plants (*10*). Ultimately, the goal must be a change in thinking and organizational priorities, to focus on achieving the highest practicable levels of nuclear safety and security, even when the risks being addressed seem small. Given large uncertainties, cost-benefit analysis should not always be the driver: Wherever low-cost steps could help protect against potential catastrophes, those steps should be taken, even if the dangers they protect against are thought to be very unlikely. Operators and regulators must assess regularly whether their organizational cultures focus sufficiently on safety and security. While much attention has been paid to power plants, safety and security of all nuclear installations that pose a risk of large radioactive releases should be reviewed. Much now depends on bold leadership from IAEA Director-General Yukiya Amano and the leaders of major states operating and exporting nuclear plants.

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