

After Fukushima: Early Implications for Nuclear Industry and Policy Makers

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Amidst the drama of the worst seismic catastrophe in Japan's recorded history, the Japanese government and its nuclear industry have been struggling since last Friday to meet their greatest-ever challenge: preventing a power reactor core melt accident similar to that which occurred at Three Mile Island in the United States three decades ago.

The scope of this challenge to Japan is almost inconceivable. When a force 9.0 earthquake struck off the Pacific coast on Friday, March 11, two nuclear power stations, Fukushima-Daiichi and Fukushima-Daini, with a total of ten reactors, suffered a loss of external power. Shortly after the seven operating reactors at these stations shut down automatically in response to the shock, emergency cooling systems—needed to remove decay heat from the reactors' radioactive fuel—ceased operating. Without external power, the cooling systems were reliant on local backups that, according to Japanese experts, were damaged by the devastating tsunami that followed the earthquake.

Since Friday afternoon in Japan, Japanese authorities and the plant's utility owner have been implementing a strategy to provide backup power and coolant water to the beleaguered reactors. The objective is to lower the temperature and pressure inside the reactor vessels, assure that the fuel is covered by water, avert significant fuel melting, and minimize the consequences if it does occur.

Thus far we know very little about how Japanese authorities managed this accident. Until Sunday, the world had very little information about whether authorities were taking concrete measures to get the situation under control. With events at the site still unfolding, that could be troubling because Japan's nuclear sector does not have a history of alacrity about its problems and transgressions of regulations by plant owners.

But given the shock, uncertainty, and massive overall logistical challenges faced by Japan beginning on Friday, we should not expect perfection in how information was made available to the outside world in this case. It may turn out that Japan's government and industry in fact supremely rose to the challenge and responded to the meltdown threat by taking effective and well-coordinated action.

Recognizing that it is going to take many months to fully understand what has transpired in Fukushima, there nevertheless are a few preliminary conclusions one may draw from these events:

- * First, the accident dramatically underscored that using nuclear reactors to generate electricity requires extraordinary and in-depth know-how, resources, infrastructure, and planning and management experience. During the last decade, in step with growing energy demand worldwide and recognition of the threat of global warming, nuclear power has gained in esteem and promise. Some existing operators have been significantly scaling up their nuclear operations and about 50 countries are considering launching nuclear power programs. The unfolding of events in Japan should prompt them and the international community to ask whether they have fully identified, and can meet, the necessary preconditions for safe operation of power reactors, including the ability to manage a severe accident. Greater international cooperation and time may be needed to demonstrate that suitable social and physical infrastructure is in place around current and prospective nuclear power plants, particularly those to be built in active seismic zones.
- * In addition, the experience from Japan clearly demonstrates why safety and licensing standards—for design, construction, operation, and maintenance—of power reactors must be high and continually improved whenever and wherever possible. The reactors at severe risk in Japan this week are about 40 years old. Japan's regulators would never award this reactor design a construction or operating license today. In recent years, some countries have extended the licensed lifetimes of older power reactors. China and India, two countries that expect to significantly expand nuclear energy, continue to build reactors which were designed more than 25 years ago. The events in Japan suggest that the safest option for moving forward with nuclear power is to build the most modern and safe reactors available.
- * Two earthquakes—one in 2007 and the second last week—have been far more powerful than anticipated for their location and disabled all but two of the seventeen reactors owned by Tokyo Electric Power Co. at two sites in northern Japan. This suggests that countries that are highly dependent on nuclear power to generate their electricity could be thrown into a power supply crisis should a major nuclear accident there take place. Overdependence on nuclear power may also pressure decision makers to operate reactors under conditions that are not safe. It also suggests that the existing methodology for seismic risk analysis for nuclear reactors ought to be urgently reviewed given its repeated failures to predict the type of challenges that nuclear power plants (and other sensitive facilities) must be built to withstand.
- * Countries aiming to set up their first nuclear power plants will be tempted by dire energy need, reasons of prestige, and financial limitations to concentrate on building the plants and getting ready to operate them as soon as possible. There is a danger that seemingly less-immediate needs that do not contribute directly to energy production—such as spent fuel and waste management, but also emergency preparedness—will be only superficially addressed. Japan is working overtime to try to prevent loss-of-coolant accidents at three reactors from becoming a radiological catastrophe. If Japan succeeds, it will be because it brought to bear discipline, management, organization, experience, and advance preparation.
- * Reactor-owning utility companies, governments, power plant vendors, international organizations, and non-governmental organizations worldwide will and should consider whether all other current and prospective nuclear power plant operators would be similarly prepared and equipped to deal with largely unpredictable environmental and logistical challenges as extreme as those that Japan faced at Fukushima. Given the implications of a nuclear catastrophe for the global commons, this is an interest shared by all.

About James M. Acton

James M. Acton is an associate in the Nuclear Policy Program at the Carnegie Endowment and a Stanton Nuclear Security Fellow. A physicist by training, Acton specializes in nonproliferation, deterrence and disarmament. His research focuses on developing realistic pathways towards a world without nuclear weapons by strengthening nonproliferation bulwarks and rethinking nuclear deterrence.

Acton is co-author of the Adelphi Paper, *Abolishing Nuclear Weapons*, and co-editor of the follow-up volume, *Abolishing Nuclear Weapons: A Debate*. He is currently the joint UK member of the International Panel on Fissile Materials and from 2007 to 2009 was a regular contributor to the widely read blog, *Arms Control Wonk*.

Before joining the Endowment in October 2008, Acton was a lecturer at the Centre for Science and Security Studies in the Department of War Studies at King's College London, where he helped organize the February 2008 Oslo disarmament conference. Prior to that, Acton was the science and technology researcher at the Verification Research, Training and Information Centre (VERTIC), where he was a participant in the UK-Norway dialogue on verifying the dismantlement of warheads.

Acton has published in *Bulletin of the Atomic Scientists*, *Foreign Affairs*, *Jane's Intelligence Review*, the *New York Times*, *Nonproliferation Review*, and *Survival*. In the UK, he appeared regularly on TV and radio, including on the BBC programs *Newsnight*, *Horizon*, and the *Six O'clock News*.

About Toby Dalton

Toby Dalton is the deputy director of the Nuclear Policy Program at the Carnegie Endowment. An expert on nonproliferation and nuclear energy, his research focuses on cooperative nuclear security initiatives and the management of nuclear challenges in South Asia and East Asia.

From 2002-2010, Dalton served in a variety of high-level leadership positions at the U.S. Department of Energy (DOE). Most recently, he was acting director for the office of nuclear safeguards and security, where he implemented the U.S. Next Generation Safeguards Initiative and international nuclear security programs.

Previously, he established and led the department's office at the U.S. embassy in Pakistan, managing critical bilateral and multilateral nonproliferation issues and overseeing the implementation of U.S. nonproliferation and counterproliferation initiatives.

While at DOE, Dalton was also senior policy advisor to the office of nonproliferation and international security on issues relating to International Atomic Energy Agency (IAEA) safeguards, the nonproliferation regime, and a range of countries, including Pakistan, India, China, North Korea, and Israel. He also was detailed to the Senate Foreign Relations Committee to provide support and guidance on nonproliferation and arms sales issues.

Prior to his work at DOE, Dalton was named a Luce Scholar for the Institute for Far Eastern Studies in Seoul, a research associate at the National Bureau of Asian Research, and a project associate for the Carnegie Nuclear Policy Program.

Dalton has authored numerous op-eds and journal articles, and contributed to the books *Understanding New Political Realities in Seoul: Working toward a Common Approach to Strengthen U.S.-Korea Relations* (The Maureen and Mike Mansfield Foundation, 2008) and *The Future of U.S.-Korea-Japan Relations: Balancing Values and Interests* (CSIS, 2002).

About Mark Hibbs

Mark Hibbs is a senior associate in Carnegie's Nuclear Policy Program, based in Berlin. Before joining Carnegie, for over 20 years he was an editor and correspondent for the nuclear energy publications, including *Nucleonics Week* and *Nuclear Fuel*, published by the Platts division of the McGraw-Hill Companies.

Hibbs started at McGraw-Hill as the European editor, then became editor for Asia-Pacific, and finally, in addition to his Asia-Pacific responsibilities, senior correspondent.

From the late 1980s until the mid-1990s, he covered nuclear developments in the Soviet bloc, including research on the USSR's nuclear fuel cycle facilities and its nuclear materials inventories. Since the mid-1990s, his work has focused emerging nuclear programs in Asia, including China, and India.

Throughout the last two decades, many of the over 3,000 articles he wrote investigated nuclear proliferation-related developments in Argentina, Brazil, China, India, Iran, Iraq, Israel, Japan, Libya, North and South Korea, Pakistan, South Africa, Syria, and Taiwan.

Since 2003 he made many detailed findings about clandestine procurement in Europe related to gas centrifuge uranium enrichment programs in Iran, Libya, North Korea, and Pakistan.

About Ariel (Eli) Levite

Ariel (Eli) Levite is a nonresident senior associate in the Nuclear Policy Program at the Carnegie Endowment. He is a member of the board of directors of the Fisher Brothers Institute for Air and Space Strategic Studies.

Prior to joining the Carnegie Endowment, Levite was the Principal Deputy Director General for Policy at the Israeli Atomic Energy Commission from 2002 to 2007. Levite also served as the deputy national security advisor for defense policy and was head of the Bureau of International Security and Arms Control in the Israeli Ministry of Defense.

In September 2000, Levite took a two year sabbatical from the Israeli civil service to work as a visiting fellow and project co-leader of the “Discriminate Force” Project as the Center for International Security and Cooperation (CISAC) at Stanford University.

Before his government service, Levite worked for five years as a senior research associate and head of the project on Israeli security at the Jaffee Center for Strategic Studies at Tel Aviv University. Levite has taught courses on security studies and political science at Tel Aviv University, Cornell University, and the University of California, Davis.

About George Perkovich

George Perkovich is vice president for studies and director of the Nuclear Policy Program at the Carnegie Endowment for International Peace. His research focuses on nuclear strategy and nonproliferation, with a focus on South Asia and Iran, and on the problem of justice in the international political economy.

He is the author of the award-winning book *India's Nuclear Bomb* (University of California Press, 2001). He is co-author of the Adelphi Paper, *Abolishing Nuclear Weapons*, published in September 2008 by the International Institute for Strategic Studies. This paper is the basis of the book, *Abolishing Nuclear Weapons: A Debate*, which includes 17 critiques by 13 eminent international commentators. Perkovich is also co-author of a major Carnegie report, *Universal Compliance: A Strategy for Nuclear Security*, a blueprint for rethinking the international nuclear nonproliferation regime. The report offers a fresh approach to deal with states and terrorists, nuclear weapons, and fissile materials to ensure global safety and security.

He served as a speechwriter and foreign policy adviser to Senator Joe Biden from 1989 to 1990. Perkovich is an adviser to the International Commission on Nuclear Non-proliferation and Disarmament and a member of the Council on Foreign Relations' Task Force on U.S. Nuclear Policy.

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