PHYS.ORG

Storage for spent nuclear fuel more crucial than ever

April 27 2011, By David L. Chandler

The United States and other countries around the world looking to nuclear power for their energy needs must consider how spent fuel will be handled as they construct new plants and examine existing ones, especially in light of the recent crisis in Japan, according to a comprehensive study from MIT.

The ongoing problems at Japan's Fukushima Daiichi powerplant — caused by the March 11 earthquake and tsunami — have been significantly exacerbated by the presence of used fuel housed in the reactor buildings, and demonstrate the urgency needed in dealing with such waste, the report's authors say. It specifically underscores the importance of finding a way to deal with the growing amount of spent nuclear fuel housed at existing U.S. nuclear plants.

The report, a summary of which was released last September, strongly recommends that an interim solution be developed to remove spent fuel from storage facilities at reactor sites, and move it to regional, medium-term repositories where the fuel can be monitored and protected as it decays over time. Spent fuel loses much of its radioactivity with every passing decade, as the most dangerous radioactive isotopes decay and lose much of their potency during the first 50 years, thus diminishing the problem of long-term storage.

Planning for the ultimate handling of spent nuclear fuel “has frankly been an afterthought in U.S. fuel-cycle policy,” said Ernest J. Moniz, director of the MIT Energy Initiative (MITEI) and co-chairman of the new report, at a press conference today to introduce the report. “It can’t be that,” he said. Instead, “it should be integrated” into the overall planning for the nation’s energy policies and “the U.S. should move toward centralized spent nuclear fuel storage.”

While the situation in Japan has not changed any of the basic conclusions of the study, called “The Future of the Nuclear Fuel Cycle,” the study’s executive director Charles Forsberg, a research scientist in MIT’s Department of Nuclear Science and Engineering, said the recent crisis “will place more emphasis on getting a geological repository program up and running” for permanent storage of the United States’ spent nuclear fuel. Doing so, the study says, faces no real scientific hurdles, and is essentially a social and political issue at this point.

Even before the problems in Japan, Moniz said, there had been “increased interest in Congress, among the chairs of relevant committees” on looking at options for interim spent fuel storage. In response to a question, Moniz said that the right time for the United States to start looking seriously into how to set up regional interim storage facilities “was a few years ago.”

Consequences of Japan's nuclear crisis

But there are other possible impacts on the global future of nuclear power in the aftermath of the Japanese crisis, where four reactors at the Fukushima plant were crippled and work continues to bring the situation fully under control. In a postscript to the report's introduction, the authors point out two other likely consequences, at least in the short run: The cost of new nuclear plants is likely to increase, as a result of the increased perception of risk associated with such plants, which will raise the cost of capital for plant construction; and public support for a resurgence of nuclear power, which had been growing in the United States, is likely to suffer at least a temporary setback. Already, several countries have suspended or delayed plans for new nuclear plants or for extending the operating lifetime of existing plants.

One important factor that might help counter the erosion of public support for a renewal of nuclear power as a result of the Japanese crisis is to put clear policies in place now for dealing with the spent fuel, Moniz said. "Solving the nuclear waste problem does influence public attitudes," he said.

Because of repeated delays in creating a national long-term storage repository for spent nuclear fuel (SNF), U.S. nuclear reactor sites already house more spent fuel than those in Japan, Forsberg noted. That confirms the study's existing conclusions about the need for a comprehensive U.S. policy on spent fuel, to replace the present ad-hoc policy.

The Japanese crisis "will place a greater emphasis on our recommendation for centralized storage or disposal in a repository with the option of SNF recovery," Forsberg said, referring to the report's suggestion that used fuel be stored in such a way that it could easily be recovered later if the nation decides to pursue a nuclear program based on reprocessing it to produce new fuel for a future generation of reactors.

The full 253-page interdisciplinary study, released today, was produced under the auspices of MITEI and co-chaired by Moniz, the Cecil and Ida Green Distinguished Professor of Physics and Engineering Systems, and TEPCO Professor of Nuclear Engineering Mujid Kazimi, who also is director of the Center for Advanced Nuclear Energy Systems.

The latest in a series of broad-based MITEI studies of different aspects of energy, this report was produced by 10 faculty members, three contributing authors and eight student research assistants, with guidance from a 13-member expert advisory panel comprising members from industry, academia and nonprofit organizations; it took about two years to produce.

Improving efficiency through design

The study suggests that nuclear power can play a significant part in displacing carbon-emitting fossil-fuel plants, and thus help to reduce the potential for global climate change. About half of existing nuclear powerplants around the world — and all of those in the United States — use a once-through fuel cycle, in which fuel rods are sent to a disposal site after a single use in the reactor, rather than being reprocessed for future use. But to decide on the best kind of fuel cycle for the anticipated next generation of nuclear powerplants — whether it should continue to be a once-through system, or one using partial or full reprocessing for a "closed-loop" system — will require more research, the report concludes.

As long as demand for new nuclear plants continues at rates similar to those experienced so far, there is no danger of running out of uranium in the next several decades, the report concludes. But, Kazimi said, "If demand starts to grow more rapidly, we will need more efficient fuel cycles."

One promising possibility, the study suggests, is an enriched uranium-initiated breeder reactor in which fissile materials bred inside the reactor are recycled, and additional uranium is added to the reactor core at the same rate that nuclear materials are consumed. In such a system, no excess nuclear materials are produced, leading to a simple and efficient self-sustaining fuel cycle. However, there is little hard data on whether such a cycle would be practical and economically competitive. One of the report's major conclusions is that more research is needed before such decisions can be made.

There has been much interest in recent years in advanced reactor designs such as small, self-contained modular reactors or ones that use passive cooling systems that reduce or eliminate the need to keep water circulating. As Moniz said, "Moving to any of these smaller reactors does not change the choice of fuel cycle," and so was outside the scope of this study. But Andrew Kadak SM '70, PhD '72, a member of the study panel and former MIT Professor of the Practice of Nuclear Energy, said that so far "the industry has not taken this [possibility of small modular plants] seriously," pointing out that none have been ordered so far.

A holistic approach

One key message of the report is that it's time to really study the underlying basis of nuclear-plant technology — what kind of fuel goes in, what comes out, and what happens to it then — before focusing too much money and effort on the engineering details of specific powerplant designs.

The report also supports the current U.S. policy of providing loan guarantees for the first several new nuclear plants to be built after the current three-decade hiatus, in order to reduce the risks of new construction and thus reduce or eliminate financing premiums for nuclear plant construction.

The study, unlike most earlier examinations of possible future nuclear plants, looked comprehensively at all the various components — from mining to reactor operation all the way through to waste disposal — in a holistic way. It was funded by the Electric Power Research Institute, Idaho National Laboratory, Nuclear Energy Institute, Areva, GE-Hitachi, Westinghouse, Energy Solutions and NAC International.

Provided by Massachusetts Institute of Technology