Japan maintains firm commitment to nuclear energy for the future

by Charles B. Stevens

Nuclear energy has played a significant role in Japan's plans to achieve energy independence, since the 1950s. Now, about a third of Japan's electricity is generated from nuclear power reactors, and by the year 2010, Japan intends to have 40% of its electrical power generated by nuclear plants. The critics of Japan's nuclear policy—from environmental groups like Greenpeace to the New York Council on Foreign Relations—have tried to stop Japan's nuclear progress, by stirring up public anxiety in Japan about the dangers of plutonium and nuclear power in general, via lurid press headlines that have exaggerated two recent incidents at Japanese nuclear facilities.

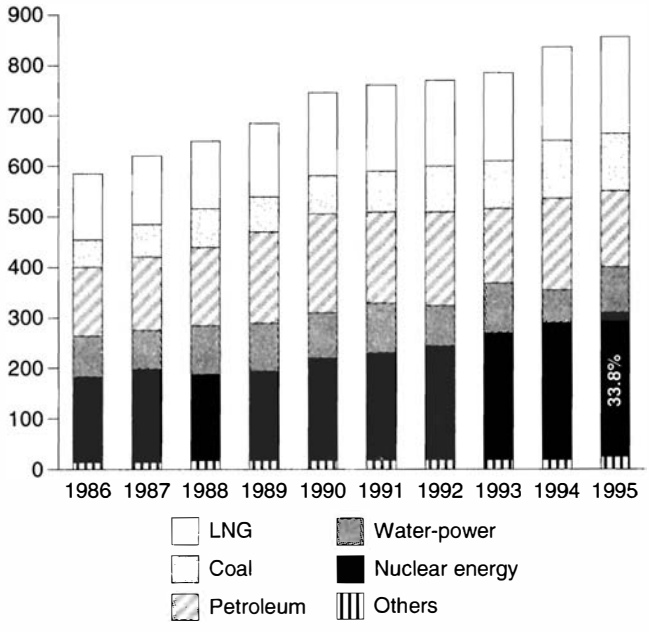
Dr. Yoshirnori Ihara of Japan's Atomic Energy Commission assured a U.S. audience recently, that despite this negative press campaign, Japan was continuing its firm commitment to the utilization and further development of nuclear energy, based on the plutonium fuel cycle. Dr. Ihara is vice chairman of the Atomic Energy Commission (AEC) of Japan, and he spoke at a luncheon meeting of the Washington, D.C. chapter of the American Nuclear Society on March 20. (His speech follows this article.)

Japan currently has 52 commercial nuclear power plants, of which 48 are light water reactors, with 26 of these being boiling water reactors and 22 pressurized water reactors. Japan also has 19 research reactors. Three new commercial reactors are under construction now, and 19 others are proposed or planned. By the year 2010, forty percent of Japan's electricity will be provided by nuclear power plants, compared to over just 30% now (see **Figure 1**). Japan currently also has the world's largest national fusion energy research and development effort.

Ihara said that after a much-reported incident at Japan's prototype fast breeder reactor, Monju, in December 1995, the government, the AEC, and the Japanese nuclear industry launched a major program of education and roundtable discussions throughout Japan, which involved a broad spectrum of experts and the general public, including opponents of nuclear energy.

The AEC's 1996 "White Paper on Nuclear Energy," which Ihara circulated at the meeting, summarized the situation as follows: "It is important that people living in this country be reassured and have their minds at ease about the development and utilization of nuclear energy. The government has been making efforts in that regard, but still they have not been entirely sufficient. Taking the recent rise in uneasiness among the public concerning nuclear policy, the government has decided to take active measures to cope with it."

FIGURE 1
Annual generated power output in Japan
(million megawatt-hours)



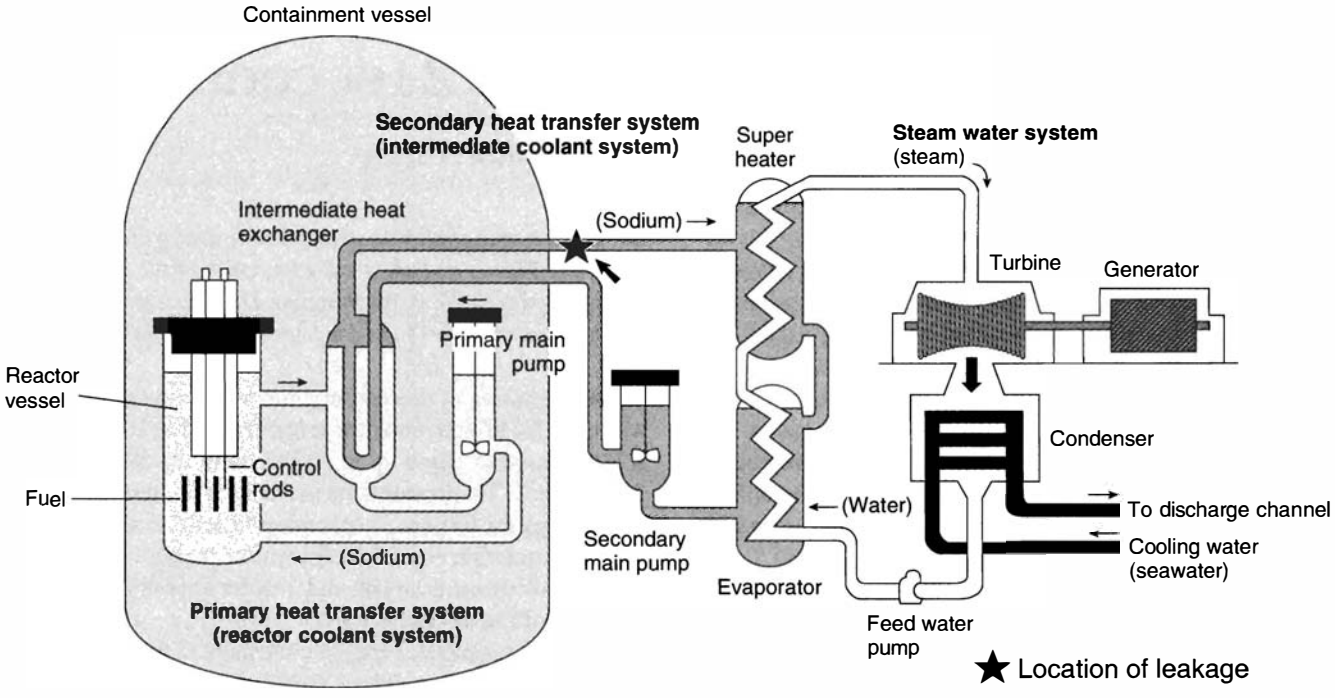
Source: Atomic Energy Commission of Japan, "White Paper on Nuclear Energy," 1996.

Nuclear power generation now accounts for nearly 34% of Japan's total electric power generation.

The roundtable conferences determined that nuclear energy was essential to the future of Japan, and to a developed, prosperous world, and that the use of plutonium as fuel and the development of nuclear fuel recyling are indispensable. Therefore, Dr. Ihara noted, Japan decided to continue its ongoing program for utilizing plutonium fuel in existing light water fission reactors, and to continue the research program for breeding plutonium nuclear fuel in fast breeder reactors, together with research on the various methods of disposing

FIGURE 2

Schematic diagram of the Monju Fast Breeder Prototype Reactor



Source: Atomic Energy Commission of Japan, "White Paper on Nuclear Energy," 1996.

The Monju generates electricity and also breeds more plutonium nuclear fuel from depleted uranium than it consumes. The reactor core is surrounded with a blanket of depleted uranium. Neutrons from the core react with depleted uranium to generate plutonium fuel. The fuel bred in this manner can either be utilized in other fast breeder rectors or burned in conventional nuclear reactors.

Heat from the reactor core is transferred via two separate loops of liquid sodium to make steam. The steam then propels a turbine, which generates electricity.

of nuclear wastes—the so-called back-end of the nuclear fuel cycle.

Dr. Ihara said that neither of the two recent incidents reported so widely in the U.S. press had led to substantial injuries or to the release of radioactive materials outside the sites of these nuclear facilities. The first incident occurred in December 1995, when a sodium leak was detected in the secondary loop of the Monju fast breeder reactor. No one was injured, and no radiactive materials were released.

The second incident occurred at the Tokaimura nuclear fuel processing facility, and involved a fire which led to 10 workers being exposed to very small amounts of radioactivity. The maximum dose level received, despite all the scare stories, was *less than one-2,000th of the dose considered tolerable for an individual within one year.*

Dr. Ihara noted that there were problems in the way in which information about the incidents was released to the public, but this is now being addressed. The incidents themselves, he stressed, did not represent any significant danger to the public.

He stressed that Japan is developing nuclear energy not just for itself, but for the world. He emphasized that the developing world requires nuclear energy, and he reviewed the commitment of the Asian nations, in particular, to go nuclear. Recently, he said, Japan's AEC held the Eighth International Conference for Nuclear Cooperation in Asia. In East Asia, he said, there are now 83 nuclear power plants in operation, 15 under construction, and plans for another 57.

Plutonium breeding

Japan's commitment to a plutonium economy has come under particular attack from the anti-nuclear lobby and the Malthusians, because of its implications for efficiently supplying energy for a growing economy. For Japan, plutonium is seen as an energy resource that can be made indigenous, once the nation develops the capability to complete the nuclear fuel cycle by reprocessing spent reactor fuel and burning the extracted uranium and plutonium in commercial reactors, and by breeding plutonium in breeder reactors.

Japan currently ships the spent fuel from its existing nu-

clear reactors to Europe for reprocessing, and then plutonium extracted from this spent fuel is shipped back to Japan for use as fuel in its reactors. Dr. Ihara emphasized that Japan is committed to the completion of its own industrial reprocessing facilities.

Conventional light water reactors utilize uranium nuclear fuel, which is extracted from naturally occurring deposits of uranium ore. The uranium is then enriched so that it contains more of the more fissionable isotope, uranium-235. In the fission process within the light water reactor, some of the remaining uranium-238 isotope is transmuted into the element plutonium-239. It is this plutonium that is extracted from the spent fuel rods in the current reprocessing program. Plutonium-239 is highly fissionable, like uranium-235, and can thus provide fuel for reactors. But conventional light water reactors only "breed" a fraction of the total fuel that they burn up. Thus, these systems require continued inputs of uranium fuel. A fast breeder, however, generates more nuclear fuel than it consumes. This excess fuel can then be utilized either to start up new breeder reactors or to fuel existing light water reactors.

Japan's prototype fast breeder, Monju, was built by the Japan Power Reactor and Nuclear Fuel Development Corporation (PNC), and began transmitting electrical power in August 1995. The Monju is the R&D prototype for the development of future commercial fast breeder nuclear power plants. In a fast breeder, the nuclear core operates at higher energy densities, which maintain the released neutrons at much higher velocities within the core than those of a conventional light water reactor. These fast neutrons permit such a reactor to breed more nuclear fuel then it consumes.

To maintain such a higher energy density, the fast breeder utilizes more efficient heat transfer fluids than ordinary water. In Monju, liquid metal sodium provides the means of extracting heat from the reactor core (**Figure 2**). (In conventional light water reactors as well as in the fast breeder, this extracted heat is used to generate high-temperature steam, which is then used to turn a turbine which generates electricity.)

In the Monju type of fast breeder, two heat transfer sodium loops are utilized: There is a primary loop that extracts heat from the core and a secondary loop that transfers this heat to water heat exchangers. The 1995 incident involved a leak in the secondary loop. Such incidents are not unexpected in such complicated systems involving high-temperature liquid metal, especially in an R&D prototype.

Eventually, the best method of breeding fission fuel will be via nuclear fusion reactors. Hydrogen fusion reactions, like those which power the Sun, do not consume neutrons. And in fact, the easiest fusion reaction to harness actually generates neutrons as its chief product. These "free" fusion neutrons can be utilized to breed copious quantities of fission fuel. For example, a 1,000-megawatt fusion reactor could provide enough fuel to run five to ten 1,000-megawatt fission reactors.

Nuclear energy needed for the 21st century

by Yoshinori Ihara

Dr. Ihara is vice chairman of the Atomic Energy Commission of Japan. This is a slightly edited version of the talk he presented on March 20, in Washington, D.C., to a meeting of the Washington chapter of the American Nuclear Society.

At the beginning of this century, the population of the world was only 1.6 billion, and now it has reached nearly 6 billion. It is expected to climb up to 10 billion in the middle of the 21st century. The tremendous increase in the number of human beings on this small spaceship "Earth" occurs in only two centuries. Our essential concerns are to be:

- How can we establish and transfer a wealthy advanced society to the next generations?
- What can nuclear energy contribute to these efforts?

The economic growth of OECD [Organization of Economic Cooperation and Development] countries remains at a low level. However, in developing countries such as those in Asia, economic growth and population explosion are causing a rapid increase in the demand for energy. These situations also bring the growing necessity to solve global environmental problems.

Recently, the Atomic Energy Commission of Japan held the Eighth International Conference for Nuclear Cooperation in Asia. In this conference, many representatives from nine Asian and Pacific countries expressed their strong commitment to the use of nuclear energy in order to solve these problems. I am confident that the utilization of nuclear energy is the intellectual challenge that will allow us to cope with common issues of all the crew on spaceship "Earth."

Japanese policy

There is no question that we must reconcile the development and utilization of nuclear energy with nuclear safety and non-proliferation. The Nuclear Safety Summit was held in April of last year in Moscow. It was significant that the heads of state from all attending nations, including Japan, endorsed the fact that safety should have the highest priority in the development and utilization of nuclear energy, and that a general consensus was reached to strengthen nuclear materials management.

The first international safety agreement, "The Convention on Nuclear Safety," came into force in October of last year, and should contribute significantly toward improving nuclear safety around the world. Japan will do its utmost to ensure