March 24, 2011

Pressing Ahead Where Others Have Failed

By KEITH BRADSHER

SHIDAO, China — In pursuing pebble-bed nuclear reactors, China is pressing ahead with a nuclear technology that other countries have struggled to master. In some ways, its progress is a result of being less adventurous than foreign researchers.

Rather than heating water, as conventional reactors do, pebble-bed systems heat gas. And for decades, Western engineers studied pumping the hot gas directly through a turbine to produce electricity. Most recently South Africa tried this approach, only to experience huge cost overruns that led to its program being largely shut down last year.

Chinese engineers have chosen instead to use conventional steam turbines of the sort already found in fossil fuel and nuclear power plants all over the world. Rather than spinning a turbine directly, the hot gas — helium — from the reactor is used to heat coils full of water that, in turn, produce steam to spin the turbines. (China itself already produces some of the world's most advanced steam turbines.)

The drawback of using a steam turbine in a pebble-bed reactor is that some of the heat is lost in the transfer from the helium to the water. So the process is slightly less efficient than South Africa's design.

And yet, "we saw from the technical point of view, the helium turbine is not ready for industrial use," said Xu Yuanhui, who oversaw the construction of China's experimental reactor as a Tsinghua University professor. He is now the vice general manager of Chinergy, the contractor building two pebble-bed reactors here for Huaneng Group, China's largest electric utility.

Pebble-bed nuclear reactors have a variety of passive safety features that are intended to let the core cool on its own without human intervention — instead of melting down — if something goes wrong.

Thousands of pinhead-size grains of uranium are embedded in each pebble: spheres of graphite and ceramic that resemble dull gray billiard balls. The graphite helps limit the pace of nuclear fission. If the reactor's equipment breaks down, the pebbles are supposed to warm up only a little further and then reach a stable temperature at which there is little risk of a meltdown.

The helium used in pebble-bed reactors has several safety advantages over water. Water can release hydrogen gas, which explodes on contact with air — as has happened repeatedly, for example, at the Fukushima Daiichi plant in Japan. Water turning to steam can also expand explosively.

In a conventional reactor, if the water drains and fuel rods are exposed in reactors or the storage pools of used rods, meltdown can occur. But in a pebble-bed reactor, if an accident causes the helium to escape, the helium itself has only negligible radioactivity; the pebbles are supposed to cool gradually on their own.

Greenpeace has warned that if the pebbles ever became extremely hot, they might burn. But Dr. Xu said that his team had done many tests and had never been able to get the pebbles to burn even at very high temperatures.

Dr. Xu, who shortly before the Japanese accident led a rare private tour of the experimental pebble-bed reactor outside Beijing, said that while the technology was safe, the reactors still needed to prove themselves to be as cost-effective as conventional nuclear power plants.

"The safety is no question," Dr. Xu said, "but the economics are not so clear."