NUCLEAR UPDATE

South Africa Is Preparing for the World's First Commercial PBMR

by Tom Ferreira

Anti-nuclear activists would love to see it go away, and some skeptics are gleefully claiming its demise, but South Africa's Pebble Bed Modular Reactor Company is still steadfastly preparing for the construction of the world's first commercial pebble bed modular reactor (PBMR) at Koeberg, near Cape Town.

While a change in design from electricity generation to a more versatile concept that can provide both electricity and process heat, has resulted in a delay in the PBMR program, it has broadened its potential customer base. In addition to electricity, the new design is aimed at steam process heat applications operating at 720°C, which provides the basis for penetrating the nuclear heat market as a viable alternative for carbon-burning, high-emission heat sources.

EIRNS/Marjorie Hecht

PBMR CEO Jaco Kriek: "PBMR is one of the few engineering and science megaprojects South Africa has. We should not waste that opportunity. It's an opportunity in a lifetime for a developing country."

Pebble Bed Modular Reactor (Pty) Limited is a public-private partnership comprising the South African government, nuclear industry players, and utilities. The PBMR is a strategic national project due to its significance to South Africa and its potential in international markets, as a prospective provider of safe, clean energy.

The successful deployment of this leading-edge technology has the potential to make a significant contribution to local and international energy supply, says Jaco Kriek, CEO of Pebble Bed Modular Reactor (Pty) Ltd. In addition, it will contribute to the transformation of South Africa's current resource-based economy and the creation of an advanced manufacturing industry.

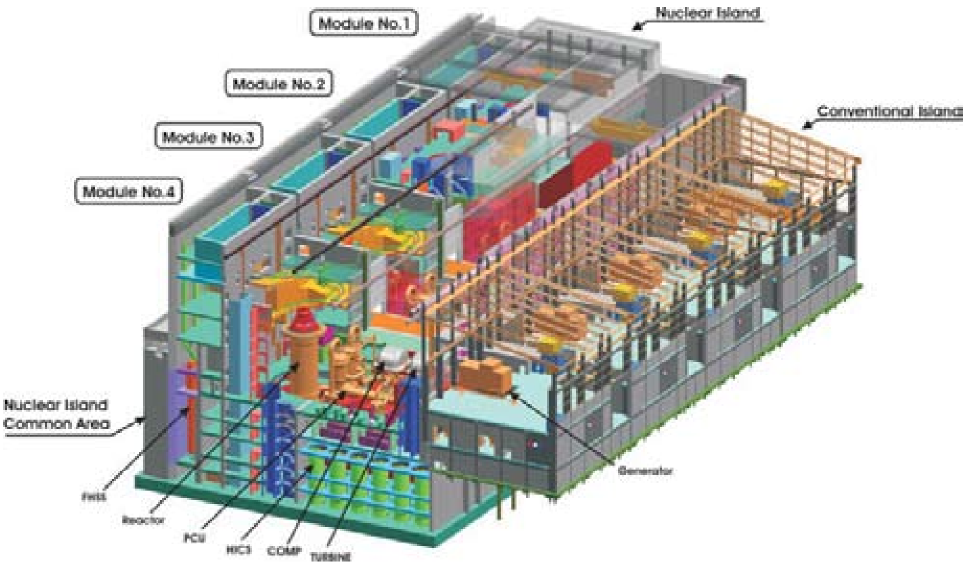
Kriek says that PBMR's goal is to be one of the first organizations that successfully commercializes pebble bed technology for the world's energy market. If everything goes according to plan, the first pebble bed reactor will be commissioned towards the end of 2018.

This will be the first time that South Africa is designing, licensing, and building its own nuclear reactor system.

Strong Government Support

The South African government recognizes the importance of energy security and supply, and the fact that PBMR can contribute significantly to local economic growth and development by forming part of a technology-intensive nuclear manufacturing sector which could, in future, export this technology.

The government therefore regards the PBMR project as one of the most important capital investment and development projects yet undertaken in the country. At



PBMR

Design for a PBMR with four nuclear modules. Because of the modular design, nuclear reactors can be added to the complex as needed, making use of the same non-nuclear facilities.

a media briefing in Cape Town on June 23, 2009, Ms. Portia Molefe, the director general of the Department of Public Enterprises (DPE), confirmed the target date of 2018 for the commissioning of the demonstration PBMR reactor.

In June 2009, PBMR's U.S. investor, Westinghouse, reiterated its belief in the PBMR. Said Rita Bowser, the company's regional vice-president: "We continue to believe in the PBMR. There are good synergies between the U.S. and South Africa to demonstrate the benefits of PBMR."

From a small research and development company, with barely 100 employees at its inception in 1999, PBMR has grown into one of the largest nuclear reactor design teams in the world. In addition to the core team of some 800 people at the PBMR head-office in Centurion near Pretoria, more than 1,000 people at universities, private companies, and research institutes are involved with the project.

Salient Features of the PBMR

What exactly is the pebble bed modular reactor, and why is there so much international interest in the concept?

The PBMR Demonstration Power Plant (DPP200) earmarked for the Koeberg site is a helium-cooled, graphite-moderated high temperature reactor (HTR). It has a capacity of 200 megawatts thermal or 80-MW electric, which means that about 14 PBMR modules will be needed to generate the equivalent of a conventional reactor such as the Westinghouse AP1000 concept.

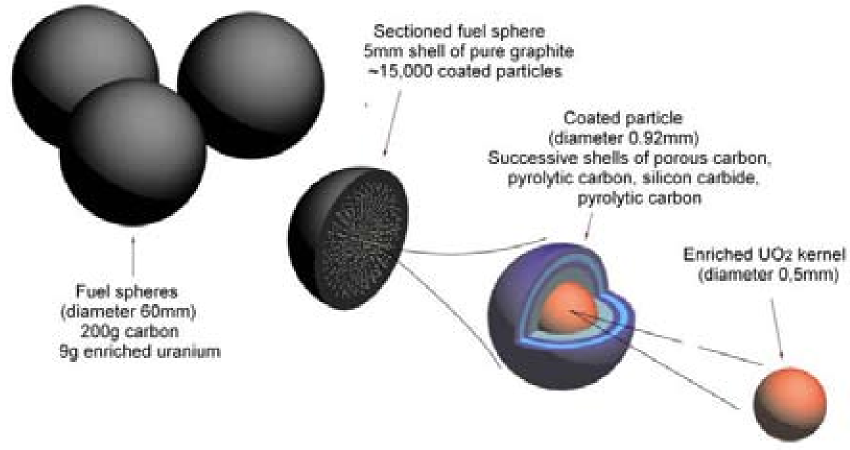
The PBMR reactor has a vertical steel reactor pressure vessel which contains and supports a metallic core barrel, which in turn supports the cylindrical pebble fuel core. This cylindrical fuel core is surrounded by an outer graphite reflector, and, on top and bottom, by graphite structures which provide similar upper and lower neutron reflection functions. Vertical borings in the side reflector are provided for the reactivity control elements. Two diverse reactivity control systems are provided for shutting the reactor down.

The PBMR DPP200 uses particles of enriched uranium dioxide coated with silicon carbide and pyrolytic carbon. The particles are encased in graphite to form a fuel sphere or pebble about the size of a billiard ball.

The Pebble Bed Reactor's Competitive Advantages

- Inherently safe features
- On-line refueling
- Competitive economics
- Hydrogen production
- Desalination properties
- Can be placed where the energy is needed
- Job creation potential
- Short construction lead times
- Allows for additional modules to be added
- Requires a small tract of land
- Proliferation resistant
- Designed to withstand significant external forces
- Low environmental impact

—Tom Ferreira



Source: PBMR

The tiny fuel particles (lower right) have a kernel of fission fuel (uranium oxide) at the center, and are coated with containment layers; they are then inserted into a graphite sphere to form "pebbles" the size of tennis balls, each of whch contains about 15,000 fuel particles. Pebbles travel around the reactor core about 6 times in their lifetime. During normal operation, the reactor will be loaded with 360,000 fuel pebbles.

The core of the reactor contains approximately 360,000 of these fuel spheres and during normal operation, the core produces nominally 200 MW of heat. Helium is used as the coolant, and the energy absorbed in the core is transferred to a secondary loop through a heat exchanger.

The secondary side of the heat exchanger contains water, and the heat absorbed changes it to steam which, in turn, is used to drive a steam turbine connected to a generator to produce electricity in the same way conventional power stations operate. In this configuration the reactor is an electricity producing plant. The secondary side of the heat exchanger may also be coupled to a process plant directly to provide the energy directly as process heat. In this configuration, the reactor is a pure process heat producing plant.

Another possible configuration is a cogeneration plant that produces both electricity and process heat. The design is such that modules can be combined to suit the specific energy requirements of the user.

There are several factors that make the PBMR concept promising and attractive, such as its short (24-month) construction time, low operating cost, fast load-following characteristics, and inherent safety characteristics.

Accident-Proof

There is no conceivable accident scenario that can cause a fuel meltdown or otherwise lead to a large release of radioactivity. It should therefore eventually be possible, subject to licensing authority approval and public accep-

University of Greenwich Public Services International Research Unit

The attack by George Soros on the PBMR has been fronted by green fascist and so-called Professor of Energy Policy, Steve Thomas, of the University of Greenwich.

The Soros-Funded Anti-PBMR Faction

The anti-nuclear group, Physicians for Social Responsibility, sponsored a U.S. tour in May 2009 for the leading British anti-nuke guru, who has made a career out of trashing the PBMR. The George Soros-funded Steve Thomas spread his distorted opinions, including that the PBMR was "dead," in a conference call and other publicized speeches, with the theme of "The Myth of The European 'Nuclear Renaissance.'"

Most recently Thomas, a professor at the University of Greenwich, regurgitated his PBMR allegations in June 22 *The Bulletin of the Atomic Scientists,* under the wishful-thinking title, "The Demise of the Pebble Bed Modular Reactor." To read more about Thomas, see "Who's Trying to Strangle the PBMR?" (http://www.21stcenturysciencetech.com/Articles%202008/F-W_2008/HTR_4.pdf)

A special report on the PBMR, including an interview with PBMR's CEO Jaco Kriek, can be found at http://www.21stcenturysciencetech.com/Articles%202008/F-W_2008/HTR_1.pdf

—Marjorie Mazel Hecht


PBMR

Wildebeest and zebra grazing near the Koeberg nuclear site, where Eskom, the state utility, operates two 900-MW pressurized-water nuclear reactors, the only nuclear reactors on the continent. The PBMR demonstration reactor will be built near here. Koeberg is on the coast, near Cape Town.

tance, to site PBMR modules close to centers of industry. The design of the fuel spheres, and of the uranium particles within them, will facilitate ultimate disposal of spent fuel.

Maintenance will be relatively straightforward. The reactor is refueled on-line and is designed to run continuously at full power for several years. Indeed, in the case of direct cycle electricity generation, the planned maintenance interval is six years.

The reactor is continuously replenished with fresh or reusable fuel from the top, while used fuel is removed from the bottom. After each pass through the reactor core, the fuel pebbles are measured to determine the amount of fissionable material left. If the pebble still contains a usable amount of the fissile material, it is returned to the reactor at the top for a further cycle. Each cycle takes about six months.

Each pebble passes through the reactor about six times, and lasts about three years before it is spent, which means that a reactor will use 12 total fuel loads in its design lifetime.

The extent to which the enriched uranium is consumed during the lifetime of a fuel pebble (called the extent of burn-up) is much greater in the PBMR than in conventional power reactors. There is therefore minimal fissionable material that could be extracted from spent PBMR fuel. This, coupled with the level of technology and cost required to break down the barriers surrounding the spent fuel particles, protects the PBMR fuel against the possibility of nuclear proliferation or other covert use.

Recent Developments

Recently, PBMR entered into a Memorandum of Understanding (MOU) with the Institute of Nuclear and New Energy Technology (INET) of Tsinghua University and Chinergy Co. Ltd. of China, whose pebble bed concept is based on a 10-MW (thermal) research reactor that was started up in Beijing in December 2000. INET is a top nuclear research and experimental institute in China.

The MOU, based on mutual respect and appreciation for the developments achieved by both countries to date, is designed to facilitate cooperation on identified areas of common interest. South Africa and China hope to pursue collaboration in a number of strategic and technical areas relating to high temperature reactor (HTR) projects in both countries.

In December 2008, PBMR's Fuel Development Laboratories, in collaboration with NECSA (the South African Nuclear Energy Corporation), successfully manufactured High Temperature Reactor coated particles containing 9.6% enriched uranium. The coated particles were shipped to the United States and are currently being tested at the Idaho National Laboratory.

While these are still early days for the PBMR, it is clear that its potential contribution to meeting the world's energy needs in difficult days to come is considerable.

Tom Ferreira is head of communications for the PBMR Company.