EIR Science & Technology

South Africa's PBMR: World's Most Versatile Nuclear System

Jonathan Tennenbaum reports on an international conference in London to discuss the fantastic economic potential worldwide of South Africa's Pebble Bed Nuclear Reactor.

Next year the Republic of South Africa will begin on-site construction of the first Pebble Bed Modular Reactor (PBMR)—a revolutionary nuclear power source which South Africa's Minister of Public Enterprises calls "the perfect nuclear technology for Africa and the developing countries."

With the PBMR, South Africa has taken the leading edge in fourth-generation nuclear technology, combining extraordinary simplicity, robustness, and "inherent safety" with the capability to produce high-temperature heat for the production of hydrogen-based fuels and other industrial processes, as well as cheap electricity.

The PBMR is a leading exemplar of the High Temperature Reactor (HTR) technology, which Lyndon LaRouche and his collaborators have long identified, in the context of development programs (for example, the Eurasian Land Bridge and the recent campaign for re-industrialization of the United States), as the key "workhorse" power system for global economic reconstruction and growth in the coming period.

The PBMR project builds upon a long historical development, which began in the 1950s, when the German nuclear physicist Prof. Rudolf Schulten began to think about creating a 100% "inherently safe" nuclear power source, which could be deployed all over the world, including in developing countries, as an efficient industrial heat source and for the generation of electricity. A key to Schulten's ingenious solution was to encapsulate small particles of fuel within ceramic materials that could withstand high temperatures, in such a way that the radioactive fission products remained permanently trapped in situ, where they are created.

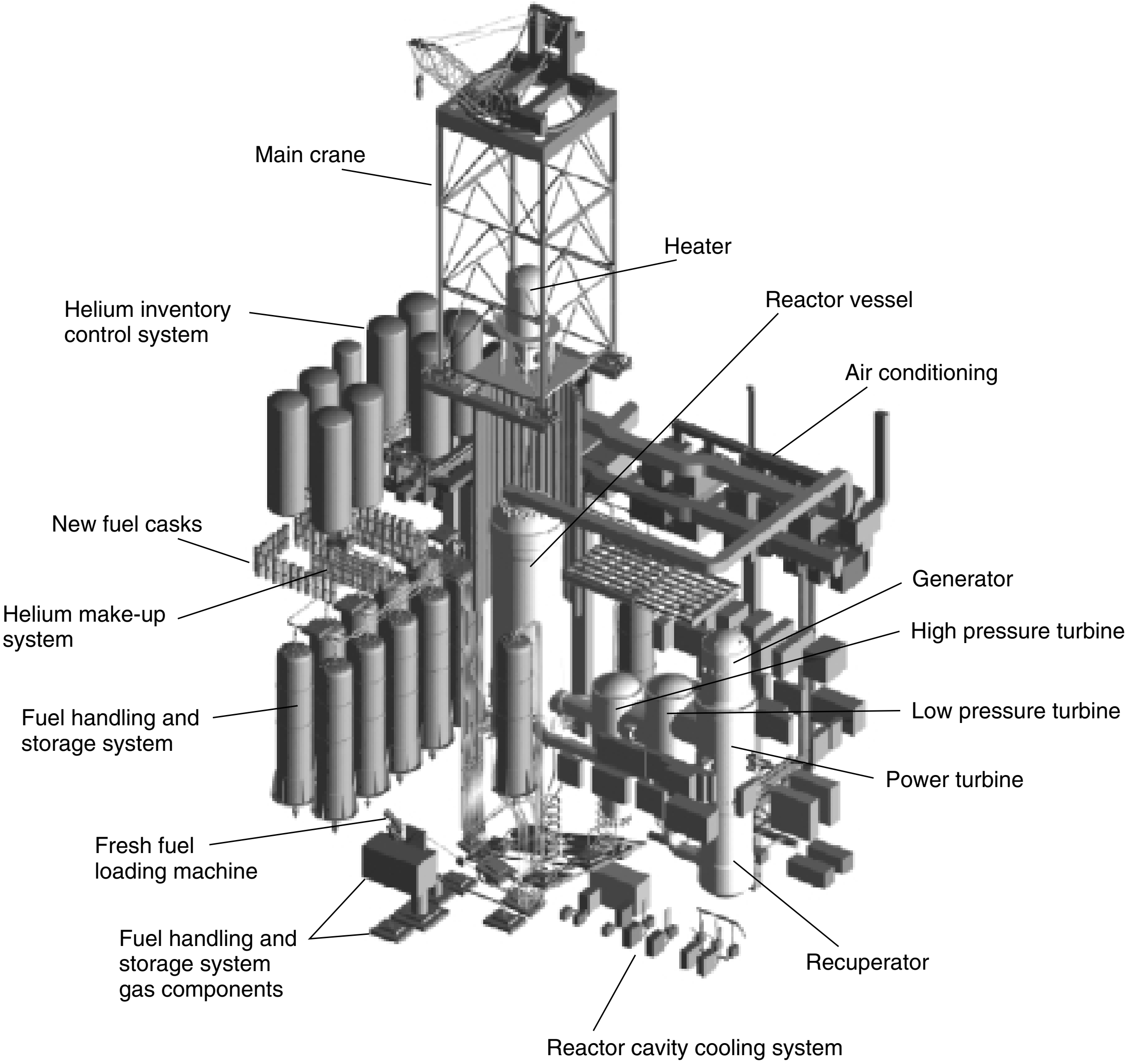
At the same time, Schulten tailored the choice of fuel, helium coolant, and reactor construction, to ensure a uniquely favorable nuclear reaction behavior, which excludes the danger of a runaway chain reaction, and permits routine operation at temperatures up to 1,000 degrees. Schulten's concept was tried and proven in over 20 years' operation of the AVR 30-megawatt test reactor at the nuclear research center in Jülich, Germany.

A somewhat different reactor type, based on the same basic ceramic-coated particle principle, was pursued by General Atomics in the United States. The General Atomics' GT-MHR uses tiny fuel particles, but places them in small rods that are stacked into columns, not as loose pebbles.

Unfortunately, after brief operation of a larger, 300-MW HTR version, all work on Schulten's concept was dropped in Germany, as part of the politically motivated, virtual shutdown of that nation's once-proud nuclear sector. The U.S. HTR work did not fare much better, and it is only thanks to three countries, South Africa, China, and Japan, that this technology has been kept alive.

Today, HTR test reactors are operating in China and Japan—the first based on Schulten's essential design, the second closer to the U.S. design. China has recently announced that it will move to large-scale production of commercial HTR units as part of its nuclear energy program. General Atomics has a joint project with Russia to build a GT-MHR

FIGURE 1
South Africa's PBMR: A Meltdown-Proof Reactor



Courtesy of Eskom

This schematic drawing shows the main power and support systems for the Pebble Bed Modular Reactor.

that will burn weapons plutonium. However, by far the most advanced project, one which promises to deliver a crucial, long-delayed breakthrough for Schulten's original concept of a univerally applicable nuclear energy, is South Africa's PBMR.

The International PBMR Conference

On Jan. 30 of this year, Britain's Nuclear Industry Association sponsored an international conference devoted entirely to the PBMR, and attended by some 200 industrialists, nuclear experts, and political representatives from South Africa, the United Kingdom, the United States, Japan, France, Germany, Spain, and Switzerland. The conference, addressed by leaders of the South African program, as well as that nation's Minister of Public Enterprises, served both as a first full-fledged public presentation of the entire PBMR program in Europe, and as a follow-up meeting of international suppliers and investors, to an August meeting in South Africa.

The account of the conference presented here speaks for itself, and should enable the reader to become familiar with leading features of the technology and its potential importance. I shall not comment on the geostrategic implications of this technology not being produced in Germany (its country of origin) nor in the United States, but in a nation of the British Commonwealth. This should be a wake-up call to all, that the era of suppression and stagnation of nuclear energy development has drawn to an end.

The author was also impressed by the display of national pride and optimism on the part of the representatives from South Africa, and also of a certain basic competence in industrial and economic policy, which is a highly refreshing contrast to the sheer insanity that still dominates policy-making in the United States and Europe. If there was a certain, understandable amount of "hype" in the PBMR presentations, it was a pleasant one.

Greeting the conference, Robert Hawley, former Chief Executive of British Energy, emphasized two points. First, the major technological advances embodied in the PBMR; its simplicity, speed of design, and rapid construction. The 165-megawatt-electric modules are very appropriate for developing countries, which lack extensive electricity grids. Hawley noted also the massive support given to the project by the South African government and the state-owned electricity company, Eskom, as well as the wise decision by both to draw in world-renowned industries, such as Mitsubishi Heavy Machinery, in supplying certain key components of the reactor, alongside the major role of South Africa's own domestic industry.

"Tears of frustration come to my eyes when I compare the attitude of the UK government to that of South Africa," Hawley said.

Dr. Alistair Ruiters, the chairman of the PBMR project, emphasized the fruits of "14 years of hard work," starting with the 1990 decision by Eskom to devote a small budget to examining the potential of the original German technology. A crucial turning-point came in 1994-95, when South Africa voluntarily abandoned its originally military nuclear program and redeployed its manpower and resouces into the PBMR project. Now the project is engaging suppliers spanning the globe, guaranteeing the commercial viability of a new path for nuclear energy. At the same time, the PBMR will constitute a major contribution by South Africa to improving the lives of people in Africa.

Courtesy of General Atomics

The predecessor of the PBMR, the AVR experimental pebble bed reactor in Jülich, Germany, came on line in 1967 and operated successfully for 22 years. It demonstrated many safety effects of the high-temperature reactor. One test showed that in a total sudden shutdown, the plant cools down and the fuel remains intact.

'Join Us on an Exciting Journey'

Jaco Kriek, CEO of PBMR, showed an upbeat video on the South African project, entitled "Expand your mind." The basic message was well presented: In the context of the need to upgrade an infrastructure that is already strained by South Africa's rapid economic growth, and at the same time to recapitalize the country's heavy industry and scientific-technological capability, South Africa has decided to make itself into a "global center for nuclear excellence," placing export of standardized nuclear reactor modules at the forefront of a strategy to cement the country's role as a major exporter of capital equipment. At least 12 countries are currently interested in purchasing PBMRs.

Kriek noted that "energy is a hot topic," and that the PBMR is "South Africa's unique contribution to the global challenge" of meeting mankind's power needs, not only for electricity, but also for transport and industry. He pointed to the decisive importance of this technology for Africa in particular—the giant continent that shows up nearly totally dark, from lack of electric power, in the satellite image of the world at night. Power is the key to kick-starting the African economies.

The first pilot PBMR will be completed in 2011, to be followed by commercial mass production of at least 30 commercial modules for domestic use and export. Eventually, hundreds could be produced. At present the approximate timetable looks something like this: First commercial units produced by 2014; production rising to 6 modules a year by 2015; at least 24 modules eventually to be delivered to the electric utility, Eskom. It could go even faster.

Key components of the technical infrastructure already being set up for the PBMR effort include a pilot fuel-element plant at Palindaba, the HTR helium test facility, and the HTTF, Heat Transfer Test Facility. These, Kriek emphasized, are world-class test facilities that will offer their services worldwide, in addition to supporting the PBMR program itself.

Kriek emphasized also PBMR's commitment to leverage the project toward creating new jobs in South Africa. Besides beefing up the country's high-value capital goods export potential, PBMR is encouraging international suppliers to the project to localize parts of the production in South Africa itself. Production of PBMR modules will have a local content of about 60%, while international partners will provide the remaining 40%.

The electricity-producing version of the PBMR already has a large customer in the South African power company, Eskom, which is committed to purchasing a total of at least 4,000 megawatts-electric of PBMR capacity, as the spearhead of its modernizing and expansion program for power production. However, in the future, the process-heat application may be even more interesting, not least of all for hydrogen production. PBMR is already planning to construct a second demonstration plant that will demonstrate the process-heat capability.

PBMR is classified as a "National Strategic Project," but at the same time it involves a remarkable international cooperation. The list of PBMR's international suppliers includes Mitsubishi Heavy Industries (MHI), which will provide the crucial helium turbine systems for the PBMR direct-cycle electricity production, as well as British Nuclear Fuels/Westinghouse, Germany's Nukem and Uhde, SGL Carbon, Spain's steel supplier ENSA, Canada's SNC-Lavalin, Murray Roberts, and many more.

Africa Needs Power!

Most interesting was the presentation by the CEO of South Africa's state-owned national electricity company Eskom, Thulani Gcabashe. Eskom is currently the 9th largest electrical utility in the world, he noted, producing 95% of South Africa's electricity and 50% of the entire electricity consumed on the continent of Africa.

Gcabashe showed once again the impressive satellite mosaic of the Earth at night, pointing to the fact that Africa—very literally the dark continent in the picture—accounts for 12% of the world's population, but only 2% of the world's energy consumption. On the other hand, Africa has extremely plentiful natural resources for energy generation, in terms of hydro, coal, and uranium, which could be used. Gcabashe made clear that Eskom's strategy takes into consideration not merely South Africa's needs, but the requirements of the entire African continent, home now to 700 million people.

For the last ten years, despite a massive electrification campaign in South Africa, Eskom has maintained an excess of power-generation capacity. That excess is rapidly shrinking, however, and the country is now only one year away from the point at which a rapidly growing demand for electricity will overtake presently installed capacity. As an immediate measure, Eskom added an additional 3,600 megawatts-electric of capacity in 2005, by bringing several power plants back on line that had been mothballed since the 1980s. Further capacity of 5,304 megawatts-electric is being added, by upgrading the performance of existing units. But in the medium term, it is only by mounting a massive program of new plant construction, that South Africa will be able to keep up with the skyrocketing demand.

After taking into account all available options, Eskom decided to choose nuclear energy, in the form of the PBMR, as the key vehicle to meet this challenge. The crucial areas of application are the rapidly growing coastal regions in the Cape and Kwa-Zulu regions of South Africa, which are located far from the country's coal-producing area.

After a detailed feasibility study in 2002, Eskom made its initial commitment to install a minimum of 1,100 megawatts-electric of nuclear PBMR capacity, beginning with the "Strategic National Demonstration Project" that goes into construction next year. Beyond this, Eskom is looking at a total of at least 4,000 megawatts-electric of PBMRs. Gcabashe's projections suggest that in the longer term, some 10,000 megawatts-electric of additional capacity will be needed, corresponding to about 60 of the standardized PBMR modular units.

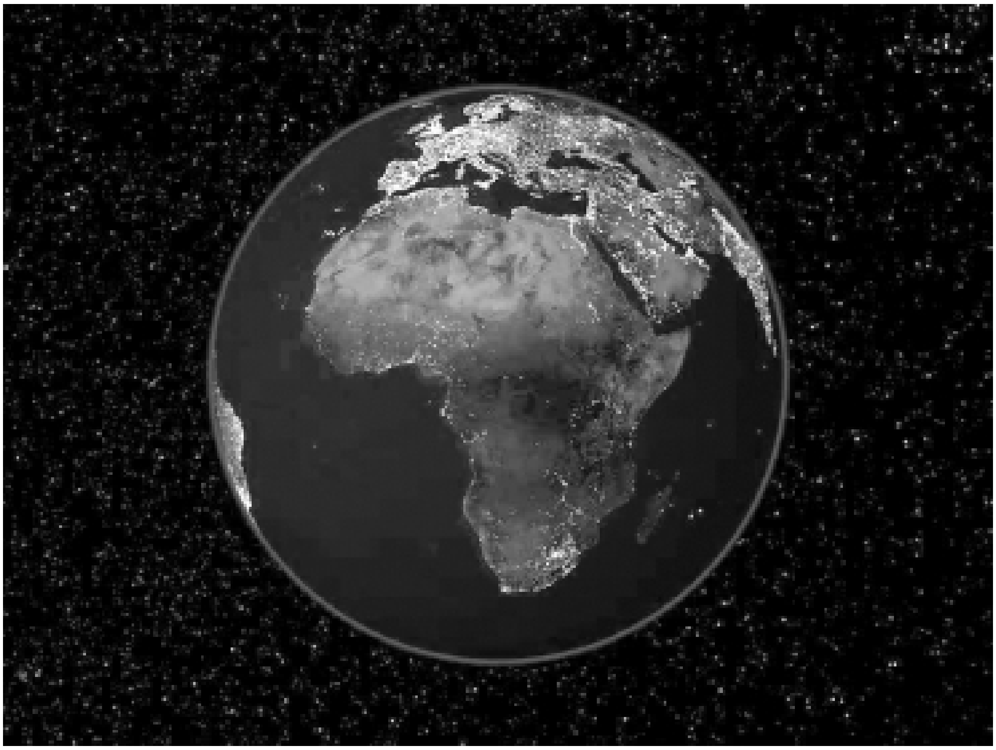
How To Build a Stable Energy System

South Africa's Minister of Public Enterprises, Alec Erwin, elaborated on the thinking process behind the strategic decision by the South African government to go for its ambitious PBMR-based nuclear energy program. Why would a country like South Africa opt for such a policy course? For a long time, energy was not at the forefront of the government's agenda. But after ten years of rapid economic growth, Erwin said, we had to really start thinking about the problem: How do you get a stable energy system?

Because there are no powerful energy suppliers among the neighboring countries, the emphasis would have to be on South Africa's own production. The nature of South Africa's economy dictated the need to diversify, and at the same time provide for long-term stability of energy production and energy costs.

The South African government decided to keep the electricity company Eskom in state hands, giving it the ability to raise capital and to carry out sophisticated projects. South Africa is one of the world's largest uranium producers. In addition, South Africa possesses an entire complex of facilities previously connected to the military nuclear program. Going with the PBMR project was not an easy decision, but the technology seemed to fit so well, particularly in view of its potential impact on the industrial development of South Africa's economy.

Further, the favorable fiscal situation gave the government the possibility to support big projects. The worldwide community of scientists and nuclear technology suppliers provided enthusiastic support, giving us the sense that we were not alone, Erwin said. Thus, the PBMR has the character of a global project.



Data: AVHRR, NDVI, SEAwifs, MODIS, NCEP, DMSP, and Sky2000 star catalog; texture: Reto Stockli; Visualization: Marit Jenoft-Nilsen

Africa's lack of electricity is striking in this satellite view of the continent at night, where electric lights show up as white dots. Although the continent has 12% of the world's population, Africa accounts for only 2% of the world's energy consumption.

Erwin emphasized the unique advantages of the PBMR for the developing countries in Africa and around the world (see accompanying interview). He noted the major interest from many countries with whom South Africa is in discussion, including Brazil, India, and China. China, which is already operating a small test reactor based on the same basic pebble-bed technology, has signed a memorandum of understanding for cooperation with South Africa.

There is a certain amount of opposition to nuclear energy in the country, Erwin noted, but most of it is coming through the global non-governmental organizations, NGOs. The debate in South Africa is more reasonable than it has been in the so-called developed world, and in reality, the so-called renewables like wind provide no serious alternative to nuclear technology, he said.

All in all, Erwin concluded, "this is an important time for nuclear energy as a whole" and a "wonderful confluence of events" that placed South Africa in a position to play the leading role in realizing the revolutionary PBMR technology.

Nuclear Modules in Six-Packs

A particularly enthusiastic note was added from the United States by Regis Matzie, Chief Technical Officer of Westinghouse Electric Corporation. Matzie called the PBMR project a "model of international cooperation," noting that in addition to the international suppliers already mentioned, Russia was also playing an important supporting role by providing testing facilities for the PBMR fuel elements.

Matzie had high praise for the South African effort and the full-hearted support given to it by the government. Already 4.3 million man-hours have gone into the design, and world-class test facilities. South Africa's Northwest University has carried out extensive work on the Brayton-cycle helium cooling system, and the helium test facility with its 40-meter tower is nearly completed.

"There are no serious technical issues left," Matzie said, noting that the PBMR construction will incorporate the proven fuel element design and operating experience of the AVR and THTR systems in Germany, as well as standardized materials from the conventional light water reactor industry.

What about the future market? When we speak of the PBMR being able to supply a "niche" for plants with total power of 700 megawatts-electric or lower, "that niche is pretty big." It includes much of the developing sector of the world economy. Moreover, the possibility of combining many standardized PMBR modules in "four-packs," "six-packs," and "eight-packs" (so-called "multi-modular design") could make them building-blocks for commercial plants worldwide.

But the process heat applications, Matzie said, are potentially even larger. Of the U.S. energy consumption, for example, about one-third is electricity, but two-thirds is transportation and heat applications. The PBMR will be key to a future hydrogen economy.

Europe's Energy Challenge

Dr. Sue Ion, technical director of the company British Nuclear Fuels (BNF), which has been a major partner of the

South African project, spoke about "A European perspective on nuclear energy and the PBMR."

"Could there be a renaissance of nuclear energy in the UK and Europe?" Dr. Ion asked. The European Union is the largest energy importer in the world, and the import quota could increase from 50% to as much as 70% in the coming decades.

The stability and security of energy supplies is in serious question. She said the UK is facing a gradual depletion of the North Sea oil and gas reserves. The reserve storage of natural gas in the UK is a mere 14 days. Europe currently has 685 gigawatts-electric of electric-generating capacity, which must be expanded to more than 900 gigawatts-electric by the year 2020. At the same time, much of the existing fleet of power plants is aging and must be replaced, many already in the coming 10- to 15-year period. The present state of the electricity distribution system in Europe, including the limited capacity for interconnections, leaves no alternative to a major push for new plant construction.

In this context, European countries are having to look very seriously at the role of nuclear energy. France is set to begin major replacements of its nuclear reactor fleet. In the UK, influential "environmentalists" such as Gaia proponent James Lovelock and Hugh Montefiore have come out in favor of nuclear energy, and recent studies of the British Institute of Civil Engineers have underlined the weakness of wind power and other so-called alternative technologies. Finland is building a new nuclear power plant, and in Switzerland the population voted in a referendum to keep the nuclear option open, Ion said.

In addition to the electricity-generation problem, we must do something about the energy requirements of the transport sector, which accounts for nearly 56% of energy use in the European Union, she said. Here the pebble-bed technology, as a heat source for hydrogen and other synthetic fuels, gives us "the first real breakthrough."

"The PBMR is a fantastic technology," Ion said, and would be ideal for a number of locations in Great Britain itself, where smaller units are most suitable. In addition, the UK could exploit its extensive experience with gas-cooled reactor technology. "I hope I live to see the first PBMR switched on here," she concluded.

Building on a Long History

Dieter Matzner, the general manager of the Power Plant Division of PBMR, detailed the historical process leading to South Africa's taking up the High Temperature Reactor technology originally developed in Germany. A key turning-point, ironically, was the German government's own decision in 1990 to discontinue all work on its HTR. This crazy decision came just months after the basic HTR modular reactor design, which provided the take-off-point for the later PBMR development, had been officially licensed by Germany's Nuclear Safety Commission.

The inventor of the HTR, Prof. Rudolf Schulten, died suddenly in April 1995, just two weeks after having signed a crucial agreement with South Africa for the transfer of the HTR technology. South Africa's early interest in the HTR was heightened by realization of the implications of large-scale desalination for a largely arid country, as well as the large distances separating the country's huge coal fields from most of its population centers.

Matzner emphasized the uniqueness of the safety features of the PBMR, underscoring the difference between so-called "passive" safety incorporated into the latest-generation light water reactor designs of the European EPR and the Westinghouse AP-1000 on the one side, and the "inherent safety" of the PBMR on the other. A crucial difference is that in the PBMR a meltdown of the reactor core is not only extremely improbable—as in the EPR and AP-1000—but literally *impossible.*

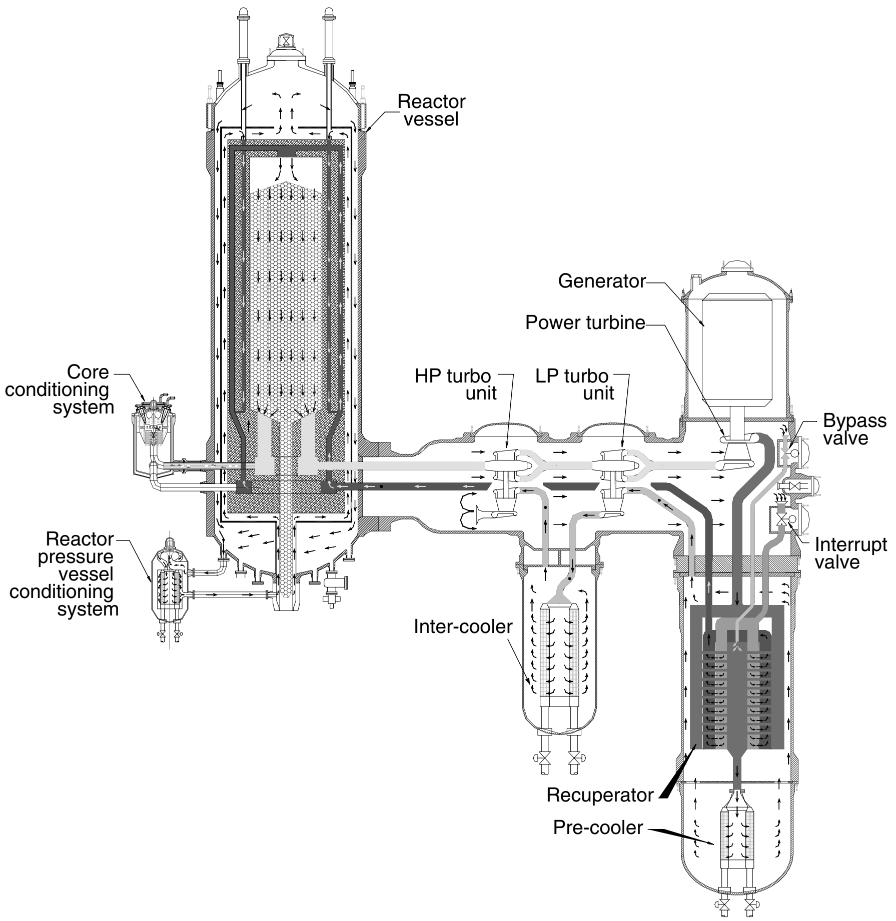
In addition, Matzner said, the same design for the spherical fuel elements, based on encapsuling tiny particles of fissile fuel in high-temperature ceramic coatings, which is key to the inherent safety features of the PBMR, also provides an unrivaled packaging system for nuclear waste. The ceramic materials employed, remain stable and corrosion-proof for millions of years. In the context of the reactor fuel, the ceramic encapsulation prevents significant release of radioactive substances up to temperatures of 1,800° F or more, far above the maximum temperatures attained in the reactor, even in the "worst-case" accident scenarios.

Among other additional advantages of the PBMR design (see accompanying interview), Matzner mentioned the uniquely favorable dynamic behavior of the reactor, which is linked to its strongly negative-temperature coefficient. This means, that when the reactor temperature increases beyond a certain point, the efficiency of the fission reactions decreases rapidly, leading to the chain reaction "shutting off" by itself. This not only excludes the possibility of a dangerous runaway chain reaction, with overheating and other negative effects, but also means that the reactor's power output can be regulated essentially by the rate of cooling that the cooling system provides. The faster we cool it, the more power the reactor supplies. And the less we cool it, the less heat the reactor produces, as the fission reactions slow down automatically.

Japanese Know-how

A very important feature of the South African PBMR system, is the decision to use a "direct-cycle" helium turbine to power the generator for electricity production. Virtually all existing nuclear power stations and conventional electricity plants employ steam turbines for their power generation. The very high (900°) operating temperature of the PBMR, the extremely low level of release of radioactivity from the fuel, and the characteristics of the coolant itself—inert helium gas—provide the possibility of operating a gas turbine at very high efficiencies, while at the same time avoiding the bulky and complex heat exchangers of conventional light water nuclear power plants.

FIGURE 2
Cutaway View of the PBMR



Source: Courtesy of Eskom

Shown is the reactor vessel of the Pebble Bed Modular Reactor (at left) along with the direct-cycle helium turbine (right).

It also affords great ease of repairs and maintenance in a low-radioactivity environment.

The helium turbine of the PBMR has some similarity to a jet engine; it is simpler, relatively much smaller, and has a higher power density than the steam turbines of conventional power plants.

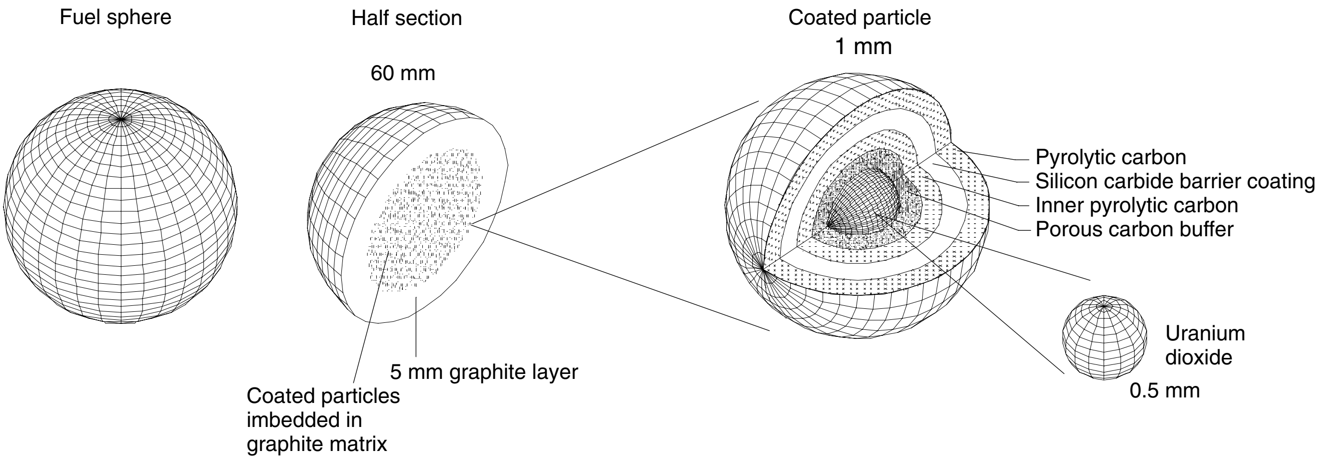
For this high-technology item, the South Africans decided to bring in the experience and expertise of Japan's famous Mitsubishi Heavy Industries (MHI), one of the world's major producers of power turbines, including gas turbines for natural gas-based power plants. Mitsubishi was representated on the conference panel by Yoshiaki Tsukuda, general manager of MHI's Takasago Machinery Works.

On the Way to a Hydrogen-Based World Economy

Willem Kriel, manager of U.S. Programs for the PBMR company, gave an exciting overview of the potential of the HTR-PBMR system as a source of high-temperature heat for industrial processes—applications that promise to generate an even greater economic impact, than that of electricity generation. These include large-scale hydrogen production; synthetic natural gas and other liquid and gaseous fuels from coal, oil, or other carbon sources; process heat for refineries and other chemical plants; heat and steam for recovery of heavy oil and other resources; large-scale desalination, and so on.

Kriel spoke of a "new frontier" opening up, symptomized by the suddenly emerging interest on the part of fossil-based fuel companies, to explore the possibility of applying nuclear energy to "leverage" existing hydrocarbon reserves. The PBMR is presently the only existing technology, apart from combustion of fossil fuels, which can economically provide large amounts of heat in the range of 900 degrees. It is also the only carbon-dioxide-free source. Applying this heat to endothermic steps in the conversion of coal and oil to synthetic fuels, and to the thermochemical production of hydrogen, which is an important intermediate for synthetic fuels,

FIGURE 3
Pebble-Bed Fuel Pellets



Source: Courtesy of Eskom

The fuel pellets for the PBMR are coated particles of uranium dioxide surrounded by several concentric layers of high-temperature-resistant ceramics, that "contain" the fission reaction. Several of these micro-particles are embedded in a graphite matrix to make up a tennis-ball-size sphere.

will make it possible, in effect, to "stretch" existing fossil fuel reserves by a very considerable factor.

The PBMR could leverage gas by 30%, and coal by 100%, while at the same time providing the basis for economically exploiting vast amounts of oil sands existing in various locations. The recoverable hydrocarbons from the oil sands in Canada and Venezuela alone, would exceed in equivalent the entire oil reserves of Saudi Arabia, Kriel said.

In this context, "he who hesitates will be last," Kriel declared, pointing to five conditions defining a unique "window of opportunity" for the introduction of nuclear process heat into the world's energy market. To succeed, any proposed technology: 1) must come soon; 2) must be safe, in order to be located close to process heat-consuming plants; 3) must be economical; 4) must have the right size, ideally in the range 400-500 megawatts-thermal; and 5) must produce the right temperatures, in the range of 800-1,000 degrees. The PBMR modules fit exactly these requirements, with no serious competition on the scene.

Kriel praised the "revolutionary" pioneering work of Prof. Rudolf Schulten and his collaborators in Germany during the 1960s, on applications of HTR process heat. It was a pity, he said, that political circumstances prevented that work from coming to full fruition. But with the PBMR, "nuclear energy has finally broken the shackles of only being able to make electricity."

Parallel with the effort to complete the demonstration PBMR for electricity production, work is now going on to prepare for a pilot plant for process-heat application, in discussion with a variety of potential industrial users, including the petrochemical industry. Kriel spoke of "three to four near-term applications" which could potentially involve "large numbers" of PBMR modules. The modules in question would be "dedicated" to heat production, and would not need the elaborate heat-to-electricity conversion system of the electricity-producing PBMR.

At the same time, work is proceeding on addressing the details of matching the output heat production of the reactor, to the different characteristics of the consuming processing plants. The first demonstration facility will involve a consortium of industrial clients. The required heat-exchanger and chemical reactor technology can be developed and tested in parallel, separately from the nuclear reactor, using other heat sources, Kriel said.

There are "three to four possible projects" in the near-term, Kriel stated, and the priority now is to push ahead with planning, complete technical development in 2007-2012, and have pilot plants running by 2015, which would be the date of "commercial roll-out" of process-heat PBMRs.

Educating a Young African Labor Force

Thabang Makubire, general manager of the Fuel Plant Division of PBMR, took his audience through the fascinating process of production of the spherical fuel elements—the "pebbles"—which constitute the heart of the PBMR technology. First, microspheres of enriched uranium-containing solution are formed in special nozzles, and then jelled and calcinated at high temperatures, producing tiny "kernels" of uranium dioxide of 0.5 millimeter diameter. These are then run through a Chemical Vapor Disposition furnace at temperatures of 1,000° C, where they are coated with successive layers of silicon carbide ceramic and pyrolytic carbon.

The result is a hermetically sealed, coated particle of a little less than 1 millimeter diameter, which is extremely hard and high-temperature resistant. This multiple coating constitutes a practically fail-safe barrier to the release of the radioactive fission products generated in the uranium kernel as a result of the nuclear reactions. Approximately 15,000 of these coated particles are then mixed with graphite powder and resin, and pressed into a sphere of about 6 centimeters diameter, covered with an additional layer of pure carbon (graphite) as a "buffer," and finally sintered, annealed, and machined to extreme hardness.

The core of the PBMR module—the pebble bed—consists of 450,000-500,000 of these tennis-ball-size fuel elements. In the course of operation, the pile of fuel elements is constantly renewed and recycled, as fuel balls are gradually introduced into the annular-shaped core from the top, and withdrawn from the bottom. Each fuel ball makes about six passes through the core, with the degree of "burn-up" measured in between.

Because this is a continuous fueling process, it is no longer necessary to shut down the reactor at frequent (18-20 month) intervals for refueling, as is necessary for conventional, nuclear power stations. A pilot fuel-element production plant is already in operation, and has produced a small lot of 81 fuel balls, which are now being tested in Russia under reactor conditions.

A full-scale fuel element plant is scheduled to be commissioned in 2008-2009. Meanwhile, the South Africans are using the pilot plant to train technical staff for the commercial plant. This, as Makubire emphasized, is part of a broader policy of PBMR and the South African government, to use the nuclear energy program as a driver for labor-force development, focussing on so-called "localization" of production, and drawing into the process young Africans, who are the key to the country's future.

Crucial Role of Government Institutions

The conference drew to a close with a presentation by Mukesh Bhavan, executivevice president of South Africa's state-owned, but self-financed Industrial Development Corporation (IDC), and by final remarks by PBMR CEO Jaco Kriek.

Bhavan noted that the IDC's present role in the financing of the PBMR project continues a very long tradition of support for government-identified strategic projects directed toward developing South Africa's industry. A key success story was the creation of SASOL, the chemical giant which leads the world in the production of gasoline and other hydrocarbon products based on coal. At present, SASOL's coal liquification plants produce about a third of South Africa's gasoline and diesel consumption. The technology developed in the context of SASOL has had "phenomenal spin-offs" for the country's industry and economy generally, Bhavan said, "and we have the same vision for the PBMR." The IDC is increasingly engaged, also, in financing industrial projects in other African countries.

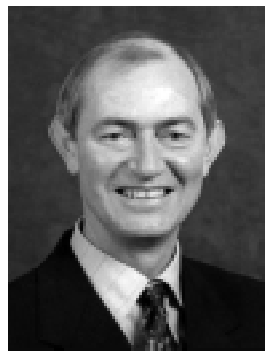
As a National Strategic Project of the South African government, the PBMR seems indeed to be on the road to success—reminding us of the kinds of things the United States and some other countries used to do so well, before the insane, radical "free market" ideology took over. Time for rethinking?

Meanwhile, South Africa is on the countdown, with officially 2,096 days to go, for its first pebble-bed modular reactor to go online.

Interview: Alex Erwin

PBMR Is 'Perfect' for Africa's Development

Mr. Erwin is Minister of Public Enterprises of the Republic of South Africa. He was interviewed by Jonathan Tennenbaum on Jan. 30 at the London conference on the PBMR.



EIR: Somebody might exclaim, "my goodness, Africa is starting at such a low level and now you are bringing in such an advanced technology like nuclear. Isn't this a complete mismatch?" What would you say to that?

Erwin: Well, I think that would be a naive view. If you look at the South African economy itself, it ranks as 25th largest in the world. It is an increasingly sophisticated manufacturing exporter. More than 60% of our exports are manufactured products. We are now a significant exporter of automotives and motor cars, and we make significant amount of avionic and aerospace equipment.

In South Africa you already have an industrial base that is strong, and if you look at Africa's needs, which are the exploitation of its mineral resources, increasing its agricultural potential, and so on, it needs energy to do that.

So, in fact, the contrary is true; this is the *perfect* technology for Africa—and not just for Africa, but for many developing countries. This is wonderful: You can take a plant, you can put it close to your energy needs, you can put it close to the surrounding town, and you don't have to put in gigantic grids, because the management of grids across an extensive