

South Africa's PBMR Is Moving Forward!

Jaco Kriek is CEO of the Pebble Bed Modular Reactor (Pty) Ltd. in South Africa. He was born in South Africa, Kwa-Zulu Natal, in a town called Vryheid and raised on a game farm bordering the Itala Game reserve. Before joining PBMR in 2004, he was executive vice president of South Africa's Industrial Development Corporation, responsible for mega-projects, including the PBMR, the Mozal Aluminum Smelter, and others. He was interviewed in Washington, D.C., by Marjorie Mazel Hecht on Sept. 29, 2008.



Marjorie Hecht

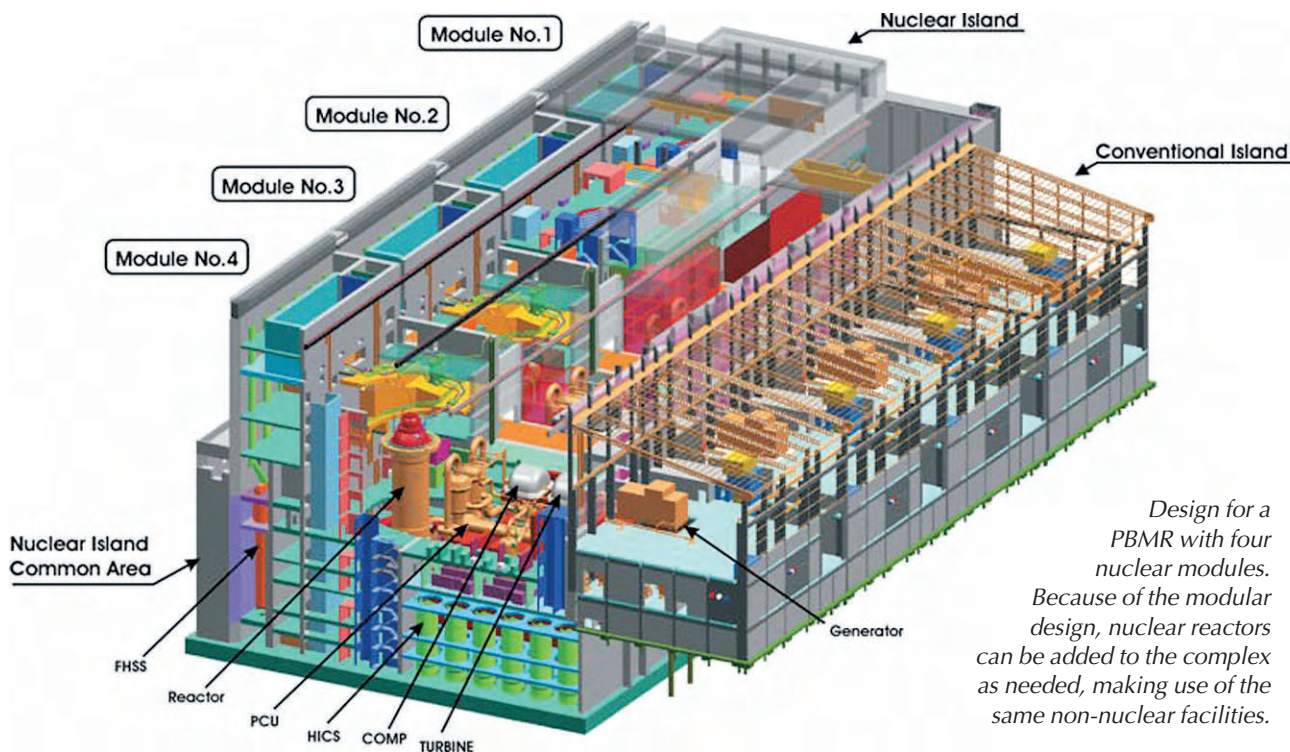
“PBMR is one of the few engineering and science megaprojects South Africa has. We should not waste that opportunity. It’s an opportunity in a lifetime for a developing country.”

forming South Africa—its economy, its industries, and its workforce?

I think the impact and the potential for gas reactors has been kept alive by PBMR for many years, at a time when nobody wanted to touch it, and nobody was interested in nuclear. Now there is a nuclear revival, and you see a lot of others coming along, that were in the business many years ago. We are not just a small local entity. Already South Africa has created a nuclear industry, although it's still young. We have the U.S. Nuclear Regulatory Commission coming to our regulator to learn how our regulatory licensing is coming along. There was a visit a few weeks ago, a delegation of about 15 people from the NRC, visiting our test facilities. And we've got an ASME workshop next week—the American Society of Mechanical Engineers—because our design is based on ASME standards, and we had to make some additions to the ASME codes and standards—ASME Plus. So ASME is engaged with our regulator.

Question: To me the PBMR represents optimism, not just for South Africa but for the whole continent. I see both the PBMR and the General Atomics GT-MHR as the “workhorses” for what we need for the future.

How do you view the PBMR and its role in terms of trans-



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.

In South Africa, we've kept the nuclear idea alive—in public opinion—and therefore when the state utility Eskom just announced that they were going to build a number of large reactors, there was no outcry. The country's citizens almost have an attitude of "We knew it was coming."

When you talk about local industry: we are now busy with about five local companies, to get them ASME accreditation, so that they can manufacture nuclear-grade components for us. We have agreements now with six universities, and we're increasing the number, to include nuclear engineering as a subject. Last year was the first year that two nuclear engineers qualified for PBMR bursaries. In addition, we have research projects with those six universities.

And we have created the Nuclear Industry Association of South Africa. Areva, Westinghouse, Mitsubishi Heavy Industries, and others—Eskom, Uranium One, Necsca—are members now. It's grown tremendously, and all the big local companies have joined. Its purpose is really to consolidate all the initiatives—education, regulatory issues, manufacturing, licensing, industrial capacity, government liaison, policy issues.

So PBMR is a substantial local industry. We have over 800 people locally employed, and worldwide we probably have 1,800 people involved in the PBMR program—suppliers, universities, and in departments of government.

Question: You are producing the first of a planned series of a new kind of reactor. What stage are you at now?

We have basically had to handle a number of challenges. This is the first time South Africa is licensing a nuclear reactor. It's a first-of-a-kind reactor. We've got the issues of conventional PWR [pressurized water reactor] safety philosophies, and we measure accordingly. This is a new concept, with new characteristics— inherent safe characteristics, meltdown proof. It's different, and for us, we have to justify on paper that it's different, and that the regulator should accept what you say on behalf of the public that it's safe, without having a reactor built. Obviously there have been other similar reactors. But the regulator wants to see what you're going to do, how you're going to operate it safely. That was the challenge for us.

Because South Africa didn't have a nuclear industry or a nuclear policy, the government didn't really know how to handle this. Remember, it was originally Eskom that started this initiative.

So, we at PBMR were a bit like a young elephant bull. We've got a lot of elephants in South Africa, and they relocate them. But what they found is that if you relocate only the youngsters,



PBMR

The PBMR Helium Test Facility at Pelindaba is testing many of the plant components in a helium environment. The non-nuclear facility is designed to test helium at the high temperatures and pressures that will be experienced in the Pebble Bed Modular Reactor.

they have no discipline. They go wild, and they actually attack rhinos, and cars. The matriarch is the one who imposes and keeps discipline. So we were without a "matriarch"! And therefore, we made mistakes with our regulator—lack of respect, let's say for the nuclear safety culture, for the regulatory requirements, for the customer.

But I think that the "matriarchs" that we got involved, for example, Westinghouse, IAEA [International Atomic Energy Agency], INPO [Institute of Nuclear Power Operations], to help us, and a lot of work inside PBMR, helped us to understand and to really get a nuclear culture. We were a company that was put together by people from the arms industry, utilities, and some from the old Atomic Energy Corporation of South Africa (currently Necsca). So, in the arms industry, you build a cannon and you test it. It's a different culture.

With nuclear, the knowledge and expertise are there, but it's how you do it, the paperwork, the procedures to follow, So those were challenges. And I think in hindsight, the disadvantage was that we were not part, for example, of Areva or Westinghouse. We were not part of a "mothership" that looks after you—people, processes, funding. We were created from scratch. Now the benefit is, we've got a unique culture, a young company....

Question: New ideas...

Exactly. So that's the benefit. But it was a rough grinding to get to where we are. And sometimes people say, "Why did it take so long?"

First of all, we had to create a company, and build two projects. Even for Areva, building the conventional Olkiluoto reactor in Finland, this is challenging—with their stop work or-



PBMR

Wildebeest and zebra grazing near the Koeberg nuclear site, where Eskom, the state utility, operates two 900-megawatt 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.

ders, etc.

So now, when you say PBMR, they assume there's a company, an order department, a licensing department, risk management, finance—that all those things are in place, at the same time that you're running with the technical aspects.

And now the latest status: We will start to produce graphite at SGL Carbon in Germany in the next month or so. This is for the core structure, the ceramics.

That was a breakthrough for us, because there was no benchmark for the quality of graphite required, no ASME standards. So we had to develop our own criteria and specifications that the regulator would accept. This was tough. But now that has been accepted, and we have a machining facility ready where these big one-ton blocks of graphite will be cut and machined for the core structure.

We also got approval from the regulator to start the welding for the pressure vessel; we've got the big shells, about 900 tons of big shells.

Then on the forgings for the core barrel. Some of the pieces have been forged, and we're now racing to get the welding for that done.

For the turbine: We want to start forgings for the turbine casings and we want to start to make the blades.

So, on the long-lead items there's been a lot of progress, but it's been a long process.

Question: When will you start to build the demonstration reactor?

We want to go on site by early next year, for the early work, the non-nuclear construction. And then in 2010, we want to start the nuclear construction. This is subject to our getting a nuclear construction license and a successful regulatory decision on the EIA, Environmental Impact Assessment.

We are starting public meetings now in the next few weeks, and hope to conclude those by the end of the year.

We hope, and we are confident—but it's not in our hands—that we will get a positive decision in the EIA by the second quarter of 2009. Then we've allowed time for appeals and legal processes to conclude, and we hope by the end of next year that we have a decision from an environmental point of view that will allow us to go to site.

Now we also have to still convince the nuclear regulator that we can go to site, because there are certain issues in the Nuclear Act—One thing I should mention is that our Nuclear Act was not designed for new builds. It was put in place after the Koeberg Nuclear Plant was built, so it was designed to *maintain* nuclear

facilities, not to build new ones. If there is an issue at Koeberg, the regulator does not shut it down; they will say, "I want you to improve on this or that." But we can't start to build until all the issues are resolved to the regulator's satisfaction.

It's a different philosophy.

Question: How is your regulatory agency put together? Is it appointed by the Parliament?

Yes, it reports to the Department of Minerals and Energy, more or less the same as the U.S. Nuclear Regulatory Commission. It's a board that's appointed by the Minister, so it is an organ of state. And also a lot of work has been done by our self capacity for co-operation, like the NRC. The National Nuclear Regulator, or NNR is part of MDEP, the Multilateral Design Evaluation Panel for regulators. When there is a new design, like PBMR, the regulators cooperate. So the NRC and the NNR cooperate on PBMR.

Question: What will be the effect of the change in government for the PBMR? Do you anticipate a lot of changes?

I don't think so. I don't want to sound arrogant or blasé about it, but we've done a lot of work for the transition. It's still the ANC [Africa National Congress] that is in power, not a new party, so the policies on nuclear, on the PBMR, should stay the same. The next ANC conference will be only in 2012.

From the work that we've done, 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. SASOL [South African oil from coal company] was another example, and there are very few of those companies in South Africa that can play on the global stage.

As a country, South Africa is way above its weight division in terms of what we're doing. But the circumstances were just there—we were in the right place at the right time to get this technology and take it further.

So, I don't think we'll see changes. Obviously for a developing country there are lots of requirements on funding: infrastructure, social welfare, job creation. But what we're saying is that there's a very direct link between science and engineering projects and anti-poverty measures. Science helps with antipoverty. It helps raise the standard of living for people.

Question: Traditionally, you need a science driver, if your economy is going to grow. A lot of people don't understand that.

Exactly. I've gone around to all the universities, to talk to the vice chancellors, to get them to cooperate with us, saying, "You need to help us to make this link more visible, and clarify it, and explain it. This is something that you should add into your communication and education about science and engineering."

PBMR is a good example because of the spin-offs. For example, we have the fastest computer in the Southern Hemisphere to work with our modeling and to test PBMR systems and equipment. These computers produce models in the *virtual world* that



This satellite view of the African continent at night gives a striking picture of the lack of electricity. Although the continent has 12 percent of the world's population, Africa accounts for only 2 percent of the world's energy consumption. More than half of Africa's electricity is produced and consumed by South Africa.

accurately predict and analyze the impact of the strains and stresses the demonstration plant will be subjected to when it goes into operation in the *real world*. This is totally different from nuclear—it's a different field, but the university can now have students and train them in it. Materials, measuring temperature in the core, these are not nuclear, but all these technologies and research are around our technology. And there are many applications. Flownex, for example, is a code that was designed for PBMR, and is now being used by SASOL in other areas.

And companies were established because of PBMR that are now servicing the economy in other areas.

It's an educational process, that we now spend a lot of time on. We have to continue this with the public, because those people who can't see the link, will claim that we are a "white elephant." That's the last thing we are. We're an asset to the country, a pool of expertise and skills.

Question: The country really has no future without nuclear. You have blackouts now with the power supply. You have enormous unemployment.

And if you think there's a magic way of getting out of that, without development, without research—nothing comes for free. You have to invest, if you want to get something out for the economy.

Question: But it has to be real, productive investment, not paper.

Yes—the taxpayer gets a third of that money back that is invested in these projects; it's spent on the people.

So, really, in my mind, one thing that has happened that I think is really positive, and maybe not noticed yet by the international community (maybe it has been, but I really don't see it) is that here in an African country: the President is asked to resign, and constitutional processes are followed, legal processes, and there is no violence. The next President is appointed three days later. The cabinet is reshuffled, new cabinet ministers are appointed, and life goes on.

It's interesting, I think we're in good company, because your President is about to change!

But unfortunately, because of the African connotation, people think that if there's a change, it's going to be another Kenya or Zimbabwe. I think South Africa, the South African market, the South African economy is just too strong, and I think it's been demonstrated that we've started to mature as a democracy, which is very positive.

Question: It's positive for the whole continent, and perhaps you can say something about that—the role of the PBMR in transforming all of Africa.

Yes, we're talking to our regulator in fact, we're putting a few people at the University of Pretoria to study nuclear law and specifically to set up regulatory frameworks in other countries.

Question: Many African countries are interested in going nuclear—about 20 of them.

Probably initially we will need an African-wide regulator. It's too expensive, too complex, and probably too risky to allow every country to have its own regulator. I don't want to sound like the U.S., or that we need to control it, but I think Africa needs to do that.

Then you have to make sure that the operators are qualified internationally, that waste issues are handled. But I think the fastest way for Africa to get nuclear is to have a very credible regulator—an African regulator with international operators.

If you look at the African grid, South Africa produces and consumes more than 50 percent of the electric power.

Question: You see that in the satellite map of Africa at night, a dark continent, with just a few spots of light....

Exactly. So if you look at other countries in Africa, some of the



PBMR

South African pioneers of the pebble bed technology. From left, Dave Nicholls, first CEO of the Pebble Bed Modular Reactor (Pty) Ltd. (now with Eskom), Dr. Johan Slabber, and Dieter Matzner.

grids are 900 megawatts, 1,000 megawatts. To give you an example: I was involved in Mozambique with an aluminum smelter. It's a 1,000-megawatt plant. It uses four times the electricity of Mozambique, just that one project. So these small 165-megawatt PBMR reactors are ideal for these countries.

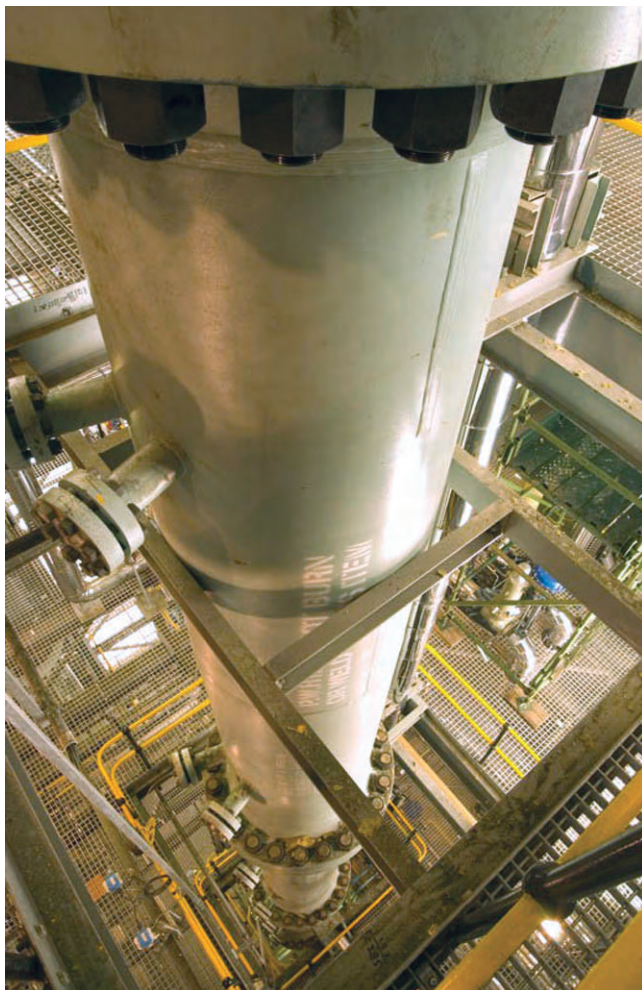
Question: It's a start that can grow with their power grids.

Yes. As somebody said in Mozambique, they use diesel fuel to generate electricity, so cost is not an issue. Even if you think that nuclear will get more expensive, it will never reach the cost of diesel. And then there's the logistics of the diesel fuel.

So it's a challenge for Africa. But South Africa is serious about this. We have a visit to Tunisia next week; they want to understand how they can cooperate with us. Algeria, Morocco, and Libya are also interested in the technology.

Question: These are places with nuclear research reactors, where there already is training of students.

Exactly. So, you'll probably find that we'll cooperate from the South with the North, Northern Africa, and we'll try and see what we can do. Some of these countries want to establish nuclear training schools with South Africa, and invest with PBMR potentially. So I think that there's a lot of potential. And that's just on the extrinsic side.



PBMR

Inside the PBMR Helium Test Facility at Pelindaba.

PBMR's Helium Testing Facility at Pelindaba is testing fuel handling, control rods, and secondary shutdown systems.



PBMR

When a person is inside, it's a very interesting development. If you think about South Africa: We've got gold, we've got iron ore, we've got uranium, we've got thorium, we've got PBMR technology, we've got companies like SASOL—with the technology of producing oil from coal. We don't have much water to generate hydro-electric power. But you put all that together, and you don't have to study too much to say it makes sense for South Africa to go with PBMR.

And we are not just talking about producing energy. We are heavily dependent on imported oil, but we've got all that coal. However, 60 percent of our coal is burned, just to make oil from the coal. SASOL, for example, claims that they can extend our coal reserves by 25 years if they don't have to burn 60 percent of the coal to get the oil out of the other 40 percent.

So I think that combination makes so much sense for us to go with the PBMR.

Now if you look at the energy situation in the world, the oil price, CO₂—and we're not saying anything on the CO₂ situation—but we can see in areas of South Africa where there are coal-fired power stations, it has an effect on the health of people.

Question: The emissions.

Yes. Worldwide, climate change, we're not saying we need PBMR for that. We're saying: Let's get clean energy. Let's get security of energy supply, because coal is not going to last forever. Oil is not going to last forever. So let's use all the energy available to us with as little impact as possible on the environment. That gets us to nuclear. I'm not saying only nuclear, because it's not realistic. We will have to continue to use coal.

We need to build 40,000 megawatts in the next 20 years. It's impossible to just build nuclear stations. We'll just run into trouble. Not just because of cost, but because of time, the schedule required to get licensing, to complete construction. So these are the issues.

Question: Once you get the licensing for the first PBMR, do you have to re-license to mass produce the rest?

Well, obviously then you've got a carbon copy of the technology, and the EIA studies, but you still have to license each site.

Question: But you can put up six or eight plants at the same site?

Yes, sure. The footprint is very small, so you can add a lot of reactors.

Again, at this stage, it depends on the customer. For process heat, you're probably talking about two or four units. For electricity, maybe you need more. But maybe you don't, because of the decentralized distribution; maybe a city or an area needs two units.

The distribution has now become an issue—right of way. The transmission lines from the coal-fired power stations in the northern parts of South Africa to the coast in the south are very

long (about 1,500 kilometers to Cape Town), and you lose energy on your transmission lines—up to 20 percent of your energy on long transmission distances. At the moment, Cape Town is dependent on the Koeberg nuclear plants, plus the transmission lines.

And the loss of 20 percent during transmission, means that out of every 100 megawatts, only 80 arrive at the end of the line.

Question: So you really need an upgrade of your transmission lines.

It's happening already.

Now, obviously with the big nuclear stations, you're limited to the coast. So location is an issue. We don't have big rivers that we can locate nuclear stations on.

There is hydro—the Congo's Inga project, but it is 4,000 kilometers away. So we can't rely too much on that. Coal is in the north of the country, and your industrialization is on the coast. So that's where the new big nuclear stations will assist.

But the areas where you've got mining activities are far from everything—far from the coal, far from the coast. So there is a good case for the PBMR, [which doesn't need water for coolant].

I don't think there will be many big changes from the new government on this. Affordability will be an issue—it's always an issue. And we're going to have to make as much progress as we can.

Question: I think the government really can't afford *not* to do it...

What about your relationship with the Chinese? China has built a demonstration pebble bed reactor. Are you working with them?

Yes, they have basically taken over the German design, with a 10-megawatt reactor. It's not a commercial size. We are in discussions with them, and I think where we could cooperate is on the issue of licensing and process heat—they have a lot of coal. One of our local companies, SASOL, is extremely involved in China. The Chinese HTR also uses pebble fuel. We will have to establish where we are each in our program, and what the common areas are for cooperation. Fuel, principles of licensing and safety—those are areas we can cooperate in.

We signed a memorandum of understanding with China in 2005; we're actually meeting them tomorrow to explore potential cooperation...

Question: China has invested a lot in Africa—they are building dams and various other big projects. So it seems that they understand the value of getting infrastructure built in the continent.

But they are not as much in South Africa yet. They are in Mozambique, Zimbabwe, Sudan, and some other West African countries. I think in South Africa, because of the economy, most of the reserves are owned by different companies: Anglo-Ameri-

can, BHP Billiton, big international companies. So I think maybe the space for the Chinese is less. In other countries, like Zimbabwe, the international companies pulled out so there is more access for China. Same with Mozambique.

You know with agriculture in Mozambique and Zimbabwe, they have the potential to feed the whole African continent!

Question: Yes, they could. And Sudan has huge agricultural potential too.

Yes, if they could just get their act together. But one of the issues is distribution, logistics. Another issue is that they are not allowed to export their goods. The duties on their exports are high. The domestic market is small—they have too much for that area. So that's always an issue for small economies.

It also applies to South Africa. If we have a big project like a steel plant or an aluminum smelter, we have to export. Our local consumption is too small. But you have to build a big plant; otherwise it doesn't make economic sense.

Question: My interest for many years has been with nuclear, and with developing the world. And we—the Lyndon LaRouche movement—have proposed the Eurasian Land-Bridge, which would extend from the east coast of China all the way to Rotterdam, to open up the interior of Eurasia for development, new cities and industries. We see the PBMR and GT-MHR as the work-horse reactors for that. We would start with nuclear there, and there is a lot of support for this program.

I think one thing that is not yet taking place is international cooperation. Commercially you're trying to protect your IP [intellectual property] and your lead in the market, but I think that is why it is difficult for companies to cooperate. But *countries* should cooperate.

And now there's a draft agreement between South Africa and the United States on research on new advanced technologies, like PBMR, and with the NGNP, Next Generation Nuclear Plant, we're participating in that program, and with the NRC, ASME. With the U.S., there is a lot of cooperation. But we're not at the point yet where we can share the funding of these projects, to make it easier.

Unfortunately, it looks like there's going to be duplication. In the U.S., they want to build their reactor; we are going to build our reactor; China is going to build its reactor. Japan, etc. And the first-of-a-kind costs involved in building these first ones is so expensive. If we could share that, then it would make it much easier to build the reactor. Then it would be just the materials.

Test facilities—we spent \$100 million on test facilities, which I think in hindsight was good. We've learned a lot, and gained a lot of experience from our test facilities. And the U.S. NRC is now saying that they want to do some of their tests in our facilities.

Question: Of course the U.S. shut down its test facility—the fully operational Fast Flux Test Facility. That was really stupid. So, in this case, you are providing leadership to the United



Courtesy of Emerson Process Management

Solvent blending at a Sasol plant in South Africa. Sasol produces oil from coal, a process that requires burning 60 percent of the coal to get oil out of the remainign 40 percent. Using the high-temperature process heat of the PBMR would be far more efficient.

States. Because you're moving ahead, and so far you've had government support. I don't think that situation exists in the U.S. in the same way.

We have a least a three-year window of predictable funding, whereas the DOE programs are funded annually.

Question: The DOE is really a dinosaur.

But if you call them dinosaur, ours is older!

Question: What about the George Soros-funded opposition to nuclear in South Africa?

It is sad that foreign companies or rich people try to dictate or influence policy decisions in developing countries, when in their own country, they are going to go nuclear. It's sad that they don't want to allow *us* to do it, I don't know what makes them feel they should spend money on this. Maybe the trust or foundation doesn't even know that the money is spent on this. Their money is so big, and spent all over the world. The funder doesn't always realize the damage they are doing to South Africa, or to other developing countries.

Because what do you want us to do? Do you want us to continue to import nuclear technology and fuel from the U.S., or from wherever else? Why can China, Japan, France, go ahead with nuclear—but foreign money is used in South Africa for anti-nuclear campaigns? It doesn't make sense to me. But unfortunately, that's how life works.

If somebody has got a conscience, they're going to spend their money combatting malaria in Mozambique, for exam-

ple. I think the anti-nuclear funders don't really appreciate the damage they are doing.

Question: In some cases, I think these groups intend to damage, because they don't want to see the world go nuclear, for population reasons.

But why don't they do it here [in the U.S.]?

Question: Well, they do! They *do* fund anti-nuclear groups here, and there is an opposition to nuclear here....

But they're not very successful here.

Question: On the other hand, we haven't built any new nuclear plants since the 1970s.

I believe that there are now signs that companies will get combined operating licenses to build new plants.

Question: Yes, but it's very slow. And there was a lot of damage done by this funding going into the anti-nuclear groups.

But because you have 104 active plants, you're a lot stronger on the nuclear front. South Africa is really at the beginning, so the damage to us is much bigger. They are planting doubts in the mind of the public and the government. They say it's too expensive; they call us a "white elephant."

You find some people listening to that. They need to balance the books on the funding, and they ask, "Should we do this for the PBMR?" And now someone from the U.S. is saying it's "stupid." Or "why not build windmills from Denmark."

Question: Well, the Danish are putting funds into the anti-nuclear movement in South Africa.

And why? Because they want to see windmills?

Question: They haven't been able to replace any conventional power plants in Denmark, even though they have all those alternative windmills. Because the windmills don't produce enough reliable energy....

On a different subject: What do you plan to do with the used nuclear fuel. Will you reprocess it?

As far as waste is concerned, so far there is just a low-level waste site called Vaalputs, in an area called Namakwaland.

There already is a policy approved that the utility, at the time when they want to store their waste, and empty the pools, they will have to justify whether they want reprocessing, or long-term storage. So the final decision hasn't been taken yet. And it is in the hands of the utility that will do the economic and technical presentations to the government.

Question: The utility being Eskom?

Yes. Now, there's a bit of waste from Pelindaba, at Necsa, the Nuclear Energy Corporation of South Africa, at the moment, is the custodian of the low-level waste. So Vaalputs is the site, but it's only for very low-level waste. None of the spent fuel from Koeberg has been moved there.

I don't think South Africa will ever put up a reprocessing facility; it's too expensive. France, Japan, and eventually the U.S., are going to go in that direction. But we'll always have to send out our spent fuel for reprocessing. I know the French have already made a proposal to Eskom, because the Koeberg station's sister station in France, is already operating on MOX fuel [mixed oxide made from recycled fuel]. So Koeberg, with some adjustments, can also operate on MOX fuel.

And what's interesting on the NGNP, is that there is now research that high temperature reactor fuel can utilize plutonium from the waste of nuclear weapons.

Question: That's what the General Atomics GT-MHR is doing.

Yes, with Russia.

And we are also looking at waste minimization. We want to recycle the graphite. This is a program we're doing with research at one of the universities, and with the European Union, with SGL Carbon, a German company that is producing our graphite for the core structure and for the fuel spheres.

So that's the picture on waste.

Question: How did you get involved in the PBMR?

By accident! I am a chartered accountant. In my previous life I was with the IDC, the Industrial Development Corporation, as the vice president for mega-projects. Steel plants, aluminum plants, all the big projects were under me, and the PBMR was one of them. And then, when Eskom pulled out from the project as the lead investor, the ex-Minister [of Public Enterprises] Alec Erwin, and my chairman, Dr. Alistair Ruiters, asked me if I'd be on a task team to discuss with the Cabinet ministers how we were going to move the project forward. That was in February 2004, and on May 27, 2004, they asked me to head the company.

It's been fascinating. The big mega-projects experience was very useful to me, because thinking big, was not new to me. But nuclear was totally new to me. Now I know it superficially. I like the industry. And the timing was good, because of the nuclear renaissance. In 2004, it was totally quiet. In 2005, also. But in 2006, we had an HTR conference in South Africa, and you could feel that the nuclear industry was coming back.

So PBMR's timing was good. It was a little ahead of its time for this renaissance. Let's say five years or more. But in the last two or three years, that has changed, and there's a lot more interest now.

We're in a unique situation in South Africa. We desperately need energy.

Question: Yes, you've had blackouts and brownouts.

They claim that the blackouts we had in January of this year cost the economy 50 billion rand.

Question: And what you could have done with that...

Exactly. We could have built lots of reactors with that... And Eskom now has to make a decision on its big reactors, between Westinghouse and Areva. The issue is cost. The nuclear renaissance, in my view, has selected the wrong time to start. Capital investment is high. The penalty is a lot more now.

The question is, will electricity get cheaper? And I don't know for the foreseeable future, because if you look at how many reactors are being built or planned, the demand is going to be there, but the supply chain might not keep up with it.

Question: At the press conference this morning, I raised the question that we're in a complete financial collapse. And what we need is 6,000 nuclear reactors to meet demand—the equivalent of 6,000 at 1,000 megawatts; they don't all have to be 1,000 megawatts.

I think if the industry is convinced that it's sustainable, the capacity will come. But even now, Finland [the Olkiluoto reactor] is late. The cost is enormous. In South Africa, the decision has been postponed. Europe is moving slower than people thought. It's slower everywhere. So, I think industry is sitting back and saying, "OK, I'll enjoy this wave of high prices, but I'm not going to expand. I'm going to wait." They were bleeding three years ago.

Question: What they did is increase the capacity of the existing plants, instead of investing in new ones, because it's cheaper for them—in the short term. They are not looking ahead. They need to be investing now.

The other question I raised at the press conference is that we really need a new policy, of the sort that Franklin Roosevelt instituted in the Great Depression. The U.S. banking system is collapsing—the \$700 billion bailout is not going to do anything for it. It can't—it's a bottomless pit. We have to put these banks into bankruptcy proceedings and start again in an orderly fashion with a New Bretton Woods. I don't see a nuclear renaissance being able to take place unless we have that kind of reorganization.

I think everywhere this is a problem. In South Africa, we've neglected infrastructure—roads, railways, ports, electricity, water.

The problem for us now is in prioritizing funding. You've got real poverty, unemployment, and the unions: When you say, you're going to build a new port, they say, "What for? We need jobs." And this short-term mentality and inability to plan will always try to make this new port look bad. It's big infrastructure, it doesn't create jobs.

But that's absolutely wrong. It's that link, the link between good roads, ports, railway lines, water...

So it's an interesting debate. You also have the element of the government that will try to say to the public, these guys are creating white elephants. "It doesn't create jobs for me so therefore



PBMR

The Pelindaba site of the Helium Test Facility, with the Hartebeespoort Dam in the background. The 43-meter-high facility was built to test the helium blower, valves, heaters, coolers, recuperator, and other components at pressures up to 95 bar and 1,200°C

it can't be good."

Question: Where do they think the new jobs are going to come from, if not from advanced technology?

Unfortunately those who think only in terms of the short term, do not see the long-term picture. For South Africa to continue to import and export, we need new ports. Our ports are full. Meanwhile, our railway lines are bad or not well maintained, so they are using trucks to haul manganese and coal, so that messes up the roads. And we lose lives too.

Question: We had better railways in the early 20th Century than we have now. We need to look at this worldwide, and we need to do what Roosevelt wanted to do, which is to decolonize Africa and all the other colonies, and go with the most advanced technologies, like maglev trains....

The South African rand is one of the most traded currencies of developing countries, and you have to be very careful with your policies, statements, fiscal policies, because things happen fast, and it does constrain you. Because if an analyst somewhere doesn't like what you're doing, then your currency goes. We are vulnerable. I'm not an economist, so I don't understand....

Question: But you do understand that you need a science driver, and that you need to produce real things—you need a physical economy, and not a paper economy.

What a lot of people don't appreciate, is that it's a chicken and

egg situation with infrastructure. You need to put the infrastructure there before industry will develop. You can't say to industry, "If you build an aluminum smelter, we'll build you a port." They are not interested. Take, for example, the Coega harbour project near Port Elizabeth on our east coast, which I was involved with on the IDC. "If you build a zinc plant there," we said, "we'll build a port." And the industry said, "No, no, no, show us you're going to build the port first." So, what happened? The zinc plant was cancelled.

And today there is a port, and now everybody's saying "It's a white elephant, it's not used." But Richards Bay is a port that was built 40 years ago. And people were saying then, "It's crazy, there's nothing there." But today it's the busiest port in the Southern Hemisphere.

Question: You need to have vision. You need to think 50 years ahead.

And energy is even longer. For a nuclear plant, you have to look ahead 60 or 80 years. So if we look back, to 1928, you had to make a decision on the nuclear stations we need now! If you make an investment decision, it's a long, long time you're talking about. If you make a wrong decision—that's where we are now. And I'm concerned that because of the cost issues with nuclear, that we're going to continue with coal. And we're going to get sanctions against us. Whether it's right or wrong, that's the reality. It's again one of those things that developed economies will say, "Look what I'm doing for carbon emissions and reduction.