INTERVIEW: JAMES WRIGHT

Texas University to Build First HTR Research Reactor!

Dr. James Wright, manager of the HT^3R project at the University of Texas.

James Wright, Ph.D., is the manager of the HT^3R project (pronounced "heater") at the University of Texas of the Permian Basin. He was interviewed Feb. 23, 2006 by Marjorie Mazel Hecht.

Question: First, congratulations! It's good news to know that there is a new nuclear project starting up, especially a high-temperature reactor. It's long overdue. How did this project get started?

In June 2005, the president of this campus, the University of Texas of the Permian Basin, was looking for ways to jumpstart research here. This campus is the smallest in the University of Texas system. The president, Dr. David Watts, is a sociologist, very bright, and he's done more for science, and has more vision for science, than many university presidents that are physicists, engineers, or chemists.

Dr. Watts asked a faculty member, an attorney, Jack Ladd, who runs the John Ben Sheppherd Public Leadership Institute, about this, and Jack suggested that he get in touch with me. Jack and I had worked on some technical projects together, when he was practicing law. So we started having discussions about implementing a scientific research program, which was basically using the national laboratory model—what Los Alamos used when I was there. That is, you start with a facility that is constructed with sound science, and then that facility also must have a myriad of activities that can be associated technologies.

So, being in the middle of the oil industry, we were aware that the oil and gas industry in the United States had already started decreasing around 2 percent per year, and that world production is soon to be decreasing. I don't know exactly when that's going to be happen.

For this reason, Andrews, a small community north of us, several years ago went out and became involved in a low-level nuclear waste facility. They educated their population about nuclear energy. And, Andrews County has historically been one of the country's leaders in oil and gas production. The oil and gas business is a dangerous one. We lose people every year to accidents, so folks are aware of industrial

The first U.S. fourth-generation nuclear reactor will be built at the University of Texas of the Permian Basin as a teaching and test facility, according to an agreement signed on Feb. 22 between General Atomics and the University. The GT-MHR is a modular high-temperature gas-cooled reactor, which uses a direct-conversion cycle that is 50 percent more efficient than the conventional nuclear steam cycles in producing electricity. (The initials stand for Gas-Turbine Modular Helium Reactor.)

In the GT-MHR, the high-temperature heat created by nuclear fission is conveyed by the helium gas to directly turn a turbine that produces electricity. The GT-MHR is similar to the South African Pebble Bed Modular Reactor. The difference is that the GT-MHR has its fuel particles stacked in rods arranged in a prismatic core, instead of the tennis-ball-size fuel pebbles of the PBMR. The GT-MHR and the PBMR both have the same passive safety systems that automatically shut down the reactors, without human intervention, if there are any problems.

The project is named HT^3R, and pronounced "heater," which stands for high-temperature teaching and test reactor. As the accompanying interview spells out, if all goes according to plan, the HT^3R should be operating in six years—2012. It will be a 10- to 25-megawatt-thermal reactor, depending on the determination of the pre-conceptual design study.

The enthusiasm for the West Texas project should spur other U.S. universities to look ahead to a nuclear renaissance and reopen the research reactors that were shut down under anti-nuclear pressure in the past two decades, or even better, to build new fourth-generation reactors to train the engineers and scientists the country will need!

—Marjorie Mazel Hecht

Participants at the signing ceremony for the HT^3R agreement give the new project a standing ovation. Standing at far left is Dr. David Watts, president of the University of Texas of the Permian Basin. General Atomics CEO Neal Blue is third from left. Among the others present are local mayors and county officials.

Rafael Aguilera/UTPB

accidents and dangers; they live with hydrogen sulfide in their communities. In fact, here on our campus we have wells that, if they weren't controlled, would emit hydrogen sulfide and kill people.

So in West Texas, we understand risk. We understand big equipment. Drilling an oil well is like mining, in a way. You hang a piece of pipe on an oil rig that goes 5,000, 10,000, even 20,000 feet down into the Earth. That's a lot of weight. You have to turn it in order to drill the well. So, the communities out here are really unique in that sense, of understanding risk.

And through the education process that this low-level nuclear waste plant went through, and the city and county of Andrews went through, it just seemed like a good opportunity for us. Dr. Watts had already recognized that.

Of course, there is also an enrichment facility that will soon be licensed—it's almost complete. They actually expect to break ground by August. That facility is just within a few feet of the waste control specialist facility, even though it's in New Mexico—on the border.

So, I looked at this, and said, really what we have is a Permian Basin Nuclear Industry Park! It's unique, and we should be able to exploit this. It's been a while since I've been around reactor technology. My Ph.D. is actually in nuclear chemistry, and so I decided I would call a friend, with whom I used to work at Los Alamos National Laboratory, Harold Agnew. Harold was the director of Los Alamos, and I worked in the director's office. I worked for him and enjoyed it—he's a tremendous guy. And I knew that he had gone to General Atomics, and was a CEO, and was still a director of the company.

I called him and told him I needed to find out about the status of nuclear energy in this country, and he said he was going to have someone call me. Literally, within minutes, Mike Campbell, the Senior Vice President for Lasers, Inertial Fusion, and GT-MHR from General Atomics called me, and invited me out there to talk about it. Two days later, I was in San Diego, and we talked and kicked around ideas for two days; and I was brought up to speed—at some level—on gas reactors, on what they had done, and what General Atomics had been doing while the rest of the country was sort of asleep at the wheel.

And so based on that, we formulated some things, and another person from GA got involved—Malcolm LeBar—and we started discussing some of the more technical issues. Then I asked the GA guys to come out to West Texas and see what we have, in the way of an educated population, and what I consider to be a nuclear-friendly environment. So, within two weeks, Arkal Shenoy, director of the MHR group, and Malcolm LaBar, manager of the MHR group, came out, and they were impressed with the community and the level of understanding that we had out here with nuclear energy and radiation. And I think we allayed their fears that even though the University of Texas of the Permian Basin had no Engineering Department yet, we were going to use this facility to build that capability.

Question: That's a good way to do it!

There are some political reasons in the state of Texas that make it very difficult to start any new academic program, because you have to have the students before you can pay the faculty. And of course, you can't pay the faculty before you have the students. It's a chicken-and-egg thing. But this facility will allow us to jumpstart that process, and be able to fund our faculty for, in essence, research, and then spin them off to teach classes.

Question: I think you'll attract students and teachers with this new research reactor.

Again, that's also our hope. We think this facility will. So what we decided we would do is create this high temperature teaching and test reactor research facility; and the keystone in the Los Alamos model would be the reactor itself—and this reactor, due to its flexibility and all the things it can do. That is: with its high temperature, it can generate electricity using the Brayton gas cycle, as opposed to the Rankin steam cycle that is now used. In addition, it has lots of that good high temperature process heat, where you can thermochemically induce certain reactions to take place, like the production of hydrogen. And once you get hydrogen, then you can make synfuels, or you can just use hydrogen itself. There are a myriad things you can do.

So, we envisioned that we would have the reactor as the keystone; and then we'd have a radiation research facility that would use the reactor to work on new fuel cycles, advanced fuel cycles, to more effectively burn plutonium, thorium fuels. And I like to say, almost the kitchen sink. We're open to looking at any type of fuel cycle in the radiation laboratory.

Another laboratory that we would put in this facility is a high temperature process and materials laboratory. Once you get into this temperature regime, first of all you have a lot of materials problems; and the way you address these is to have a facility to do the required research and development. And since we'll have lots of that 950 degree celsius process heat, we'll have enough to do some good research. We'll also be looking at new processes—for hydrogen production, synfuel (synthetically produced light hydrocarbons) production, coal gasification.

Question: What about isotope production?

Yes, that's in the nuclear part. There's just a whole wealth of new research that can go on.

The third laboratory will be a Brayton Cycle laboratory, where we'll be able to test the use of gas turbines and optimize that.

So we have our core reactor as the keystone facility, and around it we have this series of laboratories, where really good physics, engineering, science, biology can be learned and developed. It will be a great research tool for the United States.

Question: I hope it will pioneer a pattern that other universities could follow, because, really, science is not alive in this country any more.

Of course we realize that, like everyone else does. And our goal then was how to move forward. We realized that we needed a pre-conceptual design if we were ever to obtain money from the Federal government, or from industry, or from anyone. And we determined that it would take about $3 million to do that pre-conceptual design.

Question: But you're going to move very quickly and get that done in six months.

Yes—we raised the $3 million in about two months; our kickoff meeting for raising the money was in December. And the key to that was Dr. Watts being able to entice the communities. If you look at who donated the money, we have an incredible mix of donors, all charitable donations—no equity, not stock. . . .

Question: No strings. . . .

No strings. This is all for the university. And we have a series of individuals, local philanthropists. We got roughly a quarter of a million dollars from them, in amounts from $50,000 down to a couple of thousand. And they were the first people to give us money. We got some civic leaders together and we had a luncheon at the local Petroleum Club in Midland, and we gave them a presentation on how important it would be, not only for West Texas and the Permian Basin, but for the whole country and the world to follow this path.

And the next thing that happened was that the civic leaders went to their communities, and the community of Midland donated $500,000; the community of Andrews donated $500,000; and the community of Odessa donated $500,000. For Midland and Odessa, this came out of Economic Development funds. They believe that this will help provide economic development for the region, which I believe it will. And Andrews managed to scrape up $500,000, half of it from the county and half from the city government.

Question: So that's really a grass roots effort, with broad support.

That's right. We also got $7,500 from a local Rural Electric Company. . . . And the last one and a quarter million came from Thorium Power. So those are the donors.

We also had to involve the University of Texas system, which is responsible for the operation of nine academic institutions and six medical institutions, known as the University of Texas. Their role in this: Barry Bergdorf, the general counsel and vice chancellor for the system, was appointed by the chancellor to lead the effort. The University of Texas system in a situation like this is very important for the overall success. You have to realize that we are the smallest campus in the UT System, and we had no technical capability in physics and engineering until this project came along. So the University system put a "teaming agreement" together. I suggested the campuses that had the engineering programs that would be useful in this endeavor, and they arranged for those campuses to help us—Arlington, Austin, Dallas, and El Paso. And then of course, they also included the communities in this teaming agreement, since they are such an important part. Not only did these communities raise money to support us, but it's their land and their air too.

The people here are "doers"—they are the original Texans. They have minds of their own. They don't want to take a backseat to anyone. We have some incredibly wealthy people out here, who made a lot of money in the oil business by taking risks. They understand risk, but more importantly, they are doers.

Question: So you are protecting the project from environmentalist attack, by building support from the bottom up.

Yes, and we're taking great pains to keep the public informed of every step that we take, of the technologies. Information is the key.

Question: They have everything to gain. . . .

They are still actively involved with this teaming agreement . . . which will help us complete the pre-conceptual design.

We've actually already started, as of when the document was signed Feb. 22; we're going full bore on the pre-conceptual design. That's what we'll give the University of Texas system, and say that we think that we should move forward in the engineering, licensing, and construction; and before we do that, we'll need the regental approval again. . . .

Question: I would think that you'll be swamped with students, because there isn't another place like that right now, to get in on the round level of working with laboratories and a new reactor—all of those are very exciting things. And as you probably know, research reactors, except for a small number of them, have been shut down.

We'll be the first test reactor for gas reactors, and that's the future. We think it's a great place to be, and a great neighborhood to be in.

Question: What size reactor is planned?

The pre-conceptual design will actually determine that. Part of that will be determined by potential customers. Who will be interested in this type of reactor—who in the government, for example? I would say right now, it's somewhere between 10 and 25 megawatts thermal. That's somewhat larger than a standard research reactor at a university.

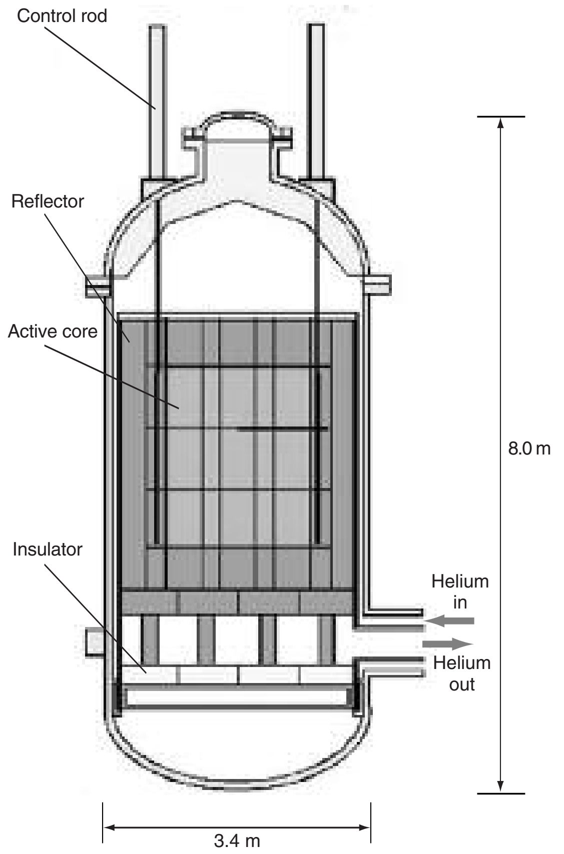


Figure 1
SCHEMATIC OF THE GT-MHR UNIVERSITY RESEARCH REACTOR
The GT-MHR University Research Reactor design has the same characteristics as the full-scale reactor: It uses a helium coolant, a graphite moderator, tiny (1 mm) ceramic-coated fuel particles, and the same passive safety characteristics. The fuel particles are stacked in vertical rods, which are arranged in hexagonal graphite blocks in the reactor core. The core is all ceramic, which permits very high temperature operating conditions. No meltdown is possible.

Courtesy of General Atomics

Question: But this will be a working test reactor. . . .

It will be a teaching and test reactor. We think it's very important to give it that name and that mission. We will be a kind of little brother to the NGNP, the Next Generation Nuclear Plant at Idaho National Laboratory. That's also a gas reactor. But that is a technology demonstration. And the belief is that before utilities will buy into a new reactor technology, they want to make sure that the new reactor can work at a high-duty factor, like our current light water reactors (LWR), above 90 percent.

We must prove that this reactor can run 90 percent of the time and reliably generate electricity and hydrogen. And can it do it for several years? That Idaho NGNP is the technology demonstration, that actually demonstrates to the utilities that, yes, we can do this.

Now, we're a little brother, a supporting piece for NGNP. We don't answer the questions that NGNP will. We're teaching engineers and scientists, and developing and testing new technologies that may well be implemented in NGNP.

Question: It seems to me that if the utilities had a brain, they would be supporting this.

Well, we're going to ask them! The key to funding this project is that it not be completely funded by the Federal government.

Question: Or run by the DOE. . . .

We're going to seek funding in several places in the Federal government, but we expect probably a third of this to be financed by private sources—non-Federal-governmental sources. The state of Texas and the communities here have already demonstrated that they're real proponents of this technology. We've already anteed-up $3 million. There's no other area of the country that has said that we believe that this is so important that we're going to put $3 million into it.

Question: That's certainly the case. Really the industrial capability of the country is dying.

So if you look at our communities: The population of Andrews, Texas, is 29,000. Now if you stop to think that a town of 29,000 people is so committed to this technology that they're willing to put up "risk" money of half a million.

Question: But it's their future.

That's right. They are truly a forward-looking community. I can't say enough about any of the citizens here in West Texas, because they put their money where their mouth is. Rather than "not in my backyard," they say, "We'll pay you to come in our backyard." So the communities here are really unique.

And local involvement is one issue, but we're also going to get industry involved. We're going to go out and find businesses that want to support this.

We're going to look for roughly a third of our money from businesses. And the rest of it, we're going to break out between the Department of Energy, the Department of Defense, and other places.

We want to make it so this project does not drain the resources of other things. We believe that it should be funded, but there are other projects that need to be funded also. The NGNP needs to be, and the GNEP [The Bush Administration's Global Nuclear Energy Partnership]. There are a lot of good nuclear programs that need to be funded, and we're all for that.

Question: Nuclear projects tend to get bogged down in all sorts of things, so if this can push ahead with the fourth-generation technology, that's great.

Well, we've already pushed farther ahead than a lot of people thought would happen.

Question: It will be great to have a U.S. fourth-generation project for nuclear engineers to work on.

We're going to need more nuclear engineers—we don't have enough. You know, by 2040, our current nuclear plants will be decommissioned, and nuclear capacity is about 20 percent of our electricity. Furthermore, by 2040, an additional 26 percent will be decommissioned from coal and gas-fired plants. What people don't understand is that all these plants have a finite lifetime, and we're not going to be able to afford to put in all these coal and gas plants. We're going to have to put in a lot more than that 20 percent nuclear; we're going to have to put in 30 to 40 percent nuclear to keep the cost down.

Question: Jim Muckerheide, who is the nuclear engineer for the state of Massachusetts, wrote an article for *21st Century* showing that by 2050, the world would need 6,000 new nuclear plants; and you can't build them all in 2049, you have to really start now. Muckerheide's project called for building all kinds of nuclear plants, but the workhorse of the plan was the high-temperature reactor in both forms, pebble bed and prismatic core.

Not only that, by using high-temperature plants, you have a higher efficiency, so actually you need to build less thermal capacity in order to get the same electrical capacity.

Question: Where will you get your fuel?

As far as licensing a reactor in the United States goes, they want you to use "proven fuel." That's a requirement for timely licensing. There is a source of fuel that has been used for this type of reactor, in Japan. So, I would imagine that one of our first shots may be to look at getting fuel from the Japanese. It's been proven, used. We'll have to really work with the NRC, and show them all the tests that have been done in Japan. But historically, it's extremely difficult to license new and unproven fuels. You need a test reactor to test the new fuel. So we will actually be able to test new fuels and help their development.

We can hypothesize about some of these decisions now, but the pre-conceptual design will more clearly define them.

Question: Can you try different fuel cycles in the reactor? I'm sure you know that General Atomics has a project in Russia that is doing engineering design on a GT-MHR to burn plutonium.

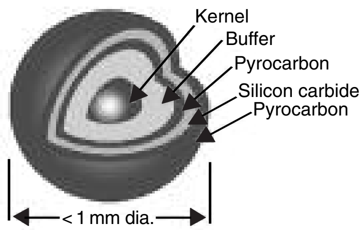
In the pre-conceptual design, our intent is to make this a real test reactor, where you can test all sorts of fuels and fuel cycles. That's our goal. The radiation laboratory will have that as its prime goal. We don't want to just refine uranium fuels in a gas reactor; we want to look at other fuel cycles. We want to look at thorium, we want to look at spent LWR fuels, we want to look at plutonium (the deep burn of plutonium); and we say we will consider all possible fuel cycles. We've done lots of calculations, and there are several that look very promising.

Question: The United States last year shut down the FFTF in Hanford, which was a reactor designed to test new fuels and materials.

We believe that this reactor will fill a real need in this country!

Some people have asked us why we haven't involved other universities in the project. One of the reasons that we haven't gone out and made a consortium is, we believe that once you start doing that, you lose focus. Two guys have a good idea and a good concept, and they ask a third facility or institution to come in, and that third party says, "You really have great ideas, however, let's add this." And so then they get a fourth institution to come in, and they say, "Boy, you three really have some great ideas, but let's add this." And pretty soon, your facility has lost its focus.

What we're trying to do is create a facility that will become a national users facility, operated by a national users group; and the University of Texas of the Permian Basin will take the lead in that. We want people to come in from all over the country. So once we get the reactor constructed, and that reactor has a real purpose and a mission, then we believe it will be really easy to get the users we need, worldwide. But we think it is really important not to include everyone until we get the construction done. We want to keep the facility's focus aimed really tight right now, so that when we do form a national users



Courtesy of General Atomics

Figure 2
COATED PARTICLE FUEL FOR THE GT-MHR
The outer layers of the fuel particle are ceramics, which provide "containment" for the nuclear fuel at the center. The temperature limit of the coating is higher than the temperature that can be achieved by the fuel particle, even in the most severe accident conditions. No fission products can be released.

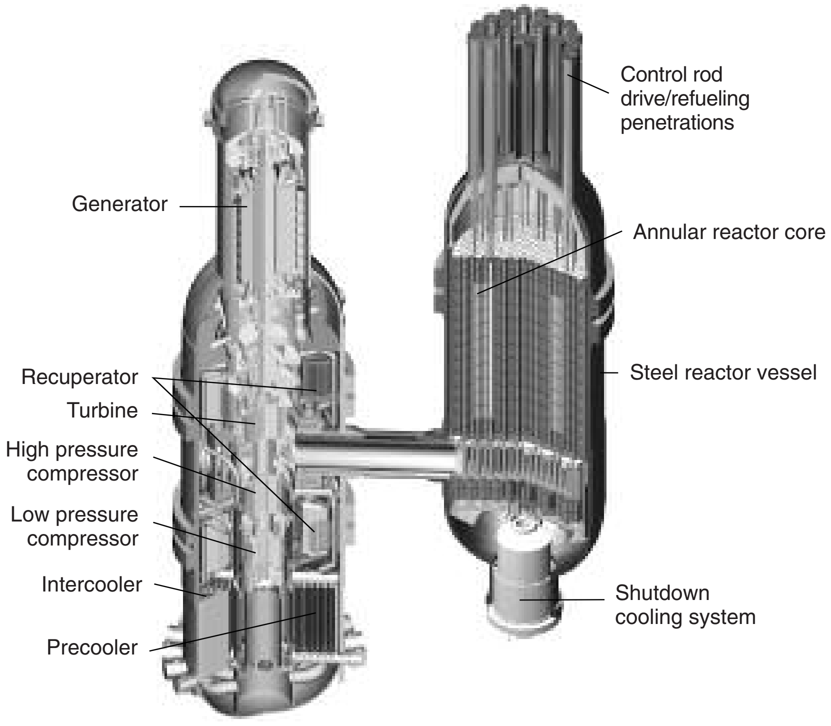


Figure 3
CUTAWAY OF FULL-SIZE GT-MHR
The university research reactor will be a smaller version of this 600 MWt GT-MHR. The advanced gas turbine system, which is based on the modern jet engine, helps make the reactor more efficient than conventional low-temperature power plants, which have a steam cycle. Conventional nuclear plants operate at about 32 percent thermal efficiency, while the GT-MHR can achieve thermal efficiencies of close to 50 percent now, and even higher efficiencies in the future. Other new technologies that increase the GT-MHR efficiency are plate-fin heat exchanger technology and frictionless magnetic bearings.

group, people will be eager to come, because they can see the real opportunities, and the opportunities will be something the country really needs.

Question: So it sounds like you could start construction pretty fast, if everything goes well with the plan.

We have a construction schedule, and if everything goes well, as we've planned, we believe that it's not too optimistic to have this operating at the end of 2012—only six years away. Some people say that that's awfully optimistic, and we just point to how long it took the Chinese and the Japanese. So, we believe that since we are designing this reactor to operate on current state-of-the-art technology, but have the possibility to extend its capability over the next 20 to 30 years—with that philosophy, we can literally be operating by 2012.

Question: You know that projects in the past, at Los Alamos for instance, took political will. If the will is there, you can do it. In the Manhattan Project, we built reactors in a very short time. And in fact, we went ahead and built things that we didn't have the technology to use—the first enrichment plant, for example, didn't have the design for the membrane yet, when the plant was in construction.

We did a lot of things on the fly.

Question: We did it because it had to be done, and if you have the right attitude, which it seems like you do, you'll get it done.

At our signing agreement ceremony this week, Neal Blue, the CEO of General Atomics, started his little talk by saying, "I think I've finally found 'Cando-sville.' "

General Atomics gets people coming through their facility all the time who want to team with them; and Mike Campbell told me that they are very polite with the people, but they seldom—generally never—make any progress.

Question: I'd like to ask you a little bit about yourself.

I received my Ph.D. at Iowa State University, while an Atomic Energy Research Fellow at the Ames Laboratory. And then I worked for a while at Hanford, and came to Los Alamos to calibrate a neutron detector that we'd developed at Hanford. While I was there, I was offered a job at Los Alamos—in the late 1970s, working in the office of the director, Harold Agnew. He and I had a great time.

Starting in 1989, there was just this nuclear vacuum. After Carter killed the Clinch River breeder reactor, that was the death knell.

I stayed in Santa Fe for a while and did some consulting. And then it became apparent that there was more money consulting for the oil business. We were doing shaped-charge work, and since I grew up in West Texas, I knew people in the oil business; so we started doing some shaped-charge work, applying some Los Alamos-type technologies to the oil and gas industry, then with defense contractors and environmental engineering. The last 10 years or so, I've done research for companies all over the world.