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NUCLEAR POWER …THE SECOND COMING

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It is a pleasure to be here in the Land of Morning Calm and to have the opportunity to spend time with and exchange views with people who take such a forward-looking approach to energy and energy research.

Argonne has close ties with the Korean energy community. Our cooperative arrangements with Korean laboratories go all the way back to the late 1950s, under President Dwight Eisenhower's Atoms for Peace Program. About 1958, Argonne established an informal sister laboratory arrangement with the Korean Advanced Energy Research Institute when it was still called the Korean ATOMIC Energy Research Institute. The arrangement was formalized in 1964.

In 1981, we established a similar arrangement with the Korean Institute of Energy Resources.

In addition, some 38 Koreans have graduated from the international school in nuclear science and technology- a program started at Argonne in the 1950s. No doubt some of you are alumni of the program.

I am hear tonight to talk to you about future of the nuclear industry in the United States and the world. I am here to tell you that despite well publicized rumors to the contrary, the american nuclear power industry is not moribund.

This news is as heartening to us at argonne as it must be to you of the Korean section of the American Nuclear Society. Like Argonne, your organizations have large investements in nuclear power in terms of both physical capital and human capital.

Still, the American nuclear industry has been on downhill slide ever since the accident at three mile isand unit number two. In the United States, not a single new reactor has been ordered since 1979. And every reactor ordered since 1974 has been canceled. When the United States Congress killed the Clinch River Project, many critics of the industry gazed into their crystal balls and announced the death of nuclear power.

But last October—seven months ago—TMI unit number one went back on the power grid. It begen producing electricity for the first time in more than five years. This was the first undeniably good news in years for the American nuclear indusry.

The start-up of TMI-one was followed scarcely a month ago by an event of even greater possible significance to the nuclear industry. On April third, two tests at Argonne's Experimental Breeder Reactor two demonstrated for the first time an inherently safe nuclear reactor.

I will describe these tests in more detail in a few minutes. But first let me discuss their significance.

I believe that the start-up of TMI and the tests at EBR-two make a turning point in the industry's history. I believe they make the start of an uptrend in the industry's fortunes the Second Coming of nuclear power in the United States.

But I don't believe the climb on the upside will be as fast as the slide on the downside. And I dont' believe the second era of nuclear power will be led by current technology. Instead, I think the second coming of nuclear power will be led by a new reactor design one that will be simpler one that will be standardized and one that will not depend upon redundant back-up systems for safety because safety will be inherent in its basic design.

Let me say at this point that I am not here to criticize the light water reactor. It is a fine technology. It Has done an excellent job when It has been allowed to…but on the whole it has not been allowed to in the United States.

Through a series of problems, mishaps and the attendant bad plblicity support for nuclear power has eroded both in the plblic mind and in the nation's political centers.

Before nuclear power can stage a comeback a new base of support must be built And this base must be built on a foundation of widely perceived need—the need for more energy to fuel a growing economy.

Today there is no such perception. The world is awash in energy. Oil prices are low and falling. utilities are adding excess capacity. In the public mind, there seems to be little or no urgency to plan for future energy needs.

Since the early 1970s, America's gross national product has risen more than 20 percent. At the same time, total energy use by industry has fallen nearly 30 percent. On the surface, it looks like more can be produced with less—and to some extent that is true.

But a deeper look one that focuses specifically on demand for electricity tells a different story—a story that is more relevant for nuclear power. Over that same period use of electricity by American industry rose 16 percent and use of electricity throughout the whole economy rose nearly 30 percent. In 1984 a very good year for the economy demand for electricity rose nine percent. Clearly, there is a tie between economic growth and demand for electricity.

If demand for electricity grows at a rate of three percent a year…a fairly typical assumption…the united states will need an additional 300,000MW of generating capacity by the turn of the century. This is the equivalent of 300 new power plant, Yet across the country. only about 100 power plants are on the drawing boards. As Peter Navarro of Harvard has said, "a shortage of electricity generation could become the binding constraint on GNP growth."

It is this growing demand for electricity that will pave the way for the second coming of nuclear power in America. But first, the need will have to be felt more urgently by the public and through the public by political and regulatory agencies. This will take time. possibly a decade or more. And we can use that time to prepare.

When the time comes for the nuclear industry to propose its solution to meeting future electricity needs who will be the competition? What other technologies will also affer solutions?

Oil and gas? Probably not. These fuels will be growing increasingly scarce and, consequently, increasingly expensive.

Fusion? Again probably not. There is simply too much basic research yet to be done on fusion.

Solar is equally unlikely. Today and for the foreseeable future it is too diffuse and consequently too expensive for large-scale applications like electricity generation.

What about coal? It seems to me that coal will certainly be in the game. In fact, coal is a good bet to be the major competition. Even today, coal is arguably cost competitive with nuclear power. And the nation has vast coal deposits. The United States is the Saudi Arabia of coal. On the negative side, however, coal is viewed as dirty.

Given this cursory look at the competiton the nuclear industry must ask itself. "How can we after a superior product one that will knock the socks off the competition?"

As a starting point fission has two clear competitive abvantages. First, it is clean. Second given the right design and the right regulatory climate it can costless.

The issue of cleanliness lack of environmental pollution needs no futrher comment. Nuclear is clearly superior to coal on this point.

In terms of cost coal and nuclear run a close race in the United States. But in different circumstances nuclear is clearly superior in cost as well. Look at the experience of other nations Korea, for example where American firms build nuclear power plants. In the United States, Westinghouse and Bechtel (BECK-tle) need 10 to 12years to build a nuclear power plant. In Korea, they can build the same plant is six years.

On this point, let me quote James O'Connor, chairman of Commonwealth Edison, one of our major electrical utilities:

"American engineering, American equipment, American constructors are building plants all over the world and bringing them in at roughly one-quarter to one-third the cost of plants in the U. S."

So what's the problem? If we can do it overseas, why can't we do it in our own country?

One attempt to answer this question leads to a recitation of problems well known to Americans. The list includes such items as excessive regulation construction delays plant retrofitting, escalating costs the list goes on.

But these problems are largely symptoms. They all grow out of a key characteristic of light water reactors. That key characteristic is their extreme technical complexity. Special systems are needed to protect the reactor and back-up systems are needed to protect the first systems.

In the last two or there years, three major studies have looked into the problems of the American nuclear industry. All three studies agreed that most of the problems with nuclear power can be traced to the complexity of the light water reactor.

Related to this problem is the fact that in the beginning nuclelear power was treated as "just another way to boil water." But this was not the case. What we had on our hands was a view and complex technology one that needed careful narturing and development. What we did was to rush it to the market before it was completely understood.

As a result many problems were encountered for the first time at the construction site or worse after construction. Solutions had to be developed on the spot. Most of them were good solutions but the result was a multi-billion-dollar industry with a custom-designed product. This was hardly the most economical way to go about it.

This is hindsight talking, of course and we all know how sharp hindsight is. Let me repeat that the light water reactor is an excellent technology and that it does an excellent job when it is allowed to.

Nevertheless as a product to lead the Second Coming of American nuclear power it bears certain undeniable liabilities…not the least of which is poor public perception and the political burden this perception entails.

Instead I think the nuclear industry must after a newproduct if it is to fully realize the coming opportunity. An ideal approach world be the development and construction of plants based on the simple, standard design. Of course, standardization alone world not solve all the industry's cost problems but it would be a major step in the right direction.

At argonne my laboratory we have a candidate. We call it the Intergral Fast Reactor also known as the IFR.

My point in describing the IFR is not to try to sell you on the concept but to give you an idea of the kind of product that will have the best change to lead the Second Coming.

At Argonne, we believe the IFR has a number of key advantages over competing technologies. First, it is inherently safe. This means it would not need layers of back-up systems to protect the plant and core.

Second, it is smaller and simpler than other breeder designs making it easy to standardize and costly to build and operate, even without standardization.

Third, its fuel recycling process is diversion proof.

Fourth because it is a breeder with its own on-site fuel recycling facility it eliminates the need to transport radioactive materials to and from the site during the reactor's operating life.

Finally as a breeder it would allow the industry to offer a truly long-term solution to growing demand for electricity.

At a press conference last year U. S. Secretary of Energy John Herrington called the IFR fuel reprocessing technology "the best technology in the world." High praise indeed and from a high source.

The IFR's inherent safety was demonstrated beyond a shadow of doubt last month in Idaho. On that occasion, fears of a runaway nuclear core were laid to rest.

On April third, we carried out two tests that could have enormous impact on the future of atomic energy in the United States and the rest of the world as well. The tests were performed at Argonne's Experimental Breeder Reactor Too , a sodium-cooled, pool-type reactor fueled with mental fuel for the occasion of these tests. The tests were witnessed by about 60 representatives from U. S. and foreign governments, the nuclear industry, and the electric utility industry.

The tests were a loss-of-flow without scram and a loss-of-heat-sink without scram. In each case the reactor shut itself down - and it did it without the intervention of human operators or emergency scram systems.

For the record, let me state that either test could have been shut down at any time by automatic action of special systems installed just for these tests.

The first test was a loss of flow without scram. With the reactor at fuel power and flow, we bypassed the normal loss-of-flow scram system, and shut off primary, secondary and auxiliary coolant pumps. This combination of events simulated a " station blackout" —as though the plant had lost all off-site power.

Contrary to popular misconceptions, the core did not begin melting its way through the earth. There was no explosion. The reactor simply shut itself down.

While no core damage was observed, it is theoretically possible—given test conditions—that some small degree of cladding erosion may have occurred. Still, we estimate that the same test could be run another 50 to 100 times without breeching the fuel clad.

The measured temperature of the sodium coolant rose about 375 of and peaked in about 40 seconds. Peak temperature was more than 100 degrees below safe levels and some 400 degrees below the sodium boiling point.

As reactor power declined in response to thermal expansion of the core and its components, core temperature began to fall. Within 10 minutes of the start of the experiment, core temperature had returned to near its initial value. Power was shut down to a low level, and the core was kept cool by natural convection currents in the sodium pool.

Within five house, we had the reactor back up to full power for the second test was a loss of heat sink without scram. In the second test. This test was a loss of heat sink without scram. In many respects, This test simulated the conditions that led to the the Three Mile Island accident. It simulates a group of very severe accidents that involve shutting down the ability of the core to transfer heat to downstream components where steam and electricity are generated. Faced with these extreme conditions—the reactor shut itself down.

The entire event lasted about 15 minutes. When it was over, sodium pool temperature had increased about 80 °F, reactor power had fallen to zero, and sodium temperature at the core outlet had fallen to below its normal operating temperature.

The key to achieving passive shutdown in these tests was the use of metallic fuel—in this case an alloy of uranium and small amounts of fission waste products. EBR-Ⅱ normally uses ceramic oxide fuel.

The fundamental safety value of mentallic fuel is its superior heat conductivity. This results in lower Doppler reactivity feedback. It allows reactivity feedback from thermal expansion of fuel, core components and coolant to play a dominant role and to limit core temperature and power naturally.

The tests were performed on EBR-Ⅱ, which is the very close equivalent of an IFR prototype. What we have here is a basic reactor design that is demonstrably safe. It answers all rational concerns about runaway reactors. And it does this without depending on complex, add-on safety systems.

But the IFR concept has other advantages besides its inherent safety.

In terms of economics, the use of a sodium-pool should help cut construction costs. Besides the core a number of other systems are submerged in the pool. These include primary heat exchangers and coolant pumps. As a result, the coolant circulation system is far simpler than in commercial reactors. The core and its support systems can be put into a compact "nuclear island" and the size of the containment building can be reduced. All this cuts construction costs.

The IFR's third major selling point is its diversion-proof fuel cycle. The IFR would use a closed, pyrometallurgical method to reprocess and recycle used fuel. The entire process would take place on site and would be performed by remote control. At all times during the process, the fuel would remain too highly radioactive or too chemically toxic for anyone to handle without highly specialized equipment. Used fuel would simply come out of the core be reprocessed and be returned to the core. There would be no opportunity for unauthorized diversion.

This method is modeled on the process used at EBR-Ⅱ from 1964 to 1969. During this period, EBR-Ⅱ fuel was routinely removed from the core reprocessed and returned directly to the core. Some 35,000 fuel pins five complete core loadings were reprocessed this way.

It wold be native to think that this process would eliminate all public and private concern about diversion of weapons-grade fuel but it would certainly take a big step in the right direction.

The fourth major advantage of the IFR is that it eliminates the need to transport radioactive materials through populated areas during the lifetime of the plant. All the non-fissile uranium needed to breed plutoniom for the life of the plant could be brought on site before startup at the same time that fuel for the first core is brought on site. Thereafter, there would be no need to transport radioactive material on or off the site not until the reactor was decommissioned and its radioactive wastes disposed of.

The last major advantage of IFR is that it is a breeder. It creates its own fuel from otherwise worthless uranium-238. The United States currently has about 250,000 tons of this waste uranium sitting around. If converted into plutonium, it could provide as much electricity as 2.5 trillion barrels of oil. At present oil consumption rates this is about 450 years worth. But when you consider that only about one-tenth of the nation's known uranium reserves have been mined it becomes apparent that breeder reactors could give the nation the equivalent of 4,500 years worth of oil. In practical terms that's about as long-range as it gets.

I have been talking about IFR in terms of possibilities – what it "would do" or "could do" It is true that IFR and what it represents is a dream a concept. But you should also know that at EBR-II we have already demonstrated most of the IFR technology. Only one part of the concept has yet to be demonstrated – an electro-refining step in the fuel recycling process.

At Argonne, we believe the next step is to build a demonstration plant based on the IFR design. We are now crystallizing the IFR concept with an eye toward building one. Most of the facilities needed for such a demonstration already exist at EBR-II or they could be made available at reasonably low cost. We think the conversion of EBR-II into an IFR demonstration plant is an idea that deserves close consideration.

In conclusion, let me repeat that I believe the startup of TMI-one and the recent safety demonstration in Idaho mark the bottom of the American nuclear industry's downtrend. But I also believe that the uptrend will be long and slow. The new era may not arrive for ten years or more. It may not arrive until supplies of gas and oil grow short and expensive and the only economical choice is between nuclear and coal.

In the menatime, the American nuclear industry has to prepare itself. And the way to do that is to develop new alternatives for the future. Alternatives that will be more acceptable than those of the past. Alternatives that do not carry the public onus that has been attached however unjustly to the light water reactor.

The Second Coming of American nuclear power lies ahead of us. So does continued growth of the nuclear industry worldwide. It will arise out of the commercial ties that bind growing economies in America and the rest of the world and out of the need for increasing amounts of electricity to fuel economic expansion. Of all the sources of electricity that are currently available only fission offers a technology that is safe, clean and economical and that can provide energy for centuries to come.