THE NEXT GENERATION OF NUCLEAR POWER

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND RESOURCES

OF THE

COMMITTEE ON
GOVERNMENT REFORM

HOUSE OF REPRESENTATIVES

ONE HUNDRED NINTH CONGRESS

FIRST SESSION

JUNE 29, 2005

Serial No. 109–67

Printed for the use of the Committee on Government Reform

Available via the World Wide Web: http://www.gpoaccess.gov/congress/index.html
http://www.house.gov/reform

U.S. GOVERNMENT PRINTING OFFICE

23–408 PDF WASHINGTON : 2005

For sale by the Superintendent of Documents, U.S. Government Printing Office
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THE NEXT GENERATION OF NUCLEAR POWER

WEDNESDAY, JUNE 29, 2005

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY AND RESOURCES,
COMMITTEE ON GOVERNMENT REFORM,
Washington, DC.

The subcommittee met, pursuant to notice, at 2 p.m., in room 2203, Rayburn House Office Building, Hon. Darrell E. Issa (chairman of the committee) presiding.

Present: Representatives Issa, Watson, and Kucinich.

Staff present: Larry Brady, staff director; Lori Gavaghan, legislative clerk; Dave Solan, Steve Cima, and Chase Huntley, professional staff members; Richard Butcher, minority professional staff member; and Cecelia Morton, minority office manager.

Mr. ISSA. Good afternoon. Jointly, Congresswoman Watson and I would like to apologize for the entire Congress and particularly our voting schedule. We were notified that we would be voting so we went over only to discover that they voiced it. So we should be uninterrupted going forward.

I am very excited today that we are going to be talking about next generation nuclear power. Although, with the distinguished panel we have here today, hopefully we will even go beyond that and veer openly toward a lot of areas of the hydrogen society, fusion, and other areas of sustainable energy.

As we all know, nuclear energy is the subject of renewed interest by the President, and Congress. Of course with it comes concerns over security of energy supplies, fossil fuel prices, the volatility of oil today, air quality, and our ability to reach our national goals of developing a hydrogen economy.

At present, there are 103 licensed reactors still operating in 31 States. In 2004, nuclear generators produced a record 824 billion kilowatt hours of electricity, accounting for approximately 20 percent of the Nation's electricity. Anecdotally, we have been at about 20 percent of the Nation's electricity coming from nuclear energy for a number of years. So these increases in reliability have kept pace with our need for power.

For more than four decades, the U.S. nuclear industry has focused on improving existing reactor technology. America's nuclear power plants have an excellent safety record and are among the most efficient and reliable in the world. However, there are obvious limits to continued expansion of existing capacity. In the 21st century our Nation needs more safe, clean, reliable electricity. The Department of Energy is currently engaged in an effort to advance research and development of next generation nuclear systems capable of meeting this challenge.

The Generation IV program seeks to develop a much more advanced generation of nuclear energy reactors to commercial development by 2030. These reactors will have a dramatic improvement in the areas of cost, safety, reliability and sustainability. The Department of Energy is supporting research in several reactor concepts, but priority has been placed on the Very High Temperature Reactor. This technology is the favored design in the United States due to its potential for competitive cost use in secondary industrial activities such as hydrogen production and desalinization. This reactor design could also burn uranium, plutonium and other waste products reprocessed from spent nuclear fuel or stockpiled warheads.

In 2004, Secretary of Energy Spencer Abraham launched the Next Generation Nuclear Plant project to develop an advanced nuclear energy system to produce both inexpensive electric power and large quantities of cost-effective hydrogen that could be used as an alternative to fossil fuels. The Department of Energy has designated the Idaho National Laboratory to be the focal point for advanced reactor and fuel cycle development.

The NGNP is a key component of America's energy future and the Federal Government must take a leadership role to ensure that a Generation IV reactor is built in the United States. The construction of a Generation IV reactor will ensure that the United States regains its position as a world leader in nuclear energy technology. Other nations are moving forward on Generation IV technologies, and if we do nothing, we will miss a unique opportunity.

The purpose of this hearing is to evaluate the progress of the Department of Energy's Nuclear Generation IV program. We also want to get a better overall sense of the administration's commitment to move forward with the Next Generation Nuclear Plant project.

We look forward to hearing from our distinguished panel.

[The prepared statement of Hon. Darrell E. Issa follows:]

COMMITTEE ON GOVERNMENT REFORM
SUBCOMMITTEE ON ENERGY AND RESOURCES

OPENING STATEMENT OF
CHAIRMAN DARRELL ISSA
"The Next Generation of Nuclear Power"
JUNE 29, 2005

Nuclear energy is the subject of renewed interest because of concerns over the security of energy supplies, fossil fuel price volatility, and air quality, as well the recently articulated national goals for developing a hydrogen economy.

At present, 103 licensed reactors are generating power in 31 states. In 2004, nuclear generators produced a record 824 billion kilowatt hours of electricity, accounting for 20 percent of the nation's electricity.

For more than four decades, the U.S. nuclear industry has focused on improving existing reactor technology. America's nuclear power plants have an excellent safety operating record and are among the most efficient and reliable in the world. However, there are obvious limits to continued expansion of existing capacity.

In the 21st century, our nation will need more safe, clean, reliable electricity. The Department of Energy is currently engaged in an effort to advance research and development of the next generation of nuclear systems capable of meeting this challenge. The Generation IV program seeks to develop a much more advanced generation of nuclear energy reactors for commercial deployment by 2030. These reactors will have dramatic improvements in the areas of cost, safety, reliability, and sustainability.

The Department of Energy is supporting research in several reactor concepts but priority has been given to the Very-High Temperature Reactor. This technology is the favored design in the U.S. due to its potential for competitive cost use in secondary industrial activities such as hydrogen production and desalinization. This reactor design could also burn uranium, plutonium and other waste products reprocessed from spent nuclear fuel or stockpiled warheads.

In 2004, Secretary of Energy Spencer Abraham launched the Next Generation Nuclear Plant (NGNP) project to develop an advanced nuclear energy system to produce both inexpensive electric power and large quantities of cost-effective hydrogen that could be used as an alternative to fossil fuels. The Department of Energy has designated the Idaho National Laboratory to be the focal point for advanced reactor and fuel cycle development.

The NGNP is a key component of America's energy future and the federal government must take a leadership role to ensure that a Generation IV reactor is built in the United States. The construction of a Generation IV reactor will ensure that the US regains its position as a world leader in nuclear energy technology. Other nations are moving forward on Generation IV technologies, and if we do nothing, we will miss a unique opportunity.

The purpose of this hearing is to evaluate the progress of the Department of Energy's Nuclear Generation IV program. We also want to get a better overall sense of the Administration's commitment to move forward with the Next Generation Nuclear Plant project.

We look forward to hearing from our distinguished panel. We are pleased to have:

Mr. Robert Shane Johnson, Acting Director, Nuclear Energy, Science and Technology, U.S. Department of Energy

Dr. David Baldwin, Senior Vice President, General Atomics

Dr. Rowan Rowntree, Independent Scientist, Visiting Scholar University of California Berkeley, Department of Environmental Science, Policy, and Management, retired

Mr. Dave Lochbaum, Nuclear Safety Engineer, Union of Concerned Scientists

Mr. ISSA. Now I would like to recognize our distinguished ranking member, Ms. Watson.

Ms. WATSON. Mr. Chairman, thank you very much for convening today's hearing. As you have already said, this subcommittee is systematically investigating each of the major energy issues that our constituents are concerned about. Energy issues are of critical importance, particularly to southern California, as well as the rest of the Nation. So the subject for this hearing, "The Next Generation of Nuclear Power," is very cogent and pertinent at this time.

In the United States, the rising costs of electricity generation from natural gas and coal-fired power plants may make nuclear power and renewable energy sources relatively more competitive. No nuclear plants have been ordered in the United States since 1978. And more than 100 reactors have been canceled. Our aging Generation II power plants have been working at tremendous power generation levels, over 90 percent of capacity, to supply approximately 20 percent of the electricity needed for the Nation.

The Federal Government would be wise to intensely research the next generations of nuclear power reactors and plan accordingly. It has been argued that expanded nuclear generation could help substitute for some of the demand for natural gas. A very significant aspect of reduced fossil fuel consumption is the reduction in carbon dioxide emission. Nuclear energy does not produce substantial air pollution. However, it could help reduce air pollution problems such as smog and particulate matter and particle matter and global warming.

The United States is responsible for about one-fourth of the world's total greenhouse gas emissions. America must do better. Generation III Plus and Generation IV reactors may be the answer.

On the other hand, current nuclear power generation has several downsides. Nuclear power produces large quantities of waste that remain highly radioactive for thousands of years. A permanent, environmentally sensitive repository for high level waste or a way to recycle nuclear waste is crucial to the future of nuclear feasibility.

Moreover, the United States must commit the scientific manpower and monetary resources necessary to educate the public and provide the appropriate protection for the Nation's environmental and physical health. The Idaho National Laboratory, online since February 2005, is a commendable step in the right direction. The 3,400 employees of the INL have a core mission to develop advanced next generation nuclear technologies, promote nuclear technology education, and apply their technical skills to enhance the Nation's security.

Another thought provoking issue regarding uranium and plutonium is domestic accidents and terrorist attacks. The potentially catastrophic nature of an accident at a nuclear power plant makes this a very serious concern. The last accident in the United States was at Three Mile Island, Pennsylvania, in 1979. The general feeling of improved safety and acceptable standards in current operations is commendable.

However, in March 2002, leaking boric acid provided a large hole in the nuclear reactor vessel head at the Davis-Besse nuclear plant in Ohio. The corrosion stopped a quarter of an inch away from a potentially dangerous loss of reactor cooling water.

The Nuclear Regulatory Commission must hold the nuclear industry to the highest standards in order to prevent problems. So Generation III Plus and Generation IV reactors must be safe for the public and not just in theory.

Last, but not least, Mr. Chairman, I want to acknowledge the current world political atmosphere. America presents a prime terrorist target on a site that contains radioactive materials. Now, all commercial nuclear power plants licensed by the NRC have a series of physical barriers to accessing the nuclear reactor area, and are required to maintain a trained security force to protect them.

Following the terrorist attacks of September 11th, the NRC began a review to improve defenses against terrorist attack. Several of the Generation IV reactor designs seemed to be prime candidates for energy production without weapons grade side effects. The over-arching issue of nuclear proliferation has been around for decades. The United Nations and other world organizations have been vigilant and aggressive in monitoring non-civil applications of nuclear energy. The United States must remain responsible and conscientious in this regard as well.

Mr. Chairman, thank you for convening this hearing today. I look forward to hearing from all of our witnesses. Thank you.

[The prepared statement of Hon. Diane E. Watson follows:]

Opening Statement
Congresswoman Diane E. Watson
Subcommittee on Energy and Natural Resources - Ranking Member
Hearing: The Next Generation Of Nuclear Power
June 29, 2005

Mr. Chairman, thank you for convening today's hearing. This Subcommittee is systematically investigating each of the major energy issues that our constituents are concerned about. Energy issues are of critical importance to Southern California, and to the nation.

The subject for this hearing is the next generation of nuclear power. In the United States, the rising costs of electricity generation from natural gas and coal-fired power plants may make nuclear power and renewable energy sources relatively more competitive.

No nuclear plants have been ordered in the United States since 1978, and more than 100 reactors have been cancelled. Our aging Generation II power plants have been working at tremendous power generation levels, over 90% of capacity, to supply approximately 20% of the electricity needs of the nation. The federal government would be wise to intensely research the next generations of nuclear power reactors and plan accordingly.

It has been argued that expanded nuclear generation could help substitute for some of the demand for natural gas. A very significant aspect of reduced fossil fuel consumption is a reduction in carbon dioxide emission. Nuclear energy does not produce substantial air pollution; therefore, it could help reduce air pollution problems such as smog, particulate matter, and global warming. The United States is responsible for about one-fourth of the world's total greenhouse gas emissions. America must do better. Generation III+ and Generation IV reactors may be an answer.

On the other hand, current nuclear power generation has several downsides. Nuclear power produces large quantities of waste that remain highly radioactive for thousands of years. A permanent, environmentally sensitive, repository for high-level waste, or a way to recycle nuclear waste, is crucial to future nuclear feasibility. Moreover, the United States must commit the scientific manpower, and monetary resources, necessary to educate the public and provide the appropriate protection for the nation's environmental and physical health. The Idaho National Laboratory, online since February 2005, is a commendable step in the right direction. The 3,400 employees of the INL have a core mission to develop advanced next generation nuclear energy technologies; promote nuclear technology education; and apply their technical skills to enhance the nations security.

Another thought provoking issue regarding uranium and plutonium is domestic accidents and terrorist attacks. The potentially catastrophic nature of an accident at a nuclear power plant makes this a very serious concern. The last major accident in the United States was at Three Mile Island, Pennsylvania in 1979. The general feeling of improved safety and acceptable standards in current operations is commendable. However, in March 2002, leaking boric acid produced a large hole in the nuclear reactor vessel head at the Davis –Besse (Bes – see) nuclear plant in Ohio. The corrosion stopped a quarter of an inch away from a potentially dangerous loss of reactor cooling water.

The Nuclear Regulatory Commission must hold the nuclear industry to the highest standards in order to prevent problems.

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Mr. Chairman, thank you for convening today's hearing. I look forward to hearing the witnesses' testimony.

Mr. ISSA. Thank you very much, Ms. Watson.

The rules of the committee require that all witnesses and any person that is going to provide advice to witnesses be sworn in. So could I ask you to please rise for the oath.

[Witnesses sworn.]

Mr. ISSA. Let the record show everyone answered in the affirmative.

I would ask unanimous consent that all opening statements beyond the ones already given be in the record. Additionally, I would ask unanimous consent that all Members have 5 legislative days in which to revise or extend remarks or include extraneous material.

Additionally, I would ask that all of your statements be placed into the record and any additional information you might choose to supplement with. And again, 5 days would be appreciated. If you need more time, let us know. But at this point, that will be entered in as an order.

Having given you all those opening statements that were so carefully written, I will say this. Those are already in the record at this moment. We give a normal allotment of 10 minutes, less if possible, to say what you want to say and then go into question and answer. Remember, you've already said everything that's in front of you.

So feel free to give us additional information for the record. Because as you know, in spite of the large audience that is here today, the record is everything that's said and everything that's written. I know some of you will read your speech complete, but I would suggest that the more you give us, the better.

With that, Mr. Johnson, you are first up. Thank you.

STATEMENTS OF ROBERT SHANE JOHNSON, ACTING DIRECTOR, NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY, U.S. DEPARTMENT OF ENERGY; DAVID BALDWIN, SENIOR VICE PRESIDENT, GENERAL ATOMICS; ROWAN ROWNTREE, INDEPENDENT SCIENTIST; VISITING SCHOLAR, UNIVERSITY OF CALIFORNIA-BERKELEY; AND DAVE LOCHBAUM, NUCLEAR SAFETY ENGINEER, UNION OF CONCERNED SCIENTISTS

STATEMENT OF ROBERT SHANE JOHNSON

Mr. JOHNSON. Chairman Issa, Ranking Member Watson, I am Shane Johnson, Acting Director of the Department of Energy's Office of Nuclear Energy, Science and Technology. I would like to thank you for the opportunity to speak today on the Department's advanced reactor programs.

I have submitted a statement for the record and I will briefly summarize that statement.

The President's National Energy Policy recommends expanded use of nuclear energy to reduce dependence on imported fuels and reduce harmful air emissions. To help achieve this vision, the Department launched two new nuclear programs: our Nuclear Power 2010 program and our Generation IV Nuclear Energy Systems Initiative.

The Department's Nuclear Power 2010 program is a partnership between industry and Government aimed at removing barriers to the licensing and the construction of new nuclear plants. The nuclear reactor technology being pursued in the Nuclear Power 2010 program, often referred to as Generation III or Generation III Plus reactors, represents an evolution in the basic reactor designs of the 103 designs in safe operation today in the United States. The evolutionary changes provided by Generation III reactors include the use of passive safety systems and simplifications in the design and layout of the various systems and components comprising the nuclear plan. We are hopeful that our country will see plant orders for new nuclear power plants in the next 2 to 3 years.

The Department's Generation IV nuclear energy systems initiative is an international partnership aimed at the development of next generation reactor and fuel cycle technologies. These next generation technologies are expected to be revolutionary changes to the basic reactor designs in operation today. These Generation IV reactor systems are envisioned to offer significant advances in proliferation resistance, safety, sustainability, and reduced waste generation over today's reactor technologies. It is expected that these technologies could be available for possible commercialization some time between the years 2020 and 2030.

These advanced systems are also expected to include energy conversation capabilities that could produce commodities such as hydrogen, desalinated water, and processed heat. In 2001, the Department led the formation of the Generation IV international forum, an international collective of 10 leading nuclear nations and the European Union working together to develop these advanced technologies.

In 2003, following a 2-year U.S.-led international effort to develop a technology road map for Generation IV systems, the member countries of the Generation IV International forum selected six promising reactor concepts for future research and development. These six concepts represent the reactor concepts with the highest expectations for meeting the key objectives of the Generation IV program.

To guide our Generation IV research activities and manage the technology development and intellectual property issues associated with international research collaboration, members of the Generation IV international forum signed a legally binding, intergovernmental framework agreement in February of this year. This agreement will further the development of advanced reactor technologies, enable the Department to access the world's best expertise, and allow the United States to carry out Generation IV research and development more efficiently and effectively by leveraging resources and capabilities.

Additionally, the Department also established a new central laboratory in February, the Idaho National Laboratory, to lead the Government's research and development on reactor and fuel cycle technologies. The formation of the Idaho National Laboratory is a key step forward for the nuclear energy program, enabling the establishment of a dedicated research site at which we can build the expertise needed to develop these advanced technologies.

Today, working through the Idaho National Laboratory with other national laboratories, universities, industry and the international research community, the United States is investing about $40 million annually on advanced research into systems, materials and fuels that are needed to bring Generation IV concepts to fruition. The Department is pursuing research and development on a range of Generation IV technologies, including the Gas-Cooled Fast Reactor, the Lead-Cooled Fast Reactor, the Super-Critical Water Reactor, and the Very High Temperature Reactor.

Our efforts on these technologies include the investigation of technical and economic challenges and risks, including waste products, developing core and fuel designs, and advanced materials for these reactors. The Gas-Cooled Fast Reactor is a fast neutron spectrum reactor that has the potential to use recycled fuel in order to maximize the value of our Nation's uranium resources. The Gas-Cooled Fast Reactor can also benefit future repository space requirements by burning long-lived spent fuel constituents.

The Lead-Cooled Fast Reactor is a fast neutron spectrum reactor that operates similarly to the gas-cooled reactor. Instead of using helium gas as the coolant, the Lead-Cooled Fast Reactor uses a liquid lead-based coolant to remove reactor heat. The Lead-Cooled Reactor can operate at atmospheric pressure, simplifying the design of the primary reactor system. Like the Gas-Cooled Reactor, a key benefit of the Lead-Cooled Fast Reactor is to operate in a more fully closed fuel cycle. It is geared toward maximizing the utilization of uranium resources and minimizing nuclear waste.

The Super-Critical Water Reactor is a highly efficient, water-cooled reactor that uses conventional, low-enriched uranium fuel and operates at high pressures and temperatures when compared to today's light-water reactors. This allows for a far more efficient plant, capable of generating electricity 30 percent more efficient than today's light-water reactors. In addition, it represents a simpler design that reduces the number of systems and components that are required of Generation III reactors, resulting in improved economics.

The Very High Temperature Reactor extends gas-cooled reactor technologies that operate today between 650 and 850 degrees Celsius to operate at or near 950 degrees Celsius. The Very High Temperature Reactor is expected to produce electricity with 50 percent higher efficiency than light-water reactors today. The Very High Temperature Reactor is also expected to be capable of producing the heat necessary for efficiently producing hydrogen gas, using water as the only consumable resource. The Very High Temperature Reactor also incorporates passive safety characteristics, and has enhanced safeguard and security features.

In addition to producing electricity, all four of these Generation IV concepts have the potential to provide hydrogen generation. While we are monitoring the progress of the international research community on the other two Generation IV concepts, namely the Sodium-Cooled Fast Reactor and the Molten-Cooled Reactor, the United States is not presently investing to any large extent in the development of these technologies.

The Department's Energy Information Administration estimates the United States will need an additional 355,000 megawatts of electricity production capacity over the next two decades to meet our Nation's growing demand for electricity. Nuclear energy will be needed to help meet this demand. Generation III or Generation III Plus reactor technologies can meet near-term demand for new baseload electricity generation. We are seeing signs from industry that these technologies will be deployed in the United States in the very near future.

The United States and many other countries agree that Generation IV reactor concepts must offer improved economics, proliferation resistance, safety and sustainability over today's reactor designs. In addition, these technologies need to be designed, developed and demonstrated before 2030, in order to support growing United States and global energy needs and also to help achieve our environmental objectives.

Mr. Chairman, this concludes my statement. I would be pleased to answer any questions.

[The prepared statement of Mr. Johnson follows:]

Statement of Robert Shane Johnson
Acting Director
Nuclear Energy, Science and Technology
U.S. Department of Energy
Before the
Subcommittee on Energy and Resources
Committee on Government Reform
U.S. House of Representatives
June 29, 2005

Chairman Issa, Ranking Member Watson and distinguished members of the Subcommittee, I am Shane Johnson, Acting Director of DOE's Office of Nuclear Energy, Science and Technology and Deputy Director for Technology. I appreciate the opportunity to provide this testimony for the record on the Department of Energy's efforts to develop advanced reactor technologies for our Nation's secure and reliable future energy supply.

The President's National Energy Policy recommends expanded use of nuclear energy to reduce dependence on imported fuels and to reduce harmful air emissions. To achieve this vision, the Secretary of Energy unveiled the *Nuclear Power 2010* initiative in February 2002 with the program aimed at encouraging licensing, construction and operation of new nuclear plants in the United States within the decade. As a result of the hard work of industry in creating a solid foundation for new plant orders and the partnership between DOE and industry to address potential barriers to new nuclear plant construction, the Department believes that the country will see new plant orders placed in this decade.

In 2001, the Department launched the *Generation IV* nuclear energy systems initiative to begin investigating advanced reactor and fuel cycle technologies – technologies that could become available for commercial deployment between the 2020 and 2030 timeframe and offer significant advances in proliferation resistance, reduced waste intensity, improved physical security, safety, and sustainability over today's Generation III reactors, which were developed more recently in the 1990's and 2000's. The primary focus of these advanced systems would be to generate electricity in a safe, economic and secure manner; other possible benefits include the production of hydrogen, desalinated water, and process heat.

While the Generation IV initiative started in the United States, the initiative has become an international initiative. In 2001, the Department led the formation of the *Generation IV International Forum* (GIF), an international collective of leading nuclear nations committed to working together to develop advanced technologies. Over a two-year period, more than 100 experts from the GIF member countries completed a technology roadmap that identified six promising reactor concepts that are the focus of ongoing research and development efforts among the nations; the GIF membership expanded to include one additional country and the European Union; and a landmark framework agreement put in place this past February 2005 guides the research investments and the collaborations among the nations on these key technologies.

Additionally, the Department of Energy established a new central laboratory in February 2005 – the Idaho National Laboratory -- to lead the Government's research and development on reactor and fuel cycle development. The formation of the Idaho National Laboratory is a key step forward for the nuclear energy program, enabling the establishment of a dedicated research site at which we can build the expertise needed to develop these advanced technologies. Today, working through the Idaho National Laboratory, with other national laboratories, universities, industry and the international research community, the United States is investing about $45 million annually on advanced research into the systems, materials, and fuels that are needed to bring Generation IV concepts to fruition.

My testimony today summarizes the efforts of the United States in developing these technologies and discusses the work that remains to be done to pave the way for the deployment of advanced reactor technologies in the United States and the world. Many nations look to the United States, the country where nuclear power began, for its leadership in key policy issues such as nonproliferation and safety, as the international research community sets the standard for future international deployment of advanced reactor and fuel cycle technologies.

GENERATION IV NUCLEAR SYSTEMS INITIATIVE

In 2001, the Department of Energy launched the *Generation IV Nuclear Energy Systems Initiative* aimed at developing advanced reactor and fuel cycle technologies that can be made available to the market by 2030. These are technologies that offer significant advances toward challenging sustainability, safety and reliability and economic goals such that technologies will be competitive in all markets.

The Department also led the formation of the *Generation IV International Forum* or GIF, an international collective of ten leading nuclear nations working in joint cooperation on advanced reactor and fuel cycle technologies on a multilateral basis to address the expansion of nuclear energy globally. With the formation of the GIF, a formal charter was signed in July 2001 by representatives of the nations of Argentina, Brazil, Canada, France, Japan, Republic of Korea, Republic of South Africa, the United Kingdom and the United States. Since then, Switzerland and the European Union's Euratom have also joined the GIF.

In 2003, the GIF completed the technology roadmap, *A Technology Roadmap for Generation IV Nuclear Energy Systems*, prepared by more than 100 technical experts from the GIF countries working together to examine promising technologies. The GIF converged on six promising reactor technologies: gas cooled fast reactor systems, lead alloy liquid metal cooled reactor systems, molten salt reactor systems, sodium liquid metal cooled reactor systems, supercritical water cooled reactor systems, and very high temperature gas reactor systems. The technology roadmap identified the research and development necessary to advance these concepts to the point of maturity for potential commercialization by the private sector.

Since then the Generation IV effort has continued to make progress. The member-countries have organized into project groups associated with each of the six selected Generation IV systems and the member-countries are negotiating international legal agreements to enable advanced nuclear research to be conducted on a multilateral basis. This past February, after a year of negotiations, an international framework agreement for collaborative research and development among the GIF member countries was signed in Washington, D.C., by the United States and its GIF partners. This framework agreement allows the United States and its partner countries to embark on joint, cost-shared research and development of Generation IV nuclear energy systems.

This landmark agreement will further the development of advanced technologies that are widely acceptable, enable the Department to access the best expertise in the world to develop complex new technologies, and allow the United States, as well as the other member countries, to carry out our research and development programs more efficiently and effectively by leveraging resources and capabilities. As noted earlier, by coordinating United States efforts with other countries our funding will be leveraged by a factor of two to ten depending on which reactor concept is involved.

GENERATION IV REACTOR CONCEPTS

The Department is pursuing research and development on a range of Generation IV reactor technologies, including the Gas-cooled Fast Reactor, the Lead-cooled Fast Reactor, the Supercritical Water-cooled Reactor, and the Very High Temperature Reactor. Our efforts on these technologies include investigation of technical and economic challenges and risks, including waste products, and developing core and fuel designs and advanced materials for these concepts. It is expected that all of these advanced reactor technologies could be sufficiently mature for deployment between 2020 and 2030.

The Gas-Cooled Fast Reactor (GFR) is a fast spectrum reactor that has the potential to use recycled fuel in order to maximize the value of the nation's uranium resources. The GFR can also benefit future repository space requirements by burning long lived actinides. The GFR has potential as a technology to support the production of hydrogen and uses helium gas as a coolant.

The Lead-Cooled Fast Reactor (LFR) is a fast spectrum reactor that operates similarly to the GFR. Instead of helium gas, the LFR uses a liquid lead-based coolant to remove reactor heat. The LFR can operate at atmospheric pressure, simplifying the design of the primary system. Like the GFR, a key benefit of the LFR is to operate in a more fully closed fuel cycle that is geared towards maximizing the utilization of uranium resources and minimizing nuclear wastes.

The Super Critical Water Reactor (SCWR) is a highly efficient water-cooled reactor that uses conventional low enriched uranium fuel and operates at extreme pressures and temperatures when compared to traditional water-cooled reactors. This allows for a far more efficient plant, capable of generating electricity with greater than 30% more efficiency than traditional light water reactors. In addition, it represents a simpler design that reduces balance of plant systems that are presently required of Generation III reactors, resulting in improved economics. Significant research and development is needed to demonstrate the safety case for the technology, to investigate materials and structures, and to develop a plant design.

The Very High Temperature Reactor (VHTR) extends existing gas cooled reactor technologies that operate between 650 and 850 degrees Celsius to operate at or near 950 degrees Celsius. The VHTR is expected to produce electricity with greater than 50% more efficiency than light water reactors. The VHTR is expected to produce the heat necessary for efficiently producing hydrogen gas using water as the only consumable resource. The VHTR maintains passive safety characteristics and has enhanced safeguards and security features.

In addition to producing electricity, all four of these Generation IV reactor concepts have the potential to provide hydrogen production without releasing greenhouse gases; current hydrogen production process primarily rely on steam reforming of methane. Nuclear generated hydrogen could introduce hydrogen into the nation's transportation infrastructure and help provide for our Nation's energy security. The Generation IV program provides support to the Nuclear Hydrogen Initiative (NHI) which serves as the focal point for conducting research and development on nuclear-based hydrogen production technologies.

While we are monitoring the progress of the international research community on the other two Generation IV concepts -- Sodium Cooled Fast Reactors and the Molten Salt Cooled Reactors -- the United States is not presently investing to any large extent in the development of these technologies. The United States has extensive experience with sodium cooled fast reactors, having operated an engineering scale demonstration of the technology for thirty years. Also, the molten salt cooled reactor is a technology that was first demonstrated in the 1960's.

CONCLUSION

Generation III or Generation III+ technologies can meet near term demand for new baseload electricity generation, and we are seeing signs that these technologies will be deployed in the U.S. in the near future. The Department of Energy's Energy Information Administration estimates the United States will need an additional 355,000 megawatts of electricity over the next two decades to meet the growing demand in this country, and nuclear energy will be needed to meet this demand. The U.S. and many other countries agree that Generation IV concepts must offer improved economics, proliferation resistance, reduced waste intensity, safety, and sustainability. In addition, these technologies need to be designed, developed, and demonstrated before 2030 in order to support growing United States and global energy needs and also to help achieve our environmental objectives.

That concludes my testimony and I would be pleased to answer any questions you have.

Mr. ISSA. Thank you very much, Mr. Johnson.

With that, we move to Dr. David Baldwin. Dr. Baldwin received his Bachelor of Science and Ph.D. in plasma physics from MIT. From 1962 to 1970, he held research and faculty positions at Stanford University and Culham Laboratory in England and Yale University. In 1988, he was named Professor of Physics and Director of the Institute for Fusion Studies at the University of Texas, Austin. Since 1995, he has been a senior vice president of the Energy Group for General Atomics in San Diego. General Atomic's Energy Group's activities include high temperature gas reactor development for both electricity and hydrogen products together with necessary supporting technologies.

Thank you very much for being here, and we look forward to your testimony, Dr. Baldwin.

STATEMENT OF DAVID E. BALDWIN

Mr. BALDWIN. Thank you, very much, Mr. Chairman and members of the committee. I won't introduce myself, you've done a very nice job, thank you.

But I do want to thank you for the opportunity to talk to you about the Generation IV technology, the impact it could have and the role the Government could play. The previous speaker has just talked a lot about the Generation IV program, so I will save some time and not enter into that. But I want to focus in particular on what he called the Very High Temperature Gas Reactor. It goes by other names, High Temperature Gas Reactor or Modular-Helium Reactor, they are all essentially the same thing.

Interestingly, this approach was inspired by a question from Congress in the early 1980's. We were basically asked, can't you make a reactor with all the virtues that are now called Generation IV virtues? In many ways, the resulting design was an answer to a maiden's prayer. It is the first reactor that was designed from the bottom up first to be safe, then to be economic, and then asked, what other applications might it have. Safety was the first consideration.

One key to the safety is in the fuel. The reactor fuel is an engineered fuel particle which is, the fissile part, only about half a millimeter in diameter, wrapped in ceramic coatings, three layers of ceramic coatings, which protect the fuel under all conditions from both loss of fuel and loss of the radiation products in both normal and off-normal operation.

In effect, the ceramic container is the containment vessel for the little, tiny particle of fuel and a fully fueled reactor would contain billions of these little particles.

The second key to this reactor's attribute is the combination of the chemically inert and neutron inert coolant gas, which is helium, and the graphite matrix into which this fuel is embedded. The dimensions of the reactor is chosen so that under any conditions, loss of coolant or whatever, the core could cool by natural conduction and conduction. That is, it does not require any form of external or active cooling system.

The heat capacity of the graphite is such that the peak temperature, in which there is some small temperature rise, takes 2 or 3 days to reach, so there is time to react to the situation. The graphite material is like diamond insofar as it is a form of carbon that does not burn in the sense of generating heat and excessive losses. If oxidation were to start, for example, if air flow replaced the helium gas flow, the result would actually be a slight cooling of the system.

The resulting reactor has many attributes. Its physical characteristics of inherent safety of any kind mean that conditions like prompt criticality and melt-down are simply not possible. The entire nuclear envelope is below grade by design. This was done for economic reasons, but since September 11th, it is obviously important. The only thing above grade are things like cranes, which are not nuclear in their character.

In operation, it burns 80 percent of its fuel load, compared to around 5 percent for the light-water reactor. This means much less high level waste for a given amount of electricity. And the resulting spent fuel is in a form ideal for geologic burial. The gas temperature, as has already been mentioned, in the range of 900 to 950 degrees, is perfect for applications like electricity production or thermo-chemical hydrogen production.

And finally, looking at costs, once we have moved beyond the startup costs of first-time engineering, the costs of these reactors will compare very favorably, even with current Generation III reactors.

But the point I want to make here today is that the reactor is also very flexible with regards to the kind of fuel burned in it. In fact, exactly the same reactor can be fueled by several means. The conventional way is low-enriched uranium, that is less than 20 percent. It will also burn a mix of thorium and enriched uranium. It can burn weapons grade plutonium for the destruction of the plutonium. Or it can burn light-water reactor spent fuel for that destruction.

The combination of the graphite matrix and the coolant and the fuel form enables these fuels to be burned safety, without dilution in high burn-up, and then placed directly in geologic storage. A preliminary test at Oak Ridge indicates that this fuel will retain its integrity for a few million years, which exceeds the lifetime of the contents.

The important part I want to leave with you is that this capability for burning light-water reactor fuel opens a very attractive alternative to today's once-through fuel cycles with subsequent geologic disposal. In fact, it presents a totally different way of thinking about spent fuel. Licensing Yucca Mountain is certainly controversial today, and this issue must be solved, as the Congresswoman said in her opening remarks.

At the current rate of generation of spent fuel, an additional Yucca Mountain equivalent would be needed every 20 years or so. And any increases would only make the situation worse.

As an alternative, by first removing the low-level unburned uranium and short-lived decay products from spent fuel and then forming the remaining plutonium and actonides into TRISO particles, some 70 to 90 percent, it depends on the isotope, of this spent fuel waste can be burned in one pass through a Very High Temperature Reactor. Even more could be burned if you do a second pass.

This process is known as deep burn. In steady state, one reactor could support five light-water reactors.

The final discharge is most unsuitable for weapons usage, because 90 percent of the plutonium isotope used in nuclear weapons has been consumed and the volume and heat load have been much reduced.

By burning the spent fuel from the light-water reactor fleet in dedicated high temperature reactors, and gradually changing over to those reactors as the light-water reactors reach their end of life, the United States would need only one Yucca Mountain or its equivalent to meet the spent fuel needs for the next 75 to 100 years, even with a 2 to 3 percent per year growth in nuclear power that some people see today. This would be enough time to develop fusion energy as an ultimate solution to the fuel problem. If fusion were unable to reach its promise in that timeframe, and personally I believe it will, then the limited number of Fast-Flux reactors could be employed to process the quite modest discharge from the High Temperature reactor fleet.

So with all this promise, why do we not see utilities flocking to these reactors? There are several reasons. First, of course, nothing has been moving in the nuclear arena for 30 years. At the end of the first nuclear era, GA had booked orders for 12 earlier versions of gas reactors that totaled over $11 billion. Those who say that the technology is not ready often forget this fact.

Now that the tide may be changing, the first priority of utilities has been Nuclear Power 2010 to restart LWR construction. The utilities are also very aware of the spent fuel issue, as witnessed by the urging of the Yucca Mountain licensing. GA has several of them on its advisory board. We receive a lot of advice and encouragement from them.

Finally, what is really needed for the utility commitment and interest in investment is a successful operating demonstration facility. Such a facility would play the same role today that the many reactors built in the 1950's and 1960's played, as part of the nuclear navy program, played for the light-water reactor program, and there is no such equivalent today. The NGNP at Idaho has been under discussion for 2 years now. Its purpose is to provide just that demonstration function. It has received authorization support and some appropriation funding, but I think it is fair to say we as a Nation have not really yet committed to carrying that out. Needless to say, I strongly endorse that commitment.

So far its mission has been couched in terms of electricity and hydrogen. But I would urge that a demonstration of deep burn be added to that mission. This could be done with no alteration to the facility itself, and only require fabrication of the appropriate fuel.

In these comments, I have not touched on some other comments made in the written testimony which dealt with how the NGNP affected the revitalization of the nuclear industry. For purposes of time I can't cover them here. What I have covered, described as a quite different vision of the future nuclear power development of this country, particularly for addressing the important issue of spent fuel distribution. It is one I believe can meet the Nation's energy needs for the next several decades by addressing and resolving all of the issues that nuclear power has raised over the last decades.

Providing this legacy for our children is a vision worthy of Government support, and I thank you for the opportunity to present it.

[The prepared statement of Mr. Baldwin follows:]

TESTIMONY OF
DR. DAVID BALDWIN
SENIOR, VICE PRESIDENT, GENERAL ATOMICS
BEFORE THE
SUBCOMMITTEE ON ENERGY AND RESOURCES
HOUSE COMMITTEE ON GOVERNMENT REFORM
JUNE 29, 2005

Mr. Chairman and Members of the Subcommittee, my name is David Baldwin. I am Senior Vice President and head of the Energy Group of General Atomics in San Diego. Thank you for the opportunity to talk to you today about Generation IV reactors and the important role they can play in a forward looking and comprehensive energy plan.

This year is General Atomics' 50th anniversary. As you might guess from our name, our roots are deeply embedded in nuclear technology. After the first Geneva Convention on the Peaceful Uses of the Atom, GA was created to harness the atom for peaceful commercial purposes. From the very beginning, GA has taken a different road to reactor development. Our approach was first to adopt a reactor concept that could be made inherently safe by laws of physics, then to make it economically competitive and finally to apply it to other national and commercial needs.

As you are probably aware, today's commercial light water reactors are an outgrowth of the U.S. Navy's nuclear reactor program. Those reactors are relatively small, have high power density and are capable of fitting into the limited space available on a ship. Today's LWR cores are relative small, have a high power density and are well proven to be robust and safe in operation. However, their efficiency is limited to approximately 30%, they operate at relatively low temperature, which is a negative for applications like hydrogen production, and they require multi-layered and costly active safety systems.

Today's existing fleet of 103 reactors in the U.S. is without a doubt one of the most safe and reliable assets on our electric grid and we applaud the federal government and U.S. utilities in their collaboration to bring about their simpler and more economic progeny under the Nuclear Power 2010 program. This is a very important step toward a brighter energy future for the U.S.

The next close behind step however must be the introduction of so-called Generation IV reactors. Gen IV reactors now under development promise even better efficiency and economics, improved safety and proliferation resistance and increased versatility. Of the six Gen IV concepts accepted for international study, only one type meets all of these criteria and has had significant industrial experience and history and is essentially ready to be built today. This type of reactor employs helium as the coolant and uses graphite as its moderator.

High Temperature Gas Reactors (HTGRs) operate at sufficient temperature to enable efficient thermo-chemical or high temperature hydrolysis hydrogen production and efficient electric power generation. The core of the HTGR is based on several gas reactors that operated in the 1970s, and the Japanese 30 MW HTTR that is operating today. Based on the ongoing Japanese success and the success of the earlier U.S. versions, we can conclude that the technology of the HTGR core is well in hand and poses little technological risk.

Importantly, the MHR also is versatile in the type of nuclear fuel that it can burn. In fact, high temperature gas reactors are, I believe, unique in their ability to burn almost any type of fissionable material including uranium at nearly any enrichment level, a thorium / uranium mixture, weapons plutonium and as I discuss below, the most toxic and long-lived components of nuclear waste.

IT'S TIME TO BUILD A GEN IV REACTOR

Importantly, from the technological point of view, a demonstration of a commercial scale HTGR is ready to be built today. Indeed, several other countries including France, South Africa, Korea, and China are seriously considering such a demonstration in the very near term. So, the question is whether it is worth it to our country to move ahead and build one or to wait and possibly let another country do it.

As the Members of the Subcommittee are no doubt aware, the construction of a Gen IV reactor for the purpose of electric power and hydrogen production is authorized in H.R. 6, the energy policy bill now before Congress. Timely and successful completion of this project would yield huge dividends to the U.S. in the following areas:

1. **DEMONSTRATION OF IMPROVED SAFETY, SECURITY AND EFFICIENCY** - If the U.S. is going to begin building new nuclear power plants in any significant numbers in order to have an impact on national energy security and improve air quality, then the nuclear plants we build should be the best we can achieve at any given time. Because of their higher operating temperatures, HTGRs are expected to be nearly 50% more efficient in producing electricity than the existing generation of reactors and have the additional benefit of being able to produce hydrogen much more efficiently also. This of course means about 30% less nuclear waste per unit of useful energy and about 30% less cooling water and less waste heat rejected into the environment. These characteristics are in addition to the increased safety and security that is brought on by a reactor design that is built underground and is, by the basic laws of physics, melt-down proof.

2. **DEMONSTRATION OF EFFICIENT NUCLEAR HYDROGEN PRODUCTION** – Without ever even assuming a so-called hydrogen economy, there is a substantial and rapidly growing demand for hydrogen in the U.S. Currently, together, the refinery and fertilizer industries in the U.S. use the hydrogen energy equivalent of about 50 large nuclear power plants. This usage grows at approximately 10 percent per year. At present, this hydrogen is primarily derived from natural gas. This, of course, further drives up the cost of natural gas and makes our industry less competitive and less likely to stay in the U.S. Indeed, we are told that many fertilizer production facilities have

moved out of the U.S. primarily on the basis of the high cost of natural gas. Efficient nuclear production of hydrogen promises competitive and stable prices for hydrogen.

3. **DEMONSTRATION OF A TECHNOLOGY TO BURN UP NUCLEAR WASTE** - There has been much discussion lately about getting the U.S. back into the reprocessing of spent reactor fuel as a means lessening pressure on Yucca Mountain. It is very important to remember however that reprocessing by itself does not get rid of any nuclear waste: it merely separates some of the components of nuclear waste as a first step to facilitate either recycling or waste treatment. One of the great strengths of high temperature gas cooled reactors is, as I've stated, their versatility in burning different types of nuclear fuel including the most toxic and long-lived components of nuclear waste. In fairness, I must mention the fact that certain other reactor designs, including some fast spectrum reactors can also burn these wastes and those capabilities should also be explored. However, work being done at GA, Argonne and other national labs is now confirming that HTGRs are uniquely capable of achieving a deep burn up of nuclear waste actinides, especially Plutonium 239, in a simple once-through fuel cycle without multiple reprocessing and recycling steps. Indeed, we believe that a reasonable growth scenario for gas cooled reactors fueled with nuclear waste actinides would reduce the amount of high-level waste from nuclear power generation to the point that the capacity of Yucca Mountain would meet projected national storage needs for several decades, rather than the 5-10 years under present disposition policy. A demonstration HTGR in the U.S. would provide an ideal test bed for research and development into this means of recycling and destroying spent fuel transuranics, and paving the say to profoundly addressing our nuclear waste disposal issues.

4. **NON-PROLIFERATION BENEFITS** – There are two primary non-proliferation benefits to the U.S. for taking a leadership role in the development of a Gen IV reactor: development of an even more proliferation resistant reactor for export and the rebuilding of the U.S. nuclear industry. For the government to be able to offer other nations with nuclear energy ambitions an extremely proliferation resistant reactor and associated fuel is an important step. Similarly, rebuilding the U.S. owned nuclear industry is extremely important to the implementation of our non-proliferation strategy around the world. Industry is an important set of eyes and ears around the world and can help keep close tabs on the flow and control of nuclear materials. This is "turf" of U.S. national strategic importance that should not be given up lightly to foreign owned industry.

5. REVITALIZE U.S. NUCLEAR RESEARCH AND EDUCATION - It is well known that the number of operating research reactors in the U.S. has continued to decline at a serious rate in the U.S. In addition, the lack of any new nuclear plant construction for over two decades has lessened the incentives for new students to enter into the nuclear arena. The construction of a Gen IV reactor in the U.S. will not only provide a plethora of research opportunities for our national labs and universities, but it will most certainly provide the type of signal to the best and brightest of our students to enter into the nuclear field.

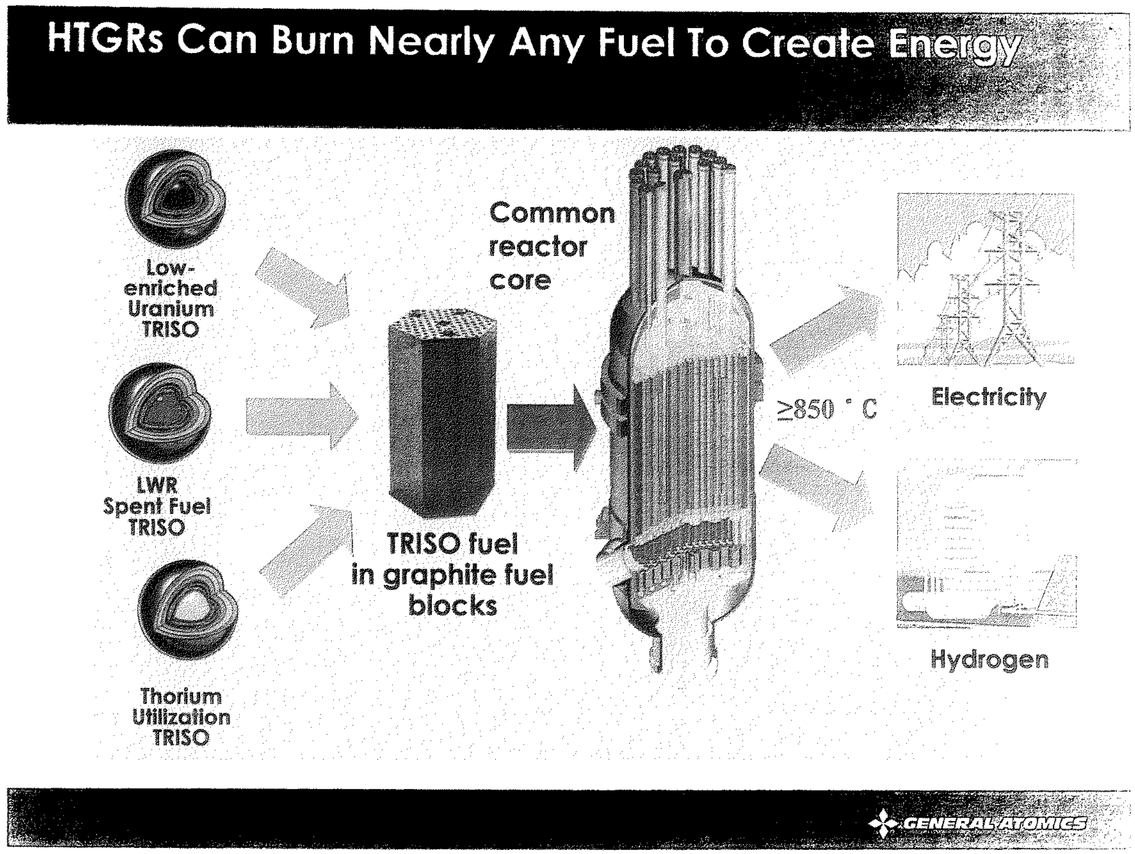
6. U.S. BALANCE OF TRADE AND COMPETITIVENESS - At the most basic level, if Gen IV reactors are indeed the wave of the future, and if the world is going to rely increasingly on nuclear energy, then the U.S. would certainly be better off as an exporter than an importer. At present however, the U.S. owned nuclear technology and supply industry is in almost an extreme state of atrophy. The construction of a Gen IV reactor in the U.S. can be the lynchpin of reviving the U.S. nuclear industry and U.S. nuclear competitiveness in the world. To make this possible, the U.S. government must enter into strategic partnerships with industry, much as it does with renewable energy or clean coal projects and much as every other nuclear nation does with its own industry. As in these other areas, U.S. industry will simply not mount a Gen IV nuclear project without federal leadership.

In summary, there are indeed several types of Gen IV reactors, each of which has its virtues and attributes. Research on all of them should be pursued at some appropriate level. However, only the high temperature gas cooled reactor is technologically ready to move forward today, enjoys the interest of a number of U.S. utilities, is capable of a deep destruction of nuclear waste actinides in a "once-through" cycle, and is the focus of a substantial amount of development in nearly every major nation involved in nuclear energy.

Gen IV reactor research by itself is valuable but does not contribute to energy security in the near- or even medium term. Something must be built and high temperature gas cooled reactors are ready to go. The U.S. has a choice now to either lead or follow in their demonstration and commercialization. Given the lessons we are learning about the geopolitical and security consequences of being an importer of energy instead of an exporter, the correct choice seems obvious.

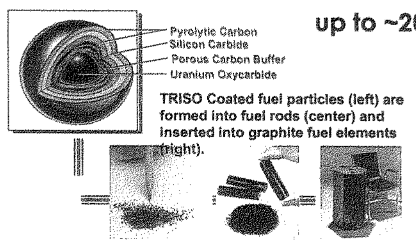
The so called "Next Generation Nuclear Plant" or NGNP project that is authorized in both the House and Senate versions of H.R. 6 is a historic opportunity to regain U.S. leadership in nuclear energy technology and help bring about a more secure and environmentally sound energy future. So, if one of the key questions being raised during this hearing is "What can the Federal government do to promote Gen IV reactor technology?", the answer is: build the NGNP project as soon as possible.

Thank you for this opportunity to testify.

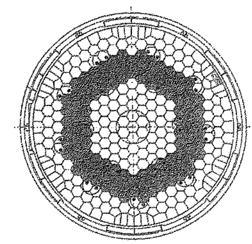

HTGRs Can Burn Nearly Any Fuel To Create Energy
Low-enriched Uranium TRISO
LWR Spent Fuel TRISO
Thorium Utilization TRISO
TRISO fuel in graphite fuel blocks
Common reactor core
≥850 ° C
Electricity
Hydrogen
GENERAL ATOMICS

The MHR Exploits a Fundamentally Different Approach to Safety

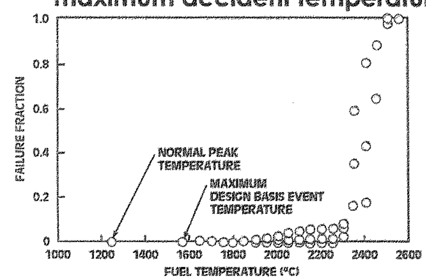
- Ceramic fuel retains radioactive materials up to ~2000°C



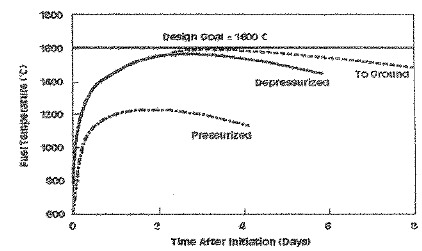
- Heat removed passively without primary coolant



- Coated particles stable to beyond maximum accident temperatures

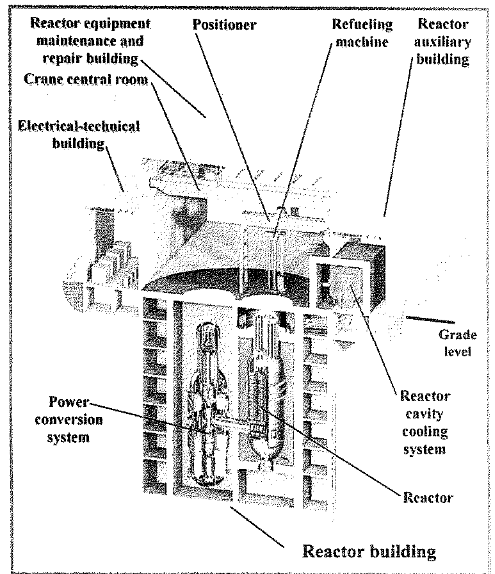


- Fuel temperatures remain below design limits during loss-of-cooling events



GT-MHR Module is Designed To Be Located In Below Grade Silo

- Electrical output 286 MW(e) per module
- Each module includes Reactor System and Power Conversion System
- Reactor System 600 MW(t), 102 column, annular core, hexagonal prismatic blocks similar to FSV
- Power Conversion System includes generator, turbine, compressors on single shaft, surrounded by recuperator, pre-cooler and inter-cooler
- Natural sabotage protection



GENERAL ATOMICS

Mr. ISSA. Thank you, Dr. Baldwin.

We now move to Dr. Rowan Rowntree, who has just concluded a 3-year appointment as a visiting scholar in the Department of Environmental Science, Policy and Management at the University of California-Berkeley. He taught courses in energy, technology and society as an assistant and associate professor in the Maxwell School of Public Policy at Syracuse University.

Three years ago, he retired from his position as National Research Program Leader in the research division of the U.S. Forest Service. His advanced degrees are in the earth sciences, and were taken at the University of California-Berkeley.

Before I allow Dr. Rowntree to speak, I have to own up to 25 years of, at times, having the opportunity to debate him about sustainable energy and other subjects, including the earth in every possible sense. So it is with great pleasure that he agreed to be here as the most independent scientist we could possibly get, and you will see that demonstrated here today. Please, Dr. Rowntree.

STATEMENT OF ROWAN ROWNTREE

Mr. ROWNTREE. Thank you very much, Mr. Chairman and members of the subcommittee, for your invitation. This is an important discussion.

I would like to address the second question in your briefing memorandum: How can Government further promote the Generation IV nuclear power technology? I suggest there are six things that Government can do. These suggestions address the public's aversion to nuclear power, and they also address the need to have energy policymaking and management become more transparent. Unless we can achieve this, support for Generation IV reactors will be difficult. So these suggestions really focus on the interim 25 years until the Generation IV reactors can come online.

First, we have to educate the Nation as to why the 100 orders for reactors were canceled, and why there have been no new orders for reactors since about 1978 or 1980. This is the first step in building public confidence that, with new and advanced technology, the Nation can safely consider continuing the nuclear component of our energy program.

The second thing I suggest is that we educate the Nation as to how safe the current 103 reactors are, at what rate they will be decommissioned, and what type of reactors will replace them. To maintain the 20 percent nuclear contribution, we need to tell the Nation whether it is better to extend the life of the current fleet or replace a portion of that fleet with what I assume will be called Generation III Plus reactors. Correct me if I am wrong on the terminology.

If it is the Government's intention to increase the nuclear contribution above 20 percent during the next 25 years, then we must explain what kinds of reactors and fuel cycles will be used and what the tradeoffs are between starting these reactors up versus just waiting for Generation IV reactors to come online.

The third suggestion is, we must solve two problems of critical public safety: the disposal question and the posture of the Nuclear Regulatory Commission. On the first one, is it better to move high-level waste to Yucca Mountain or improve technology for onsite, above-ground or below-ground disposal? Or should we get back into reprocessing, and if we do, can we really manage the plutonium proliferation problem?

On the second point, we must answer the question, is the Nuclear Regulatory Commission tilted toward public safety or toward industry solvency?

My fourth suggestion is to provide the public with a plan and a time line that takes us through the interim 25 years and through the life span of Generation IV to fusion. Now, we read this morning in the New York Times that France is going to get the first fusion experimental reactor. We just need to have the public understand what our plan is. A plan in itself builds confidence, structures discussion, and invites good ideas.

For example, the fusion education program at General Atomics, in partnership with DOE, begins at the elementary school level. Education programs like this, when placed in the context of a plan and a time line, take on added power and meaning.

Fifth, make a concerted effort, that is a concerted effort, to reduce fossil fuel consumption by strengthening corporate average fuel efficiency standards and supporting citizens' conservation efforts. This builds public participation, builds citizen responsibility and public interest in energy decisions. It also builds a sense of credibility about what Government is doing.

This approach can convince the public the Government really is making every effort to solve our energy dilemma. An example is Congressman Issa's efforts to make car pool lanes available to hybrid cars, which has been successful.

My last suggestion, and in my mind today, the most important, is give careful consideration to renewables that can come online in the next 5 years, or 10 years, to reduce the large fossil fuel component, promote solar, and take a new look at wind. I have just become more interested in wind last week, and I will tell you why. Wind turbines currently contribute about 1 percent of our electricity. But they require low front-end investment, low operational costs and they use established technology and have low environmental impacts.

But in terms of forging a national generation strategy that included wind, we really had no hard data on the wind resource. Then in this coming month's issue of the Journal of Geophysical Research-Atmospheres, which is a publication of the American Geophysical Union, there will appear a comprehensive peer-reviewed research report that establishes a calculus for wind. This study assesses the wind generation potential for all regions of the world. The author is a tenured professor of civil and environmental engineering at Stanford University and the study was funded by NASA. It is a solid study and the citation appears at the end of my testimony.

The research that they did concludes that locations around the world with sustainable Class III winds can produce about 72 terawatts of electricity. A terawatt is 1 trillion watts, the power equivalent, I am led to believe, that is equivalent to generation by more than about 500 nuclear reactors. The authors point out that capturing 20 percent of the 72 terawatts would meet the world's electricity needs, including a good portion for hydrogen production.

The Great Lakes region in the United States is designated in this study as one with many offshore sites for this type of wind generation and the availability of fresh water at the site makes it attractive for hydrogen production. I am concluding today that with Government leadership and moderate subsidy we could attract capital to bring additional wind generation online quicker and possibly with fewer costs than by building Generation III and III Plus reactors.

So to summarize, to successfully promote Generation IV reactors, this requires convincing thought leaders, investors and governments that, No. 1, Generation IV solves most of the problems of Generations I, II and III, and the testimony I have heard to this point convinces me that they are very attractive. Second, that the current reactor fleet be managed in a way that maximizes public safety.

Third, that Government is looking at all options in a clear-eyed, cost beneficial manner. Four, that Government will educate the people about the costs and benefits of each option and then make intelligent decisions about how to get us out of this dilemma.

Now, this subcommittee is taking the right step toward an open and honest discussion. I commend the chairman and the members. Thank you.

[The prepared statement of Mr. Rowntree follows:]

June 29, 2005

Testimony of **Dr. Rowan Rowntree** to the U.S. House of Representatives Committee on Government Reform, Subcommittee on Energy and Resources, Darrell Issa, Chairman

Oversight Hearing: "The Next Generation of Nuclear Power"
June 29, 2005, 2:00 p.m.
Room 2203, Rayburn Bldg.

Thank you, Mr. Chairman, Members of the Subcommittee, for your invitation to participate in this important discussion. I would like to address the second question in your Briefing Memorandum, "How can government further promote the development of Generation IV nuclear power technology?"

I understand that Generation IV reactors will be available in 25 years, that they are conceived to be systems that reduce accident potential significantly, that they efficiently produce hydrogen, and can burn reactor waste, minimize uranium use, plutonium proliferation, and significantly reduce the need for repository disposal.

I suggest six things government can do to promote Generation IV technology. These are designed to reduce the public's aversion to nuclear power and have energy policymaking become more transparent. Unless we can achieve these, support for Generation IV reactors will be difficult. These suggestions focus on the interim 25 years until the advanced reactors can come on line.

First, educate the nation as to why the 100 orders for reactors were cancelled and why there have been no new orders for reactors since 1978. This is the first step in building public confidence that, with new and advanced technology, the nation can safely consider continuing the nuclear component of our energy program.

Second, educate the nation as to how safe the current 103 reactors are, at what rate they will be decommissioned, and what type of reactors will replace them. To maintain the 20% nuclear contribution, tell us if it's better to extend the life of the current fleet, or replace a portion of that fleet with what I assume will be called Generation III reactors. If it is government's intention to increase the nuclear contribution above 20% during the next 25 years, tell us what kinds of reactors and fuel cyles will be used and what the tradeoffs are between starting these reactors up versus waiting for the Generation IV reactors.

Third, solve two problems of critical public safety: The disposal question and the posture of the NRC. Is it better to move high-level waste to Yucca Mt. or improve technology for on-site disposal. Should we get back into reprocessing, and, if so, can we manage the plutonium proliferation problem. Is the Nuclear Regulatory Commission tilted toward public safety or toward industry solvency?

Fourth, provide the public with a plan and timeline that takes us through the interim 25 years, through the lifespan of Generation IV to fusion. A plan, in itself, builds confidence, structures discussion, and invites good ideas. For example, the fusion education program at General Atomics, in partnership with DOE, begins at the elementary school level. Education programs like this, when placed in the context of a plan and timeline take on added power and meaning.

Fifth, make a concerted effort to reduce fossil fuel consumption by strengthening CAFÉ standards and supporting citizens' conservation efforts. This builds public participation, personal responsibility, and public interest in energy decisions. This approach can convince the public that government is making every effort to solve our energy dilemma. An example is Congressman Issa's efforts to make carpool lanes available to hybrid cars.

Sixth, and most important, give careful consideration to renewables that can come on line in the next five years to reduce the large fossil fuel component. Promote solar and take a new look at wind. I've just become more interested in wind, and I'll tell you why. Wind turbines currently contribute only 1% of our electricity. They require low front-end investment, low operational costs, they use established technology, and have low environmental impacts. But, in terms of forging a national generation strategy, we had no hard data on the wind resource. Then, in this coming month's issue of the *Journal of Geophysical Research-Atmospheres* (a publication of the American Geophysical Union) there appear a comprehensive, peer-reviewed research report that establishes a calculus for wind. This study assesses the wind generation potential for all regions of the world. The lead author is a tenured professor of Civil and Environmental Engineering at Stanford University. The study was funded by NASA. It's solid. (Citation and web access listed below/)

The research concludes that locations around the world with sustainable Class 3 winds can produce about 72 terawatts of electricity. A terawatt is 1 trillion watts, the power equivalent to that generated by more than 500 nuclear reactors. The authors point out that capturing 20% of the 72 terawatts could meet the world's electricity needs including, I presume, a good portion for hydrogen production. The Great Lakes Region is designated in this study as one with many off-shore sites for wind generation, and the availability of fresh water at that site makes it attractive for hydrogen production. I'm concluding, now, that with government leadership and moderate subsidy, we could attract capital to bring additional wind generation on line quicker and with fewer costs, than by building Generation III reactors.

Summary. To successfully promote Generation IV reactors requires convincing thought leaders, investors, and governments that: (1) Generation IV solves most of the problems of Generations I, II, and III. (2) That the current reactor fleet will be managed in a way that maximizes public safety. (3) That government is looking at all options in a clear-eyed cost-benefit manner. (4) That government will educate the people about the costs and benefits of each option, then to make intelligent decisions about how we get out of this dilemma. This subcommittee is taking the right step towards an open and honest discussion, and I commend the Chairman and the Members. Thank you.

Archer, C.L., and M.Z. Jacobson, Evaluation of global wind power, *Journal of Geophysical Research-Atmospheres.*, in press, 2005.
This can be downloaded from:
www.stanford.edu/group/efmh/winds/global_winds.html
And will be available from *Journal of Geophysical Research-Atmospheres*
In early July. See also
www.stanford.edu/group/efmh/jacobson/ for additional resesearch assessments on costs of wind and hydrogen.

Dr. Rowntree just concluded a three-year appointment as Visiting Scholar in the Department of Environmental Science, Policy, and Management, at the University of California, Berkeley. He taught courses in Energy, Technology and Society as Assistant and Associate Professor in the Maxwell School of Public Policy at Syracuse University. Three years ago, he retired from his position as national research program leader in the reseach division of the United States Forest Service. His advanced degrees (M.S., Ph.D) are in the earth sciences, taken from the University of California, Berkeley.

Addenda to:

Testimony of **Dr. Rowan Rowntree** to the U.S. House of Representatives Committee on Government Reform, Subcommittee on Energy and Resources, Darrell Issa, Chairman.

Oversight Hearing: "The Next Generation of Nuclear Power"
June 29, 2005, 2:00 p.m.
Room 2203 Rayburn Bldg.

Addendum Number One: Following comments
Addendum Number Two: Letter from Professor Mark Jacobson, Stanford University, to Chairman Issa, July 12, 2005.

My testimony focuses on the next 25 years prior to the first Generation IV reactor availability. During this time, government must act to overcome a deep resistance to nuclear power in the United States. This resistance will be exacerbated by an increasing number of incidents and breakdowns as the current fleet of fission reactors ages.

Since the hearing on June 29th, I have observed discussions related to the creation of the current Energy Bill, and I conclude that to prepare the way for Generation IV reactors, government must act to: (1) Gain credibility, and (2) Engage the public in energy management to heighten understanding and commitment.

Credibility: The hearing testimony and discussion suggests that the strongest argument for Generation IV power is it could release us from a dependency on fossil fuels. The Energy Bill is contradictory in this respect and, thus, the argument is undermined. On the one hand, the bill does extend the Production Tax Credit for wind generation and supports development of other renewables at a relative low level of investment. On the other hand, the bill continues large subsidies for fossil fuel development. Government credibility is weakened with this contradiction. In this low credibility environment, the bill subsidizes the building of new reactors to fill the gap between now and Generation IV power. Thus, a nuclear power program implemented during the next 25 years is erected on a weak foundation of government credibility and can only make the implementation of the later Generation IV technology more problematic.

Public Engagement: During WWII, the public was engaged and committed. Rationing stamps, Victory Gardens, Blackouts, Block Wardens. The nation understood the problem and made sacrifices to meet the challenge. Today, government can act to encourage public engagement and commitment to a rational energy policy by encouraging more rational demand-side behavior. Some of this is in the Energy Bill: hybrids, energy efficient appliances, solar wind credits, etc. However, this is overshadowed by the silence on national vehicle efficiency (e.g. Corporate Average Fuel Efficiency standards). Transportation efficiency is the one area in which government leadership can improve credibility and engage the public.

A New Focus on Wind: My testimony focused on the new role of wind power, and it is amplified here by Addendum Number Two, the informative letter to Chairman Issa from Professor Jacobson, following these comments. This Stanford engineering study finds that there are enough practical wind power sites to meet the U.S. demand for electricity ten times over. An immediate goal would be to use wind to provide 30-50% of our electric power. After meeting that goal, there are ample prime sites to provide enough hydrogen to power all U.S. motor vehicles. Now that the Energy Bill extends the wind energy Production Tax Credit of 1.9 cents/kWh, capital should flow to that sector. A reasonable estimate is that over $3 billion of investment will flow to new wind generation in the next year, with 2500 megawatts of capacity scheduled to come on line in the same period. Investment in wind power has been hampered by the short-terms, and associated uncertainty, of the Production Tax Credit. Now that the credit is guaranteed with an annual inflation adjustment, it is reasonable to plan for a 30-50% contribution from wind during the next 25 years. Since the cost per kWh from wind is lower than the cost per kWh from current nuclear power plants, wind power is clearly preferable to building interim nuclear plants during this time before Generation IV reactors come on line.

Addendum Number Two: Letter from Professor Mark Jacobson, Stanford University, Dept. of Civil and Environmental Engineering, to Chairman Issa (Following as separate document.)

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July 12, 2005

The Honorable Darrell Issa
United States House of Representatives
Chair, House Subcommittee on Energy and Resources
211 Cannon House Office Building
Washington, D.C. 20515-0549

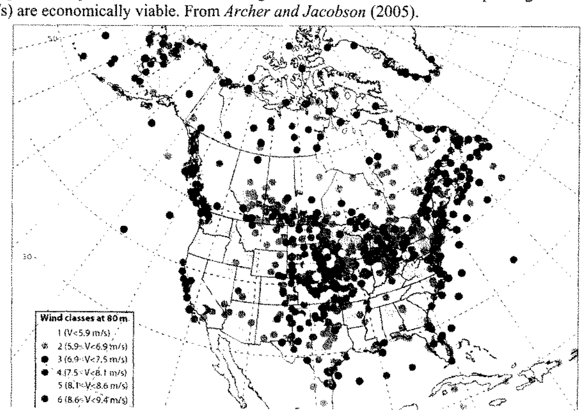
Dear Representative Issa,

This letter was requested by Dr. Rowan Rowntree to be included as an addendum to his June 29, 2005 testimony to the House Subcommittee on Energy and Resource. The letter summarizes some important recent research on wind resources in the United States (and worldwide) and compares unsubsidized cost estimates of onshore and offshore wind energy with those of nuclear energy. It also compares the cost of wind-derived hydrogen for fuel cell vehicles with the cost of gasoline.

Wind Resources

Recently, global wind speeds at 80 meters above the ground, the hub height of many modern wind turbines, were mapped for the first time from data (*Archer and Jacobson*, 2005). The figure below shows the resulting map for North America. The Great Plains has long been known to be a region of strong winds, but the figure identifies some areas of intense winds that were previously unknown, including off the southern and southeastern coasts of the United States, along the coasts of Texas, California, Washington State, and Alaska, and over/around the Great Lakes.

Annually-averaged wind speeds 80 meters above the ground in North America. Wind speeds greater than 6.9 meters per second (m/s) are economically viable. From *Archer and Jacobson* (2005).



For wind energy to be economically viable, the annual-average wind speed at 80 meters must be at least 6.9 meters per second (15.4 miles per hour) (*Jacobson and Masters*, 2001). Based on the mapping analysis just discussed, we calculate that 15 percent of United States land area (and 17 percent of land plus coastal offshore area) may have wind speeds above this threshold (globally, 13 percent of land area is above the threshold).

Wind to Produce Electricity

From the numbers above, we further calculate that the total energy available from the wind in the United States (onshore plus coastal offshore) is about 55,000 TWh, about twice the total energy consumed by all energy sources in the United States (28,000 TWh, *EIA* 2005) and more than ten times the electricity consumed (3700 TWh). In other words, if the United States could capture only a fraction of the available wind at 80 meters, wind could supply a significant portion of our electric power.

One concern about electric power from wind has been that winds are intermittent, and grid operators prefer a constant electricity source. However, as demonstrated by Spanish transmission network measurements available on the internet (*Red Electrica De Espana*, 2005), which show the combined output of 81 percent of Spain's wind farms, the linking of wind farms together nearly eliminates intermittency on times scales of hours and less, smoothing out the electricity supply. This factor has also been demonstrated with wind data in Archer and Jacobson (2003) and has been shown in other studies. Thus, although backup is needed for wind, a conversion of 30-50% of current and future electric power sources to wind is not an unreasonable goal.

Wind to Produce Hydrogen

One potential use of wind that does not depend much on wind's intermittency and that will also reduce U.S. oil dependence is the generation of hydrogen by wind-electrolysis for use in fuel-cell vehicles. Recently, it was estimated that using wind to generate hydrogen for fuel-cell vehicles might save 3700-6400 premature deaths and millions of cases of asthma, cardiovascular disease, respiratory diseases, and other ailments per year, in addition to reducing greenhouse gas emissions significantly (*Jacobson et al.*, 2005). The health and climate cost benefit to the U.S. of switching from gasoline to wind-hydrogen was estimated to be between $0.29 and $1.80 per gallon of gasoline equivalent. In other words, each gallon of gasoline used today costs U.S. citizens $0.29 to $1.80 in health (primarily) and climate damage, and converting to wind-hydrogen fuel-cell vehicles would eliminate this cost and improve the quality of life for all citizens. The polluted skies in many U.S. cities would clear up, and people would live longer and have fewer ailments during their lives.

The study also calculated that the hydrogen fuel cost to a consumer to drive a wind-based hydrogen fuel cell vehicle the same distance that a gallon of gasoline currently drives a vehicle is between $1 and $3. Given that the current mean U.S. cost of gasoline is around $2.23 per gallon (July, 2005) and that gasoline currently results in a hidden health and climate cost of $0.29 to $1.80 per gallon (*Jacobson et al.*, 2005), the calculated cost of wind-hydrogen ($1 to $3 per gallon of gasoline equivalent), is less than or equal to the real cost of gasoline ($2.52-$4.03 per gallon).

Cost of Wind Energy
During the last thirty years, the cost of electricity from wind has declined significantly due to (a) larger turbines that are able to capture faster winds aloft, (b) better design and materials, and (c) economies of scale.

Today, the unsubsidized cost of electricity from a modern, onshore wind turbine (e.g., a General Electric 1.5 MW turbine with a 77-meter diameter blade) with a 20-year life in the presence of winds 6.9 meters per second or greater is estimated to be 3-5 cents/kWh, and 3-4 cents/kWh at the faster wind sites close to consumers (*Jacobson and Masters*, 2001; Jacobson et al., 2005). The range given is consistent with data from *Bolinger and Wiser* (2001), who calculated (p.3) the 25-year real costs of 17 new wind farm proposals in California in 2001 as 3.2 to 3.7 cents/kWh, with a weighted average value of 3.6 cents/kWh. Their analysis also stated that the numbers were based on proposal information that presumably contained worst-case estimates for wind.

The cost of offshore wind energy in water of less than 30 m depth (and often 5 to 10 km offshore) is about 25-40% higher than that of onshore wind energy (*Irish Wind Energy Association*, 2005). Most of the additional cost is due to the fact that larger turbines are used for offshore wind, and the cost of transporting and installing turbines at sea is more expensive than over land. On the other hand, offshore winds are faster, providing more energy. The Danish Wind Industry Association (2005) estimates the 25-year cost of an offshore turbine as about 5.2 cents/kWh (0.325 DKK/kWh, where $1=6.25 DKK in July, 2005). For offshore foundations and other materials designed for 50 years, the cost decreases to 4.5 cents/kWh. The cost of wind energy in water greater than 30 m depth is more expensive than is the cost in shallower water. Overall, we estimate the cost of offshore modern wind energy as approximately 4.5-5.5 cents/kWh. The costs of onshore, shallow offshore, and deep offshore wind energy are expected to decrease further as technology improves.

Cost of Nuclear Energy
Comparing costs of different electric power technologies is complex, and the results are highly sensitive to input assumptions. Generally, it is best to rely on consistent comparisons when analyzing relative costs. Unfortunately, nuclear cost estimates calculated consistently with the wind cost estimates are not available in an "off the shelf" form, so we rely here on cost calculations for nuclear power performed elsewhere. Two recent studies of the costs of nuclear power include those completed by the University of Chicago (2004) and MIT (2003). Results from these studies are reported here without modification, so are subject to some possible differences in methodologies in comparison with the wind cost estimates provided.

The University of Chicago study estimated pre-tax costs of different nuclear power technologies in the U.S. (Table 1-1, p.1-8) of between 3.6 and 8.3 cents/kWh (in 2003 dollars). In addition, it compared costs of nuclear energy in twelve different countries using Organization for Economic Cooperation and Development data (their Table 2.5 on pages 2-10), assuming an 8% discount rate (2003 dollars). The lowest costs (3.9 cents per kWh) were found in Canada and China, while the highest costs (8.3 cents per kWh) were found in Japan.

Unlike the University of Chicago study and the wind cost estimates, the MIT study included taxes so may be less comparable than the other two studies. The base case cost estimate of nuclear power in the U.S. from the MIT study (Table 5.1, p.42) was 6.7 cents per kWh (in year 2002 dollars, assuming a 40-year reactor lifetime). This declined to 5.5 cents per kWh if capital costs were reduced from current levels by 25%, to 5.3 cents/kWh if construction time was reduced from 5 years to 4 years, and finally to 4.4 cents/kWh if financing costs for nuclear were assumed to be comparable with those for fossil-fuel fired power plants. If the construction period for nuclear reactors is longer than the 5 years assumed and costs escalate as they have in previous generations of reactors worldwide, then the MIT costs will underestimate the true costs of nuclear energy.

Based on this rough comparison, the lower ends of the ranges for nuclear costs cited by both the University of Chicago and MIT studies are within the range of wind generation costs described earlier. The higher end of the nuclear cost estimates is above the high-end estimates of wind energy.

Summary

- We estimate the cost of electricity from modern wind turbines in the presence of mean annual wind speeds greater than 6.9 meters per second as about 3-5 cents/kWh onshore (3-4 cents/kWh for the faster wind sites) and 4.5-5.5 cents/kWh offshore.

- U.S. wind energy would be most efficient if wind farms were interconnected through the transmission grid so that fast winds at one farm can offset slow winds at another, smoothing out electrical output.

- Recent studies by the University of Chicago and MIT estimate the cost of nuclear energy in the U.S. over a broad range (3.6-8.3 cents/kWh). The lower end of this range is within the range of the cost of modern wind energy. The higher end for nuclear is above the cost of modern wind energy.

- We find that the United States has enough wind energy to power all electricity in the United States by a factor of ten times over, but a practical goal would be to produce 30-50 percent of electric power from wind.

- We find that the United States has enough wind to power all motor vehicles with hydrogen in addition to supplying the U.S. with 30-50% of its electric power.

- We find that a conversion to wind-hydrogen may reduce mortality and health problems and costs in the United States significantly and reduce climate problems. The cost benefit of replacing gasoline with wind-hydrogen is estimated to be \$0.29-\$1.80 per gallon of gasoline equivalent.

- Hydrogen from nuclear power would also reduce health and climate problems related to fossil fuels, but at a similar or higher direct cost per unit energy than wind. Because of the possible similar cost of wind and nuclear (at the low nuclear estimate), additional factors aside from direct cost should be considered. Some of these are listed below.

- Because wind turbines can be built and put online much faster than can nuclear power plants, the cumulative health and climate benefits of converting to wind must exceed those of converting to nuclear power.

- Because wind is a distributed energy source, it is not prone to terrorist attack, except through the transmission system (like all other sources). Nuclear power is a concentrated electric power source, thus it has a higher risk of being targeted by terrorists.

- Modern wind energy has only a few environmental side effects or risks associated with it, including visual impacts (which some enjoy but others do not), and avian deaths (which are minimal compared with avian deaths from transmission lines and buildings). Avian deaths have been an issue primarily in one location, Altamont Pass, California because it is a raptor pathway. The energy input into building and decommissioning a wind turbine is approximately 1-2 percent of the energy it produces over its lifetime, thus building/removing turbines has a small environmental cost.

- Nuclear power has risks associated with accidental or terrorist release of radioactive material, environmental damage associated with mining uranium, and the continuous emission of pollutants from coal-fired power-plants generating electricity used to refine uranium.

- Given the enormous untapped wind potential in the United States and the significant health and climate benefits of converting fossil fuels to wind, we recommend that an Apollo-like program for the expansion of wind would benefit the United States for generations to come.

Thank you for considering this information,

Sincerely,

Mark Z. Jacobson

Cc: Rowan A. Rowntree

Acknowledgment
I would like to thank Dr. Jon Koomey of Lawrence Berkeley National Laboratory and Stanford University for compiling a summary of the MIT and University of Chicago nuclear cost studies and Dr. Cristina Archer of the Bay Area Air Quality Management District and Stanford University for compiling helpful energy statistics.

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Mr. ISSA. Thank you, Dr. Rowntree.

We now move to Mr. David Lochbaum, nuclear safety engineer, Union of Concerned Scientists.

Mr. Lochbaum received his bachelor of science in nuclear engineering from the University of Tennessee. He has more than 17 years of experience in commercial nuclear power plant start-up, testing, operations, licensing, software development, training, and design engineering. Since 1996, he has been a nuclear safety engineer for the Union of Concerned Scientists, UCS, not to be confused with USC. UCS is a non-profit partnership for scientists and other interested citizens, combining scientific analysis, policy development and citizen advocacy to achieve environmental solutions.

Mr. Lochbaum has also been a member of the American Nuclear Society since 1978 and has written numerous articles on nuclear safety. We look forward to your testimony. Thank you.

STATEMENT OF DAVID LOCHBAUM

Mr. LOCHBAUM. Thank you, Mr. Chairman. I appreciate this opportunity to share the vies of UCS with the subcommittee.

The role of the Department of Energy, which has been a key part of today's hearing, is an important one if there is to be a future for Next Generation Nuclear Power in this country. To complement that important role is that of the Nuclear Regulatory Commission, which plays not as an immediate role, but is clearly a deeply important role if that next generation is to be successful.

As the chairman pointed out in his opening remarks, there hasn't been a serious accident at a U.S. nuclear power plant since 1979, Three-Mile Island. There are several reasons for that. If you look at the chance of failure versus time for nuclear power plants, or cars or light bulbs or anything, it pretty much follows a bathtub curve, named for its shape. The highest risk is early in life, the break-in phase, and late in life, the wear-out phase.

The experience with nuclear power in this country, is that we have a lot of accidents during the wear-in phase, Three Mile Island being the most serious of those accidents, but we also have Browns Ferry, SL–1, the Fermi 1 reactor accident and so on; accidents that all happened in the first year or two of its lifetime. Once we got out of that phase, past the break-in phase, where the chance of failure goes down, we are on in the peak middle health period of that curve, heading toward the wear-out phase of the curve.

So the Nuclear Regulatory Commission in the future faces the two areas where the risk is the highest: from the existing reactors as they enter or they head toward the wear-out phase, or the risk of new reactors that by nature have to be put down in the left hand part of the curve, which is the break-in part of the curve where again the risk is higher. It doesn't guarantee failure, but the risk is higher in this portion of the curve.

We are concerned that the Nuclear Regulatory Commission hasn't been reformed or its effectiveness hasn't reached a point where it can really deal with both of those challenges successfully. Dr. Rowntree commented that maybe the NRC has a bias toward industry. My personal belief is they don't really have a bias, they are asked to do an awful lot with limited resources. So we have too many balls up in the air, and the chances of dropping them are always greater. Our concern that the focus has been on the DOE's role, at the sake of the NRC's role, in making that agency effective in dealing with the challenges it will face in the future.

Other evidence of the difficulty of meeting this challenge we think are not quite as bad as accidents, but are equally suggestive of the problem. Over its entire history, the Nuclear Regulatory Commission has licensed a total of 132 nuclear power reactors. Forty-four times one of the reactors has been shut down for a year or more because of its safety levels. Those were not accidents, but they were still break-downs, they cost the country billions of dollars as ratepayers and stockholders paid for those safety levels to be restored.

An effective regulator would have seen signs of trouble sooner and intervened sooner and brought about changes that allowed problems to be fixed before it took a year for them to fix the problems. That resulted in lower safety levels and higher costs than were necessary.

Over the last 20 years, there hasn't been a single moment, where a reactor in the United States hasn't been shut down fixing safety levels. We haven't had an accident in 25 years, but we still have these money drains that are costing billions of dollars. They are also precursors to more serious accidents if we don't correct the performance that leads to these problems.

Other compelling evidence of the need for change at the NRC are surveys conducted by the NRC's own Inspector General. The most recent of those surveys was released in 2002. That survey reported that only slightly more than half the employees of the NRC feel that it is safe to speak up in the NRC. That is simply unacceptable. The agency that is in charge of safety cannot silence its own employees.

There is a safety culture at the NRC that the agency is aware of and is taking steps to address. I think they are very sincere in trying to fix those problems. Our concern is that they don't have the resources to bring about those changes fast enough, while they are also dealing with the other issues that they face. These facts should be troubling regardless of whether somebody loves or hates nuclear power, whether you see nuclear power as having a role in the future or not. The fact is that nuclear power is here today and those problems that the Nuclear Regulatory Commission face need to be addressed to ensure safety of the existing reactors and provide a real solid foundation for the next generation.

Mr. Johnson in his remarks spoke of the need to demonstrate the technologies for the Generation IV reactors. We heartily endorse that concept. The consequence of not doing full testing has been lower safety levels and higher costs.

If you look at the existing fleet of reactors, we have had material surprises that have caused costs to be much higher than they need be. Right now, the industry, which is a fairly mature industry, is facing problems with alloy 600 materials, that were supposed to last for the life of the plants but are not. They are requiring steam generators and other complements to be replaced at a higher cost and also representing a greater risk until they are replaced. Better testing years ago before these reactors were built and tested would have identified these problems and allowed the materials being used today to begin producing at a sooner time. Both safety and economics would benefit.

Another example is a material called ENON, which is a material used as a fire protection barrier, so that a fire does not destroy the cables in the emergency equipment in the back-ups. What we are finding out through the testing done at Sandia earlier this year is that this material does not last, does not perform, and does not function. The fire burns it up.

For some reason, the safety tests were not done until years after the material was deployed in a large number of our U.S. reactors. This is not good from either a safety or economic standpoint. Testing is a way to ensure that the expectations that were set up for the future in terms of safety and economics are demonstrated rather than just proven in cyberspace.

I would also like to address a point that Dr. Baldwin made, safety of the reactors. We hear a lot of talk about the improved safety and have no reason to doubt the sincerity of this plan. At the same time, we see the nuclear industry asking that Price Anderson liability protection be extended to nuclear reactors. If you look at the efforts that have been underway for many of the reactor designs, the attempt is to reduce the likelihood that the design has an accident, which is a commendable goal. But the second part of that, should an accident occur in spite of all these nice efforts to reduce the likelihood, will the public be protected? Will the containment protect the public from release of radioactivity?

With Price Anderson in place, the second part of that equation isn't as important, because you pay the same insurance rates whether you have a good containment, no containment or bad containment. If you disallowed, and didn't renew Price Anderson on nuclear reactors, it would be an incentive for vendors to come up with safe designs. Because those safe designs would translate into lower insurance premiums over the life of the plant. Whereas right now, there is no safety incentive to come up with that great design that protects the public.

Similar to cruise ships, the operators of cruise ships go to great lengths to avoid wrecking those cruise ships. But should something happen, there are also lifeboats and other things to protect the passengers in the unlikely event that a cruise ship accident occurs.

With Price Anderson, there is not the incentive to provide lifeboats and other things that nuclear power plants can have to protect the public. We are concerned that if Price Anderson is continued, there is a huge disincentive to make safety improvements. We should not provide barriers to safety in the future.

Last, on the issue of the fuel cycles, we at UCS have long been concerned about nuclear safety. We have also been concerned about nuclear proliferation. One of our concerns with many of the nuclear designs is the separation of plutonium does increase the likelihood and potential for proliferation of the technology, making it easier for rogue countries and terrorist groups to get their hands on the material necessary to make a nuclear weapon. So we have a concern about proliferation in the processing. These are not necessarily showstoppers, but we are concerned about how that is being done, what are the protections necessary to ensure that the right material does not fall into the wrong hands.

I appreciate the opportunity to share our views, and I would be glad to answer any questions.

[The prepared statement of Mr. Lochbaum follows:]

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

Statement Submitted by David Lochbaum to the House Government Reform Subcommittee on Energy and Resources: "The Next Generation of Nuclear Power"

Mr. Chairman and members of the Subcommittee, I would like to thank you on behalf of the Union of Concerned Scientists for the opportunity to present our views on the next generation of nuclear power.

My name is David Lochbaum. I have been the Nuclear Safety Engineer for the Union of Concerned Scientists (UCS) since October 1996. Prior to joining UCS, I worked in the nuclear power industry for more than seventeen years. I received a Bachelor of Science degree in Nuclear Engineering from the University of Tennessee in June 1979.

UCS, established in 1969, is a nonprofit partnership of scientists and citizens combining rigorous scientific analysis, innovative policy development, and effective citizen advocacy to achieve practical environmental solutions. UCS has monitored nuclear safety for over 30 years. We are neither a proponent nor an opponent of nuclear power. We advocate nuclear safety.

The subject of today's hearing is not new to me. Fifteen (15) years ago when I still worked in the industry, I served on the Committee for New Construction, a panel created by the American Nuclear Society (ANS) to examine the issues before this Subcommittee today. I volunteered to serve on that panel because I felt the proper foundation for the next generation of reactors was lacking and I wanted to make sure the steps needed to provide that foundation were taken. The circumstances motivating me to action back then included the year-plus outages needed to restore safety levels at the Peach Bottom (PA), Pilgrim (MA), Davis-Besse (OH), Surry (VA), Calvert Cliffs (MD), Nine Mile Point (NY), Sequoyah (TN) and Browns Ferry (AL) nuclear plants in the mid to late 1980s and the nuclear industry's inability to stop the poor performance pattern. I find myself in the same role today. It is my hope that my participation in this Congressional hearing will be more successful in establishing the right foundation for the next generation of nuclear power than my involvement in that ANS panel.

GENERATION GAPS

It is more sad than ironic that we hear today about a Generation IV array of nuclear reactors when we do not have a Generation I high-level waste disposal site or a Generation III regulator. These generation gaps are *prima facie* evidence that we lack a proper foundation for the next generation of nuclear power reactors. This Subcommittee and the Congress must take steps to narrow rather than widen these gaps.

GENERATION GAP – NUCLEAR WASTE

More than one hundred nuclear power reactors have operated in the United States despite having no place to store the long-lasting, high-level waste they produce. As the National Academy of Sciences recently described in study conducted for the Congress,[1] the "interim" storage of this hazardous material at nuclear power plant sites across the country caused higher risks and increased costs.

> **Recommendation: The federal government must license a repository for high-level nuclear waste <u>before</u> it licenses the next nuclear power reactor.**[2]

[1] National Academy of Science, "Safety and Security of Commercial Spent Nuclear Fuel Storage," Washingon, DC, 2005.

[2] While UCS advocates the necessity for a geological repository, we have not examined the viability of the proposed Yucca Mountain site in meeting that need. Our point is that the federal government must license and open a suitable repository (i.e., the first generation of high-level waste disposal) prior to licensing another generation of nuclear power reactors.

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GENERATION GAP – NUCLEAR REGULATOR

The other generation gap that the federal government must narrow involves the regulator for nuclear power plants. The Atomic Energy Commission (AEC) was created in 1947 by the Atomic Energy Act. The AEC was charged with the dual tasks of developing nuclear power and regulating its safety. In 1974, the Congress passed the Energy Reorganization Act to separate these conflicting roles by dividing the AEC into the Nuclear Regulatory Commission (NRC) and what is today the Department of Energy (DOE). The NRC is thus a second generation regulatory body. As I testified last year to the Senate,[3] the 2002 near-miss at the Davis-Besse nuclear plant in Ohio, which according to the NRC's own estimates came within a few months of disaster, is merely the latest evidence of the need for NRC reform. My Senate testimony documented the NRC's failure to address repetitive findings by the Government Accountability Office (GAO), the NRC's Office of the Inspector General (OIG), and its own staff. For example, the NRC's internal examination of its Davis-Besse regulatory breakdown tabulated lessons learned from the regulatory breakdowns at Indian Point (2000), Millstone (1997), and South Texas Project (1995) that remained unimplemented and contributed to yet another breakdown.[4] More than two years after determining that failure to implement past lessons learned contributed to the Davis-Besse regulatory breakdown, the NRC has still not implemented nearly 25 percent of the lessons learned the agency itself deemed "high priority."[5] In all too many respects, the NRC today is what NASA was prior to the *Columbia* disaster. The NRC's failure to resolve known problems mirrors NASA's failures to address o-ring problems prior to the *Challenger* disaster and foam debris problems prior to the *Columbia* disaster. A nuclear plant disaster would likely bring about the reforms needed at NRC – it is our hope that these overdue reforms can be obtained without that high price tag.

The NRC and its predecessor the AEC have licensed a total of 132 nuclear power reactors. Forty-four reactors have had to shut down for outages lasting at least one year in order to restore the minimum safety levels prescribed by federal regulations. The year-plus durations reflect how far safety levels were below acceptable levels and how much higher the costs of nuclear electricity generation were above what they should have been. An effective regulator would neither be blissfully unaware of safety problems so extensive that it takes a year to fix them nor be so passively tolerant as to watch safety problems deepen and broaden until a year is needed to fix them. By letting 44 reactors bury themselves into year-plus safety holes, the NRC has repeatedly demonstrated it is not an effective regulator.

Other compelling evidence of the need for reform at the NRC comes from surveys of its employees by the NRC's OIG. The latest survey reported:[6]

> *Slightly more than half (53%) of the employees feel that it is "safe to speak up in the NRC"*
>
> *In comparison with 1998 survey data, the only item that shows a significant decrease (-5 percentage points) in favorability is "I believe NRC's commitment to public safety is apparent in what we do on a day-to-day basis."*

Forty-seven (47) percent of NRC employees do not feel it is safe to speak up in the NRC! An effective regulator simply does not silence its own staff.

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[3] David Lochbaum, Nuclear Safety Engineer, "Testimony before the Senate Subcommittee on Clean Air, Climate Change and Nuclear Safety," May 20, 2004.

[4] Lessons Learned Task Force, U.S. Nuclear Regulatory Commission, "Degradation of the Davis-Besse Nuclear Power Station Reactor Pressure Vessel Head Lessons-Learned Report," Appendix F, "Summary of Related Issues Involving Previous NRC Lessons-Learned Reports," September 2002.

[5] U.S. Nuclear Regulatory Commission internal memo dated February 22, 2005, from J. E. Dyer, Director – Office of Nuclear Reactor Regulation, to Luis A. Reyes, Executive Director for Operations, "Semiannual Report – Status of Implementation of Davis-Besse Lessons Learned Task Force Report Recommendations."

[6] Office of the Inspector General, U.S. Nuclear Regulatory Commission, OIG-03-A-03, "2002 Survey of the NRC's Safety Culture and Climate," November 2002.

These facts should be troubling whether one loves or hates nuclear power, comes from a red state or blue state, sits on left or right side of the aisle, or has a pro-business or pro-safety outlook. Building a next generation reactor without first providing a next generation regulator is destined to produce lower safety levels and higher operating costs than is necessary.

> **Recommendation: Congress must provide the attention and resources necessary to reform the NRC into a consistently effective regulatory body with a good safety culture.**

NEXT GENERATION REACTORS

Dr. Edwin S. Lyman, Senior Scientist in the Global Security Program at UCS, has examined the various reactor designs under consideration for the next generation of nuclear power in the United States. My testimony summarizes his work and its results. Dr. Lyman observed that, until recently, development largely focused on "evolutionary" refinements of current reactor designs. The NRC certified three of the evolutionary designs: the General Electric Advanced Boiling Water Reactor (ABWR), and the Westinghouse System-80+ and AP-600 Pressurized Water Reactors (PWRs). A scaled-up version of the AP-600, the AP-1000, is under certification review, and five other evolutionary designs are under pre-certification review.

The ABWR and System-80+ designs are very similar to current plants. Although certified by the NRC, they have not led and are unlikely to lead to any new U.S. reactor orders – absent heavy subsidization – because of their high capital costs. The AP-600 was designed to significantly reduce capital costs "*by eliminating equipment which is subject to regulation.*"[7] It uses more dual-purpose equipment (e.g., systems that provide feedwater to the steam generators during both normal operation and accidents) and employ "passive safety" features, such as a reliance on gravity, rather than motor-driven pumps.

The AP-600 design has some safety benefits over current reactors, but these gains are largely offset by steps taken to reduce capital costs. Concrete and steel account for a significant portion of the capital costs of current reactors, so Westinghouse reduced the size, and thus robustness, of the containment and other safety-grade structures. Even so, the economics of nuclear plants with mid-range power ratings (e.g. the AP-600) were still too poor to attract customers. As a result, Westinghouse abandoned plans to market the AP-600 in favor of pursuing certification of a bigger version called the AP-1000. The AP-1000 nearly doubles the power output without a proportionate increase in construction cost. However, as a result, the AP-1000 has a ratio of containment volume to thermal power below that of most of current PWRs, increasing the risk of containment overpressure and failure in a severe accident.[8] The other evolutionary designs in pre-licensing review suffer from similar problems.

The pebble-bed modular reactor (PBMR) was another attempt to reduce capital costs through an "inherently safe" design. Proponents of this design, which was submitted by Exelon in 2000 for NRC pre-licensing review, argue that the reactor was so safe that it did not require a pressure-resisting containment, but only a less costly "confinement" building.[9] However, the technical basis for the untested PBMR design was not sufficiently complete to allow the NRC to assess the adequacy of the confinement when Exelon withdrew its application in 2002 and the PBMR pre-licensing proceeding was terminated.

There has been a renewed push in recent years from the DOE for research and development on advanced reactor systems under a program known as "Generation IV" or "Gen IV." The Gen IV program pursues development of five reactor systems. Two are "thermal" reactors – the Very High Temperature Reactor

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[7] Westinghouse Electric Company web site, www.AP-600.westinghouse.com.
[8] For the AP-1000, the ratio is 605 cu. ft/MWth, compared to 885 cu. ft/MWth for the AP-600, which is in the range of most operating PWRs.
[9] The U.S. nuclear industry and its regulator touted robust containment designs as the primary reason that a Chernobyl-styled nuclear disaster could not happen here. Chernobyl was equipped with a less costly "confinement" building.

(VHTR) and the Supercritical-Water-Cooled Reactor (SCWR). Three are plutonium-fueled fast-breeder reactors – the Gas-Cooled Fast Reactor (GFR), the Lead-Cooled Fast Reactor (LFR) and the Sodium-Cooled Fast Reactor (SFR). DOE's stated goals for the program are: "*Generation IV ... systems will provide sustainable energy generation ... will minimize and manage their nuclear waste ... will have a clear life-cycle cost advantage ... will excel in safety and reliability ... will increase the assurance that they are ... the least desirable route for diversion or theft of weapons-usable materials.*"[10]

Although one Gen IV objective is improved safety, there is little basis to assume that any of the five designs under study would actually be significantly safer than current-generation plants. All the designs use highly corrosive coolants under extreme conditions, and are predicated on the successful development of super-resistant structural materials.[11] This problem is compounded by the fact that some Gen IV designs are intended to utilize long-lived reactor cores in sealed "batteries," with operating cycles lasting from ten to thirty years. The lack of routine maintenance possible in such schemes, coupled with the uncertainties associated with exposure of new materials to extreme thermo-chemical regimes, creates the potential for severe problems.

> **Recommendation: Experiments with new and untested materials must be conducted in laboratory and prototype settings and not in commercial reactors operating near population centers.**

The safety problems with sodium-cooled fast-breeder reactors compared to light-water reactors are well known: a highly reactive coolant that burns if exposed to water or air; prompt positive feedback from coolant boiling that can lead to a far more energetic core disassembly; and a much greater inventory of plutonium and other highly radiotoxic actinides. Lead-bismuth coolant is less reactive and has a higher boiling point, but it is extremely corrosive and produces highly volatile radioisotopes when irradiated.

Most of the proposed Gen IV reactor systems rely on fuel reprocessing: the chemical separation of plutonium from spent fuel for recycling and reuse as fresh fuel. Reprocessing requires the processing, transport and storage of huge quantities of weapon-usable plutonium, and raises serious risks of nuclear proliferation and nuclear terrorism. In spite of this, through the Gen IV International Forum, the United States is enthusiastically trying to stimulate interest in reprocessing in countries ranging from Brazil to South Korea.

The purported benefits of reprocessing have never lived up to the claims of its promoters. Most countries have abandoned breeder reactor development because, compared to current-generation light-water reactors, the costs were considerably higher and the reliability considerably worse. UCS Board Member Dr. Richard Garwin has calculated that there is as much as a 2,000-year supply of uranium fuel for nuclear reactors that could be harvested from seawater less expensively than it can be recycled through breeder reactors.[12] There is little reason to expect that the Gen IV effort will achieve its goals.

> **Recommendation: Congress must ensure that next generation reactor designs satisfy, and not merely pursue, DOE's stated goals.**

Nuclear power's proponents have been many assuring claims about the safety of the next generation reactors. For example, some have argued that the next generation reactors are so safe that emergency sirens and other public protection measures can be eliminated. The shallowness of these claims is evident

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[10] US Nuclear Energy Research Advisory Committee (NERAC), *A Technology Roadmap for Generation IV Nuclear Energy Systems: Executive Summary*, March 2003, p.6.

[11] Material "surprises" have significantly increased nuclear power's costs and lowered its safety performance. For example, equipment degradation led to the premature closure – at high cost – of the Fort St. Vrain and Trojan nuclear plants.

[12] Richard L. Garwin, "Can the World Do Without Nuclear Power? Can the World Live With Nuclear Power?" Presenation at the Nuclear Control Institute, Washington, DC, April 9, 2001.

in the fact that the nuclear industry seeks extension of federal liability protection under the Price-Anderson Act, as amended, for new reactors. If the next generation of reactors were truly safe and reliable, their owners could acquire private liability insurance. That Price-Anderson is so aggressively sought for new reactors demonstrates beyond any reasonable doubt that the safety claims are more marketing panache than reality.

> **Recommendation: If the potential consequences of an accident at a next generation reactor are so catastrophic that federal liability protection under Price-Anderson is necessary for plant owners, then emergency sirens and other emergency preparedness measures are necessary for the people living near those plants.**

PREREQUISITES FOR THE NEXT GENERATION OF NUCLEAR POWER

If there is to be a next generation of nuclear power in the United States, the lessons learned from the existing and past generations of nuclear power must be addressed. Otherwise, safety levels will be lower and costs will be higher than is necessary. The top five lessons yet to be addressed for the next generation of nuclear power are:

- The federal government must license a repository for high-level nuclear waste before it licenses the next nuclear power reactor.
- Congress must provide the attention and resources necessary to reform the NRC into a consistently effective regulatory body with a good safety culture.
- Experiments with new and untested materials must be conducted in laboratory and prototype settings, not in commercial reactors operating near population centers.
- Congress must ensure that next generation reactor designs satisfy, and not merely pursue, DOE's stated goals.
- If the potential consequences of an accident at a next generation reactor are so catastrophic that federal liability protection under Price-Anderson is necessary for plant owners, then emergency sirens and other emergency preparedness measures are necessary for the people living near those plants.

These steps are prerequisites if the next generation of nuclear power is to have a safe and reliable role in American's energy future.

On behalf of more than sixty thousand members of the Union of Concerned Scientists, I thank the Subcommittee for examining this important subject and considering our perspectives.

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Mr. ISSA. Thank you very much. I want to thank all of the witnesses for going well beyond their prepared statements. That does us a lot of good and certainly makes the record more complete.

It is my custom to yield first to the ranking member. I am going to break with that tradition ever so slightly, because I saw Dr. Baldwin's head moving very much in agreement on the discussion of Price Anderson. I would like him to have an opportunity to speak on that, and then will certainly yield to the ranking member.

Mr. BALDWIN. I was certainly agreeing with the point that the disincentive for safety, the point we are making, provided by Price Anderson is important. We would agree that over a period of time these should be phased down. I think the first demonstration probably has to be covered. It is going to be in a Government installation anyway.

But the point is the one I was agreeing with, if we move into systems which are inherently safe, you don't need the protection that provides.

Mr. ISSA. Excellent. That helps clarify the issue for all of us. With that, I would recognize the gentlelady from California for her questions.

Ms. WATSON. Thank you, Mr. Chairman, for allowing me to raise some of the issues as I listened to the panel. Let me direct my first question to Dr. Rowntree. I would like you to talk very shortly about fossil fuel consumption and what are the most critical environmental impacts of nuclear waste. I am concerned about global change and weather change, global warming and so on. Would you kind of tie in what impact the nuclear waste might have on that effect?

Mr. ROWNTREE. May I ask for clarification? You asked about fossil fuel burning and climate change?

Ms. WATSON. Yes.

Mr. ROWNTREE. And also about nuclear?

Ms. WATSON. Yes.

Mr. ROWNTREE. My problem is, you asked for a brief discussion—[laughter]—with all due respect, you have two professors here.

Ms. WATSON. Why don't I talk about the origin of the galaxy? [Laughter.]

Let's just confine it then to the nuclear, fossil fuel versus nuclear power, and its impact on the environment.

Mr. ROWNTREE. Thank you. I left my cottage in Maine on a lake this morning where the loons are being infected by mercury. The mercury comes to us from the fossil fuel plants of the Midwest and the East. These loons are amazing birds. They came to their present morphology about 60 million years ago, about the time that dinosaurs were saying goodbye.

But I am afraid if we continue with fossil fuel use, we will not only be putting carbon dioxide and some methane into the atmosphere, which if you took high school physics, you would learn that when you change the chemical constituents of the atmosphere through which radiation penetrates, you are going to change the radiation balance. So I prefer not to talk not about global warming as much as about climate change, because the increased incidence of extreme events and things like that.

My taxi driver in from Dulles was from Bangladesh. If we drive our SUVs, we have to think about sea level rise and storms that flood those people out. If we are going to be citizens of the world, leaders of the world, this is part of our metric.

At the same time, the people who live in Maine around me, and I, were very, very happy to see the Maine Yankee nuclear power plant closed down. Maine Yankee was an old plant. It broke, it was too expensive to fix, it was then decommissioned at great cost. But we are happy to say goodbye to that.

So you see the dilemma. Current fission is, I couldn't say it better than Dave Lochbaum did about that curve, where we are now moving into a very precarious phase of nuclear fission. If I were king, I would bring Generation IV online, I would bring wind online, I would bring anything but the current, now outmoded, but certain used-car level of reactors, take them out of production and somehow get another system in place.

In terms of nuclear waste, I think you mentioned nuclear waste, I have a question about, as I said, whether you are going to store it onsite, all around the country, at 103 places, or if you are going to combine it in Yucca Mountain. I don't know the answer to that, but I am presuming that a lot of good and smart people put a lot of effort into deciding on, and then designing, Yucca Mountain. If we can overcome the transportation problem, which is no small problem, maybe we should subsidize the railroads so that they could be safer and have fewer derailments, and get that stuff to Yucca Mountain.

I am not the person to say which is the better way to go, but I think we have run down this road with Yucca Mountain, we ought to complete that task. I understand it has about 63,000 metric tons technical capacity, with the increase that Dr. Baldwin mentioned, how we are going to reduce that as we go to Generation IV.

But nuclear waste is obviously a big, big problem right now.

Ms. WATSON. As you know, with us, you always have the political overlay. We have discussed time and time again whether we ought to bury it in one location or leave it where it is and seal it. Of course, transporting it to Yucca, I think it goes across 34 different States. You are going to have a response from each one of those States.

See we have some serious problems. What I am probably really getting to, I think for the future, it looks like any kind of nuclear energy would be much better than the waste that we have to deal with at the current time. This is all in your province, in your domain, those of you sitting across the table. Dr. Baldwin, I see Dr. Rowntree pointing to you. Dr. Baldwin, you might want to respond.

We are just really having some difficult problems, both scientifically, geographically, geologically, and politically in trying to do away with the waste that we have now. I just want to know what you see. Maybe you would comment on this for the future.

Mr. BALDWIN. I certainly don't have an answer to the political problem.

Ms. WATSON. Tell us what you know.

Mr. BALDWIN. I understand. What we have tried to address is how to not have the problem we have today escalate several times over, which it could well do. To hold this in bounds, it came out in the earlier remarks, I have been in the fusion program most of my professional life. I believe that some day there will be the answer. I don't believe it will be in the very near future.

It will be on the order of 75 years before nuclear fusion power could have an impact on the energy economy. We may have demonstrations much earlier than that, I am not arguing that. But to really have an impact in the several tens of percent level, it is going to take a long time. So we need a bridge to that point. I very much believe that fission and fusion have to be looked at in combination, that the right kind of nuclear power, I believe Generation IV provides that, provides a bridge to fusion. Fusion is the ultimate solution to the spent fuel problem. But we have to look at it in the whole, we have to make use of other sources of energy, I agree with Dr. Rowntree very much, wherever they make sense.

But we have to stop looking at this energy problem through little straws. We look at it a piece at a time. We have to think much more strategically, over the time scale of the order of a century. That is not a political answer, I know, because political answers are short-term.

Ms. WATSON. Then that kind of is a nexus to a question I have for Mr. Johnson. That is that scientists are saying that Generation IV designs will be more effective in production and waste management. Where are these plants to be constructed and where would they be tested? What kind of input would you have on that?

Mr. JOHNSON. Thank you. One of the cornerstones of the Generation IV program is enhancements in safety, proliferation resistance and a reduction in the amount of waste generated from the operation of these facilities. But let me say that the Generation IV program is really in its infancy in terms of research and development on some of the more critical issues associated with fuel, associated with the materials necessary for the design of these facilities.

So not to belabor the point, but it is a bit early to be saying where we would expect these to be deployed for commercial operation. We do see that the technologies do have the potential for commercialization out into the future. One could expect that they would be deployed in a manner not unlike the commercial plants in operation today, that they would be deployed in localities where the generation, the electrical capacity is needed.

Ms. WATSON. This is a very sensitive comment on my part, because a couple of years ago, we were in Kwajalein. As you know, after we did the testing, nuclear testing, I think it was 1947, the Government set up a situation where the people in the surrounding islands could come together in, I guess it was called, it was a gathering where they would look at the results of their nuclear testing in subsequent generations. I think there was $150 million that was allocated for the people of the islands to come in and file for compensation as they are witnessing, generation after generation, the effects of the nuclear fallout.

When we flew over the various islands, we looked down and we could see this clear water and the beautiful white sands and the palm trees. We wondered why we were testing that area so close to land. We do know there was a shift in the winds at the time, and it did carry the fallout over. But location, and how we are going to evaluate that these particular processes will be effective and will work, that came to my mind, the situation at Kwajalein came to my mind because of the effect it has had on the land and the people. The 14 inches of topsoil was completely destroyed, they call it hot soil. So they can't grow anything on those islands, it completely destroyed islands, some of them disappeared under water.

So I think to test and to evaluate is a very crucial consideration that we must have, and I do hope that the thinking is going in where you would test and among whom you would test and all the matters and concerns that we might have affecting the populations in that area. So that's why I bring it up. I know that you are new, but I would like you to think about it.

With that, I will turn it back to you, Mr. Chairman.

Mr. ISSA. Thank you, Ms. Watson.

I am going to start where the Congresswoman finished off. I think it's fair to ask the question, we have done, the Chinese have done, the Russians, the Soviets, and other countries have done above-ground nuclear testing in which they have taken relatively significant amounts of enriched fuels and created an above-ground event of X magnitude with the accompanying fallout radiation, and so on.

It has always been a question, and I couldn't be luckier than to have this kind of a gathering of brain trust, when we look at the unknown, what if we had another Three Mile Island in which nobody died, but it was somehow different, or a Chernobyl in which we had a nuclear power plant that was nowhere close to the safety standards that the United States would accept, and people did die? What would be those releases, worst case, from a present generation facility here in the United States or around the world, relative to what we did to ourselves and the world with above-ground nuclear testing for more than a decade?

Mr. BALDWIN. I'll try to respond. There are several things to say here that have occurred to me in the last couple of comments. One, the word test means something different and is being used very differently. In the weapons test we were trying to design something that would blow up and do damage, and in fact it did.

Mr. ISSA. A lot of fallout, lot of heat, lot of radiation.

Mr. BALDWIN. Lots of fallout and so on. What Mr. Johnson is talking about is testing reactors. The test is supposed to, things happen differently, I agree. What you are worried about is, what happens if those tests fail and there is release. It is a quantitative question. First of all, for the individual design, you have to look at what is the credible kind of release. It is not literally just taking everything there and supposing it is thrown up into the air. You have to have some kind of idea of the mechanism, of how it would work.

That is a little bit what I was trying to address in saying that these high temperature gas cooled reactors are designing machines which literally cannot melt down. That is a very important difference.

But the quantitative question as you posed it is, how much would a failed test, that is, some kind of release, quantitatively compare to what we already did to ourselves. I can't answer that question at this point.

Mr. ISSA. I will take a liberty and say that I personally believe and would hope that we can quantify it going down the road, that we already know the worst case. Chernobyl is a worst case. The above-ground nuclear testing was certainly worst case, and the world did not turn upside down. Kwajalein, where there was a series of above-ground explosions, designed to see how much damage could be done, certainly is a worst case.

The strange thing that I find is that current generation nuclear reactors are virtually impossible to have happen what happened in Chernobyl, but even if it happened, and now I will pose the other question, what are we doing to the loons? What are we doing to our environment as we burn high volumes of fossil fuels, particularly current coal—not just here, but in Vietnam where they burn it just by taking high sulfur coal and just burning it? They make bricks there by throwing coal into a furnace and the black smoke puffs out.

What is the current damage versus, even if the worst case happened again, what is the trade-off? I would pose to each of you, aren't we better off even if the worst case happens, compared to what is happening every day out of the smokestacks around the world of high volumes of fossil fuels damaging our ecosystem?

Dr. Rowntree, we promised this was going to be controversial, didn't we?

Mr. ROWNTREE. I think you put it very well. I will comment on perhaps my perception embedded in public perception of the trade-off. Fossil fuel impacts on the one hand, fossil fuels in relation to nuclear are incremental, they are slow. Sea level rises very slowly, mercury up the food chain very slowly.

On the other hand, nuclear: we have this impression that it will be a Chernobyl, an event. This is probably mistaken in the terms of the kind of question that you are asking.

[Inaudible.]

Mr. ISSA. I was hoping for less bad. [Laughter.]

Mr. ROWNTREE. I'm a technology person. I would oppose any quick fixes.

Mr. ISSA. I appreciate that. Dr. Baldwin.

Mr. BALDWIN. I would like to make a comment. I thought this was where Dr. Rowntree was going, and it is a very important point, and it may lay behind your question. It has to do almost with human nature, psychology, what he called the fast event. Human nature is more concerned about a small number of deaths in a fast event than a large number of deaths over a very long period of time. I think that is where he was going.

We don't have answers to those questions. They are political, psychological and so on. But they are a little bit what we are wrestling with, that there is a certainty that we are doing damage to ourselves, to our people, to our environment following our present path.

We have a risk of following other paths that something might happen. We are trying very hard to minimize that risk, but they manifest in human psychology very, very differently.

Mr. ISSA. I appreciate that.

Moving to a subject closer to the administration, Mr. Johnson, in this year's budget, well, first of all, the President has been a champion for the hydrogen economy. Would that be fair to say?

Mr. JOHNSON. Yes.

As you heard here in testimony, and I think as we all know, there are two major ways to get hydrogen. One is to have another energy source, such as electricity, an abundance of electricity. Perhaps there is some way to get there besides nuclear. But for the most part, the vast majority uses the fossil fuel.

The other one, which is more efficient, is what we do when we crack petroleum, we tend to use natural gas, which fairly easily gives us hydrogen, but of course we are talking about a fuel that is primarily best for medicine, plastics, fertilizer, but it could be turned for one of the lowest costs into hydrogen. And that is what they do usually at oil refineries.

But from all that we have heard here today, the easiest, or let's say, the most efficient and least expensive way to get vast quantities of hydrogen will be Generation IV and beyond reactors, which have shown a tremendous ability to produce that hydrogen. I have to ask you, isn't there an inconsistency, in that the administration has offered zero for Next Generation in its budget?

How do we deal with that here in the Congress? The Senate has already put $40 million into Next Generation. In conference, I expect that most or all of that will be there. How do we see that mixed message, or is it a mixed message?

Mr. JOHNSON. Mr. Chairman, I would answer that saying, it may have the appearance of a mixed message, but it is not a mixed message. The administration's budget has seen over the last 5 years shows a steady increase in the funding request for our Generation IV nuclear energy systems initiative. It has also seen increases in funding requests for our hydrogen program.

The hydrogen program is being managed out of the Office of Energy Efficiency and Renewables. The Office of Nuclear Energy has a role in the program as well. It is actually operated as a very well-integrated program. We are working in the Office of Nuclear Energy consistent with the Department's hydrogen posture plan, and our funding requests and our activities, research activities, that we are conducting as part of our nuclear hydrogen program are consistent with the funding requests in the posture plan, consistent with the activities that we have committed to.

With respect to the Generation IV, again, over the last 5 years we have seen our funding for the Generation IV program increase by a factor of 10. I believe it was in 2002, funding for the program was about $4 million. Our funding request is part of the 2006 budget, I believe it was $45 million.

What you are possibly seeing as a lack of commitment on the part of the administration to moving forward with Generation IV is perhaps due to the absence of specific text in our budget request on the Next Generation Nuclear Plan. Based on conversations that we had with industry resulting from a request for expressions of interest that the Department issued late last spring, and also based on the results of an independent technology review that was conducted last year. Then upon further refinement of our R&D plans, as we were developing our fiscal year 2006 Congressional budget request, it was decided that we needed to increase our focus on the core research and development activities necessary to see these Generation IV technologies, whether the Very High Temperature Reactor or the Lead-Fast or the others, to address the critical issues associated with those particular reactor designs.

So what you see in the 2006 budget request reflects the fact that we have seen that there are several critical issues that need further development before committing to go forward with any kind of procurement action for design and construction services. So while our 2006 request lacks the words Next Generation Nuclear Plan, it does include funding for all the concepts, including the Very High Temperature Reactor, which could be coupled to a hydrogen production capability.

Mr. ISSA. OK. In the future, I will try to look in multiple line items in groups, and perhaps that is the best way to look at it. Thank you for clarifying that.

Dr. Baldwin, your CEO, I happen to know, is a pilot. I am also in a very, very limited way alleged to be a long-time holder of a pilot's license. Whether it is airplane design or it is automobile design, this bathtub safety curve that Mr. Lochbaum talked about clearly exists. But isn't it true, or isn't it fair to say that just when you went from the Wright Brothers planes to the aircraft of today, and you go from Henry Ford's cars to the automobiles of today, that it really is a series of those dips, but each one being at a lower level?

The worst that could happen with the newest car of the lowest, if you will, worst possible design today, isn't it a lot better than a car of just 20 or 30 years ago at its best? Aren't we in a sense, going to Generation IV, going to be going to dramatically safer products?

Mr. BALDWIN. That is just what I was trying to say, is that we are talking about different kinds of curves. That is also a learning curve, which is just what you are saying.

To assess the credible accident, you asked what is the worst possible case, you have to ask what could happen. That has to be assessed. So these more advanced designs have done a better and better job of eliminating the most destructive, of which Chernobyl was the worst example we know.

Another comment I will make, which is very much related to this, and it occurred to me during Mr. Lochbaum's talking about the NRC. In the early history of the light-water reactor development, the basic concept was laid down by the nuclear navy, as we know. There were a number of smaller demonstration reactors built.

But then it was basically turned over to industry. Industry did two things. It went off in different directions, there were multiple, different approaches to power. In a sense, every plant was designed as a boutique item, a specialty item.

Mr. ISSA. I understand that is in the United States. In France, they were organized.

Mr. BALDWIN. Yes, exactly. I am speaking of the United States. The second is, they scaled up very fast in size. So they scaled up, which increased the need for active systems and so on.

So the burden on NRC, I am not defending NRC or anything, I am trying to explain. The burden on NRC was complicated by the fact that there were many different types of designs, and that they had been increased in the size of plants for economic reasons, driven by the utility or commercial interests. Other countries did it differently, you are absolutely right, have different records, standardization earlier on. I believe if we had done that in this country, it would have been much more within the NRC's ability to handle it.

Mr. Lochbaum may want to comment.

Mr. ISSA. Actually, I am going to make it even one better. Ms. Watson would like to have another round of questioning. So perhaps you can combine those.

Ms. WATSON. I would like to direct my comments to Mr. Lochbaum, a concerned scientist. We have concerns in common. Then any of you can chime in.

But how do you think the NRC could be reformed in order to ensure that it effectively regulates the reactors and can promote the safety of the Generation IV reactors? Then how can these Generation IV designs be more efficient in production and waste management? Why should they be reevaluated and reconsidered? Maybe you could throw all that in together. Anyone who wants to respond, please just jump in.

Mr. LOCHBAUM. [inaudible.]

Ms. WATSON. Let me just raise this with the Chair. We have an oversight responsibility and I don't know how far we can follow this, Mr. Chairman. But I think our subcommittee, as long as you are the Chair, and he has prerogative, I would some way, Mr. Johnson, like to see those reports come in and we can kind of set a schedule for taking a look, not all of the detailed policy issues. But what are we doing to satisfy the public's concern? What are we doing in terms of safety measures? How are we addressing our environmental waste and so on?

So I would like to see an ongoing kind of oversight function on the new generation advancements and technologies and so on. If we can do that, I think we will really serve the interests of the general public. How do we sell nuclear powered energy to the public in general? When you say atomic or nuclear, it all of a sudden puts blinders up to so many people. I think the more we can, as Congress and as a subcommittee, get the word out to people that advancements are being made with protections and in terms of the fallout, in terms of the processing and so on, I think we would see a more massive acceptance of this type of energy, which we dearly need.

Mr. ISSA. And if I can suggest, with Mr. Johnson's cooperation, majority and minority staff would prepare a list of those areas in which there may already be briefings or materials. But if there wasn't, perhaps you could put something together. We will get it to you within a week or so. We are leaving for the 4th of July break. So I would say just after that.

Then if you could respond either with existing programs or literature, it would be very helpful and it would save us holding you for a long time with those questions. Based on that response, Ms. Watson and I would work together on seeing what we would like to have continue and then submit that back to you, if that is acceptable?

Mr. JOHNSON. Yes, sir, that sounds very good.

Mr. ISSA. Excellent. Dr. Baldwin.

Mr. BALDWIN. We in thinking about our candidate for NGNP are constantly reviewing and concerned with the safety questions as they come up. One vehicle that we have found, we have not done this in the safety, but I would like to, that is why I am suggesting it, we have done it in other areas, is bring in advisory groups from interest groups. I mentioned that we had utility advisory board of some 10 or so utilities who over the years have steered us and advised us on our thinking and from their perspective.

I am suggesting that if the NGNP really becomes a project, a viable project, that it would valuably have an advisory board made up of organizations like the Concerned Scientists, physics groups, utility representatives and so on, to advise how does this emerging Generation IV technology fit against the standards which the various stakeholders would bring to this technology.

Mr. ISSA. Dr. Baldwin, I think that is an excellent suggestion.

Mr. BALDWIN. Rather than trying to develop it in isolation then deal with it in hearings.

Mr. ISSA. I will take the liberty of suggesting that to the Senator from Idaho when we work together to renew the funding that I personally, not in indifference to the administration, but personally believe needs to be in the budget to move the demonstration project a little further, a little faster, if it becomes possible.

Ms. Johnson, as you know, we often authorize and/or appropriate funds and then at the end of the year it goes back into the President's discretionary slush fund of leftover money. So it is not all bad if we give you the money and for some reason we are mistaken and it can't be used. I know you hate the word slush fund. But the truth is that there are many of us here who believe that we need to make sure that demonstration funds are available for fiscal year 2006, should opportunities occur to move that program.

Ms. Watson, do you have additional questions?

Ms. WATSON. I just want to say, I thank you, all of the panel for coming and really educating us. As I have asked the chairman, I do hope that we will stay on top of this as it starts to develop, Mr. Johnson, and whichever way that we can be helpful in getting the word out, not only through those of us on the committee, but throughout Congress as to the development. Because these are issues that we are going to be faced with from now on. Energy and the environment, its impact on the environment, our ecosystem and so on, we need to plan for it, and we need to save this planet, Dr. Rowntree. Let's get the galaxy. [Laughter.]

So I thank you for coming and sharing with us. I will hope that we as a committee can stay on top of the information. Thank you very much.

Mr. ISSA. Thank you, Ms. Watson.

And I would like to thank the majority and minority staff who, as Ms. Watson and I know, made this all possible. I would like to thank our witnesses.

I will mention that we did have Mr. Kucinich come in and out, we actually had several calls from other Members. Every single subcommittee and the full Committee of Government Reform are meeting here today. We are a busy group, regardless of what the newspapers say about us. Because of the volume of information, the additional requests, and to be honest, our hope that the record be complete, we will hold the record open for 2 weeks from this date for additional submissions and inclusions.

Again, I would like to thank the witnesses for being here. With that, we conclude this hearing.

[Whereupon, at 4:05 p.m., the subcommittee was adjourned.]

[Additional information submitted for the hearing record follows:]

GENERAL ATOMICS

August 4, 2005

Congressman Darell Issa
Chairman
Subcommittee on Energy and Resources
Committee on Government Reform
2157 Rayburn Building
Washington, D.C. 20515-6143

Dear Chairman Issa:

During your Subcommittee's June 29, 2005 oversight hearing on the subject of the next generation of nuclear power, there was discussion of the necessity of Price-Anderson coverage for next generation nuclear power plants. More specifically, there was some discussion that Price-Anderson Act coverage may somehow serve as a disincentive for improving the safety of nuclear reactors.

Attached is a short paper that I hope can be included in the hearing record. The paper briefly reviews some of the aspects of Price-Anderson and demonstrates that contrary to some of the discussion at the hearing, Price-Anderson actually serves to enhance safety at nuclear power plants.

On another related issue raised during the hearing, high temperature gas-cooled reactors can legitimately be called "meltdown proof" and ultimately rely on basic principles of physics to ensure that there is no damaging release of radioactivity in the event of even the most serious accident. Even so, General Atomics believes that the financial markets and the public will insist on Price-Anderson coverage and that such coverage should be provided for all types of nuclear power plants now and in the foreseeable future.

Thank you for conducting this important hearing and for allowing General Atomics the opportunity to present testimony.

Sincerely,

Mark Haynes
Vice President, Energy Development

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The Price-Anderson Amendments Act Promotes Nuclear Safety

With regard to commercial nuclear power plant operators, the Price-Anderson Amendments Act of 1988 ("Price Anderson Amendments Act") provides the public with a no-fault insurance program that directs the liability for a nuclear incident to the nuclear power plant operator and requires this operator to waive legal defenses to liability, both substantive and procedural. The statutory purpose of the Price Anderson Amendments Act is to protect the public by ensuring the availability of funds to compensate the public for any injury or damage and to ensure the prompt dispersal of these funds to the public in the event of a nuclear incident. Because the Price Anderson Amendments Act increases the certainty that a nuclear power plant operator must quickly compensate the public in the event of a nuclear incident, the direct impact of the Price Anderson Amendments Act is to encourage attention to safety.

This incentive for safety is further enhanced because, the costs of the Price Anderson Amendments Act insurance program is born by the nuclear power plant operator. Each nuclear power plant operator must maintain $300 million of insurance. Therefore, the insurance companies that issue the primary insurance policies to nuclear power plant operators have an incentive to assist and support the nuclear power plant operator and the United States Nuclear Regulatory Commission ("NRC") in assuring the safety of the plants.

In addition, there is a layer of secondary insurance under the Price Anderson Amendments Act. In the event of a nuclear incident, each nuclear power plant operator in the United States is subject to payment of a retroactive premium of almost $100 million dollars for each reactor owned. Because the premium is assessed against all owners regardless of which plant has the nuclear incident, there is an incentive for mutual assurance of safety. For example, collectively, the commercial nuclear power plant operators fund the Institute of Nuclear Power Operators ("INPO"). At the expense of the nuclear power plant operators, INPO conducts peer assessments of plant operations and follows-up on corrective action by a nuclear power plant operators.

Furthermore, the Price Anderson Amendments Act only covers damage to the public. Exempt from Price Anderson Amendments Act coverage is damage to the property of the nuclear power plant operator; in other words, the plant itself is not covered. The nuclear power plant operator is separately required by the NRC to maintain sufficient property insurance to ensure adequate funds are available to stabilize the plant in the event of a major accident. However, the Price Anderson Amendments Act does not protect the plant owner from loss of its investment or loss of its profits. Therefore, the Price Anderson Amendments Act does not remove these traditional incentives on plant operators to maintain their assets intact and functioning.

Even though the Price Anderson Amendments Act provides direct safety benefits from ensuring financial protection of the public and indirect safety benefits from requiring all operators provide mutual financial protection, some voices have improperly urged that the extension of the Price Anderson Amendments Act to cover new plants is not necessary for investment in new plants. To support investment in new plants the commercial nuclear power industry needs to maintain a system that will assure the public that they will be protected. Arguably, the nuclear industry experience over the last fifty years would provide that assurance without extension of Price Anderson Amendments Act. Over a hundred commercial nuclear plants have operated safely in the United States for decades, showing the risks of catastrophic failure are small and manageable without the Price Anderson Amendments Act. For example, the largest catastrophe at a commercial nuclear plant in the United States is commonly considered the accident at Unit 2 of Three Mile Island ("TMI-2") in 1979. Despite the loss of over a $1 billion dollar investment after only a few months of operation, the owner of TMI-2 did not file for bankruptcy. Furthermore, liability from the accident was not handled under the Price Anderson Amendments Act.[1] The total amount paid to compensate members of the public as a result of the TMI-2 accident has been estimated to be less than $100 million, well within the liability insurance that is available to any major industrial plant. However, the public and the industry has faith in the system established by the Price Anderson Amendments Act. The industry is willing to pay for the insurance and the government is pleased to have the additional protection of the public provided by the Price Anderson Amendments Act.

[1] At the time, the liability limitation provisions did not apply to all nuclear incidents, only those more significant nuclear incidents that the NRC declares to be an Extraordinary Nuclear Occurrence ("ENO"). The TMI-2 Accident did not exceed the threshold for an ENO. The NRC did not declare the TMI-2 Accident an ENO; therefore public liability actions proceeded without the channeling, waiver of defenses, or liability limitations applicable to all nuclear incidents under the Price Anderson Amendments Act subsequent to the amendments of 1988.

Department of Energy
Washington, DC 20585

September 12, 2005

The Honorable Darrell Issa
Chairman
Subcommittee on Energy and Resources
Committee on Government Reform
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

On June 29, 2005, Robert Shane Johnson, Acting Director, Nuclear Energy, Science and Technology, testified regarding "The Next Generation of Nuclear Power".

Enclosed are the answers to three questions that you submitted to complete the hearing record.

If we can be of further assistance, please have your staff contact our Congressional Hearing Coordinator, Lillian Owen, at (202) 586-2031.

Sincerely,

Jill L. Sigal
Assistant Secretary
Congressional and Intergovernmental Affairs

Enclosures

QUESTION FROM CHAIRMAN ISSA

Next Generation Nuclear Plant

Q1: The Administration did not make a funding request for the Next Generation Nuclear Plant project in its FY 06 budget request. Is this indicative of an overall lack of support for moving forward with the NGNP?

A1: The Department's FY 2006 budget request provides $45 million for the Generation IV Nuclear Energy Systems Initiative. This represents a $5 million increase over the 2005 enacted level of funding and allows the Generation IV program to continue long-term, high reward research and development.

Based on discussions between the Department and industry resulting from a Request for Expressions of Interest that was issued in the spring of 2004, the results of an independent technology review conducted in 2004, and further refinement of our research and development plans, DOE recognizes that a significant amount of R&D remains to be conducted on all Generation IV reactors. Thus the Department decided, as we developed our FY 2006 Congressional budget request during the fall of 2004, to focus our full attention on the successful completion of these critical research activities prior to committing to proceed with any procurement action for design and construction services.

QUESTION FROM CHAIRMAN ISSA

Next Generation Nuclear Plant

Q2: Is the Next Generation Nuclear Plant project a critical element to move us toward meeting the President's stated goals for a hydrogen economy?

A2: That is unclear at this point. Applying Generation IV technologies as a heat source for efficient hydrogen production shows promise. Therefore, the Department's budget request for FY 2006 supports critical research and development of Generation IV reactor and nuclear hydrogen production technologies.

QUESTION FROM CHAIRMAN ISSA

Next Generation Nuclear Plant

Q3: What is the Department's schedule for ensuring that research is directed toward solving the current limitations identified by the agency during its recent solicitation of interest?

A3: In FY 2006, the Department will continue its research and development activities in the areas of high temperature fuels and materials. These research studies will be directed toward addressing the key technical uncertainties in our Generation IV research and development program. The results of these studies will pace future research and development activities in FY 2007 and FY 2008 and inform a future determination that the reactor and fuel technologies are sufficiently mature to allow initiation of design activities.