

ATOMS FOR PEACE + 50

Nuclear Energy & Science

for the 21st Century

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Panel Chairman:

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World Market for Nuclear Energy

CARD: Next we're going to internationalize the program here and hear from Chairman Bugat who has had a career in the nuclear industry, spanning all aspects that we're going to talk about today from weapons to propulsion to nuclear power. He currently heads the French agency that is most closely aligned to the responsibilities of the U.S. Secretary of Energy in that it covers the defense and civilian aspects and research and development for nuclear energy and power. I've found Chairman Bugat to be a very strategic thinker, and we're looking forward to hearing what the Chairman has to say. So, Chairman Bugat, thank you.

BUGAT: Ladies and gentlemen, I wish first to thank the organizers of this conference aiming at commemorating the 50th anniversary of President Eisenhower's famous declaration, "Atoms for Peace." It is my great pleasure to have the opportunity to speak today on the subject of world market for nuclear energy. In view of recent evolutions in the nuclear energy sector, it seems fair to recognize the visionary character of President Eisenhower's speech. Clearly it may still be considered as a guideline for the development of nuclear energy in the world.

Starting with a brief review of the current status of the world nuclear market, I will then examine the ...(inaudible) advantage of the nuclear option in responding to global challenges in terms of energy requirements, taking into account the geo-political constraints regarding economical growth and legitimate concerns of public opinions. This should allow me to try and convince you that after a rather stagnant phase of nuclear sector, the conditions are now met for its rebirth in the context of sustainable development, starting with the renewal of the existing power plants.

I wish also to underline that for the first time, we are observing the expansion of a lot of international R and D and ...(inaudible) the Generation Four program initiated by the United States associating now ten countries and, more recently, the European Union in a joint effort to

promote the shared vision of nuclear energy. Clearly such an initiative would not have been possible without the strong governmental leadership of a few member countries.

Even if the gross prospect of the early seventies has not been fulfilled, much has still been achieved in 50 years since President Eisenhower's declaration. There are now 441 reactors in 30 countries. It represents a 7% contribution to the world primary energy production in terms of the sole electricity sector, this is an average share at the world level with an extremely wide distribution ranging from a mere 1% for China to over 78% for France. But for ...(inaudible) like reactors around 30 units, the world nuclear effort(?) is essentially composed of light water reactors, two dominant technologies pressurized water reactors, 289 units, and boiling water reactors, 98 units.

It might also be worth mentioning the existence of a few operating fast neutron reactors in Russia, France, and Japan, this last technology has certainly not known the kind of development that was first envisaged. Still its interesting characteristics, regarding the optimized use of natural resources and its potential benefit in terms of ...(inaudible) management are becoming globally recognized. In my view, such reactors should definitely constitute an initial component of any long-term scenario.

Regarding safety issues, the international nuclear community has been successful in implementing new guidelines dealing with human factors and safety organization following lessons learned from past major accidents, Three Mile Island and Chernobyl. The worldwide market globalization including the trend of electricity deregulation is driving a major reorganization of the nuclear industry. For example, merger and acquisition in the U.S. have led to the consolidation of the nuclear sector with ten major utilities controlling close to three quarters of the nuclear power plants.

On the worldwide nuclear industry side, major integrated groups have appeared covering all activities from plant vendors to reactor fuel cycle services. Besides the BNFL Westinghouse conglomerate and the Ariva(?) Group, one can also mention several joint venture ...(inaudible) with Japanese companies, for example, General Electric's with Toshiba ...(inaudible), for the promotion of the ABWR reactor of Westinghouse Corporation and Mitsubishi industries for the licensing of the AP 1000.

As a rule, the nuclear industry has reached its maturity supported by accumulated operating experience of ten thousand reactors and continuously improving performance indicators in terms both of reliability and safety factors. This is most identified with U.S. ...(inaudible) owing to utilities ...(inaudible) combined with evolution of ...(inaudible) policy and regarding power plant oversight and the success of each plant lifetime extension ...(inaudible).

In this context it is also worth mentioning the French nuclear program. As you know, French have 68 nuclear reactors on 19 sites. This was achieved through an evolutionary approach starting from the first generation of 900 megawatt plants, 34 units, followed by a generation of one thousand 300-megawatt plants, 20 units and ending with the most recent N-4 type reactors, four units. The last reactor of this type, ...(inaudible) plant, having been commissioned in 1999.

This has been accompanied by a continuous improvement in nuclear safety and cost reduction based on the largely homogeneous fleet.

France also has adopted the global fuel cycle management based on the reprocessing of spent fuel. It allows to separate its reusable content, 96% from true nuclear waste, 4%. Among the waste the long-life nuclides are then vitrified 1% in waste volume for 90% of the total radioactivity. The recovered plutonium is partly recycled as ...(inaudible) fuel in the 900 megawatt ...(inaudible) following the policy of equality of flex, that means separate plutonium, ...(inaudible) recycle plutonium.

Last I would also like to point to extensive R and D programs and advanced partitioning and transportation of waste, mostly at the French Atomic Energy Commission. This program and there is a French nuclear waste law since 1991 aimed at improving the management of waste type, that is to further reduce their volume and long-term radio-toxicity with the key milestone in 2006.

I firmly, just a few words on the slide-- You have on the right ...(inaudible) processing and the time where you find again the initial radium toxicity, which you have used to build the fuel. Then the green is the without plutonium. ...(Inaudible) And efficient products and the blue one is without ...(inaudible). And so you come back to 300 years, roughly speaking.

I firmly believe that any strategy for significant development for nuclear energy may not occur without taking into account the legitimate concern of the public opinion dealing with the satisfaction of the energy demand with diverse primary sources, including renewable energies with the security of the energy supply, safety and security issues, especially after the September 11th dramatic events, the management of nuclear waste and the protection of the environment. Such ideas have motivated the organization of national debate this year in France to address all possible energy options for the future in view of the preparation of the global energy load.

International geo-political energy issues are also key parameters for such a possible restart of national nuclear programs. It is commonly accepted that a quarter of the world's population is, in fact, consuming three-quarters of the world's primary energy produced. Moreover, two billion people, a third of the current population do not have access to electricity. This is most significant in view of studies that have shown strong correlations between energy consumption per person and standard of living as measured by infant mortality or lifetime expectancy. Access to energy and economic growth translate indeed into a legitimate right to life.

Current estimates for worldwide population give a figure to ten to 12 billion people in 2100 in high growth scenario as compared with six billions today. This should lead to an increase of conception of ...(inaudible) energies going from currently nine billion of tons of oil equivalent to 20 or 40 billions of tons depending on the energy scenario. Moreover, large centralized production will be needed to satisfy the need of future mega-cities, most of which being located in the developing countries.

Last, if we look at current projection that do not rely on nuclear energy, the use of fossil energy will account for more than 80% of the total worldwide primary energy conception by 2010.

Needless to say that such a figure indicates extreme importance and urgency in dealing with global warming. This has now been considered for sometime by countries, which committed themselves with greenhouse gas emission reduction and the Kyoto Agreement. We understand that this is also a major concern of the President Bush initiative on the hydrogen economy.

Independently of the global warming issue, an extreme reliance on the fossil energy might strengthen the needed economic growth in view of both financial resources as a reasonable extraction(?) cost and over reliance on fossil fuels located in politically unstable regions. It is indeed such concerns on security of energy supplies that led France as early as the seventies to implement its nuclear policies. In this context I am convinced that it is now time for launching a vigorous expansion for nuclear energy as part of a global energy mix adapted to specific applications original requirements.

There has been over the first few years a number of initiatives to look at energy policy including nuclear energy policy in different international forums. In the U.S., the launching of the Nuclear Power 2010 in early 2002 are certainly to be viewed worldwide as a very positive signal in support of the building of the new power plants. Even more the statement of the U.S. National Energy Policy of 2001, regarding the possibility of ...(inaudible) the backend of the fuel cycle to facilitate the management of nuclear waste in the context of sustainability.

On the other side of the Atlantic, the European Commission has published a green book which reaffirms the need to continue relying on nuclear energy to limit greenhouse gas emission. Good news is also coming from Finland, which is now in the final stage of ordering a fifth nuclear power plant. Also very comforting, is a recent result of a referendum in Switzerland in 2003, where the nuclear option has been confirmed by a large majority, 66% of the votes. The case of Sweden is also interesting. There it has been decided in 1980 to phase out nuclear energy. The effective shut down of its power plants has been reconsidered and Swede public opinion seems now to be more favorable to a restart of a national nuclear program.

In Asia where much of the more recent plants have been built, Japan, China and South Korea have an important nuclear program. A number of countries already consider the renewal of their nuclear plants in developing their mid-term energy policies, whereas long-term prospects in 2030 and later is already envisaged in the framework of the already quoted Generation Four international R and D initiative. This program, aimed at developing nuclear systems, including ...(inaudible) reactor technologies and associate fuel cycle addressing the following criteria, sustainability, including waste management, better economics, ...(inaudible) process and proliferation resistance.

Clearly, in view of the need of emerging countries, they may be specifically interested in promoting ancillary services such as hydrogen(?) production(?) or sea water dissemination as well as insuring a proper level of proliferation resistant based both on technology features ...(inaudible) measures, and a strong international safeguard regime.

Coming back to mid-term policy, only reactors of the third generation will be available for industrial development as was concluded by an international interim working group. This is certainly the case in France where there is now a growing understanding for the need to renew

the power plants by 2015 to 2040 with Generation Three reactors and especially using, but not only, the European pressurized reactor technology.

The wish to rely on the feedback experience of the first operating unit before the launching of a large-scale deployment is urging the need for short-term decision to construct a first plant. I think that it could be the case in the next weeks. Thus, Generation Two and Three reactors will definitely co-exist in the forthcoming years before the natural transition toward the emergence of Generation Four plants.

However, market potential for this third generation reactors are certainly not limited to France or Europe or even USA. In fact, a number of countries are interested by the renewal of the life extension of their nuclear power fleet in the coming decades. In this timeframe, one can distinguish the possible different market opportunities for nuclear industry. Developed countries with advanced technological bases such as USA, Japan, South Korea or, in Europe, France and ...(inaudible).

Second, emerging countries with strong economic growth, typically China, which is planning for an important expansion in its nuclear power going from 1% of fixed electricity production to 4% by 2020. Brazil and Argentina could also be considered in this category. And last, eastern European countries--

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BUGAT: --Chernobyl nuclear power plant.

In conclusion, I would say that the conditions are now set for global rebirth of nuclear energy, a mature industry, a clear demand and the largest shared vision of the future. Let me just here reinforce the need to address the legitimate concerns of the public opinion, a concern that President Eisenhower might already have envisioned in the following quote from his historical declaration, "The atomic age has moved forward at such a pace that every citizen of the world should have some comprehension, at least in comparative terms of the extent of his development of the utmost significant to everyone of us." Thank you.

[applause]

Questions and Answers:

CARD: Thank you. Unless my watch is horribly off, we have a generous amount of time for questions, challenges, comments, whatever from the audience. I would just ask the commenter to please state their name and affiliation with the question. I think we have people with microphones so here we have a question and then back there, next, and then over here next and over there. Well, we're all over. We will go here and there and then we'll start over again.

COZARELLI(?): I'm Nick Cozarelli from UC Berkeley and my question is that we've heard several people talk about the hydrogen fuel cell but, obviously, the amount of energy you are going to get out of the hydrogen fuel cell is going to be less than the amount of energy you put in

to making that hydrogen and, given the fact of what we've been hearing about this morning, about how far off any kind of really substantial nuclear power is, the hydrogen fuel cell is more polluting than any other form, than just gasoline for running a car.

So I was wondering if anyone would like to respond to this negative aspect of the hydrogen fuel cell idea?

CARD: Does anyone on the panel want to take a shot at that?

MAGWOOD: Sure, I'll-- I think first I'll say that I don't entirely agree with your postulate. First, I think that hydrogen fuel cells, especially the advanced fuel cells that DOE is doing research on now, has a great potential for very high efficiencies and I think that if we're successful in having very efficient means of producing hydrogen, that the overall efficiency will be very good. I think we will be very competitive. What we're trying to accomplish is not necessarily to achieve an alternative to petroleum that is going to be cheaper than petroleum.

I mean the reason that we use petroleum is because is cheap. What we like to do is have a viable alternative to petroleum that is not vastly more expensive but yet has huge environmental and economic security benefits for the country. And discussing this in the context of a lot of the overseas meetings, I've been to, there are many countries that agree with that point of view. So I actually am an optimist on both the fuel cell development and also and possibly for having nuclear technology appear in the foreseeable future, in the next decade or two that will fuel those fuel cells especially.

CARD: Thank you Bill. I will attempt to weigh in just a bit on that. Right now, today I think well-to-wheels efficiency probably would favor a diesel or a diesel hybrid. But we really see an addition to the strategic diversity issues that Bill mentioned, which are vitally important, we're really shooting for breakthrough technologies. When you couple that with the possibility of fuel price increases and other inputs, we think the hydrogen system is an extremely important alternative.

Okay. I just wanted to make sure I had the right person.

NEFF: I don't know if I'm the right person. I think I am. I'm Tom Neff from MIT. I just had a question and a comment about renewables. Everybody there on the panel I think said something very kind about renewable resources and energy and nuclear but there is a link and not much has made of it. It is actually an old point. I wrote a book about it about 25 years ago. Most new energy technologies have payback times. They take two, three, five years even to generate as much energy as it took to make them.

So if you and to get from a low installed base for renewables to a large installed base, you need to expand a lot of traditional forms of energy in order to get that base installed. It takes aluminum. It takes-- Whether it's wind, wave, solar panels or whatever or hydrogen fuel cells. For example, if you want a gigawatt of solar next year, you've got to use about three gigawatts this year. I'm not sure why the point has not been made that, in order to have, say, expansion of

renewable resources over the next 50 years or 100 years, we actually need to build a lot more conventional capacity.

We have two choices, basically. Gas is saturated. We have nuclear and we have coal. And I think it's a great argument for nuclear. Nuclear power plants can generate the electricity that is largely used to make the facilities necessary for renewable for energy generation. And I think that might help disarm a certain amount. There is a certain dichotomy here between those who sort of favor the soft energy path, the renewable resource path as a simple, totally separate kind of path to go forward. But there is no such simple, separate path. They are linked.

CARD: Thank you Tom. Does anybody want to expand on that before we go on to the next question? [pause] Let's look over here. Burt, I think I saw your hand up and then we'll go there and over here and back.

RICHTER: I think all the technical people certainly agree that nuclear power is the way to go.

CARD: Burt, you want to tell us who you are?

RICHTER: I'm Burt Richter, physicist, Stanford. All the techies agree, nuclear power is wonderful and we should go that way. I have a question I want to direct toward Mr. Hintz and I want to start with three comments, first. The present nuclear power plants are gold mines because of the life extension programs, their capital costs are paid off and the utilities that own them are making a fortune. That's wonderful. (Laughter)

Second, fossil fuels get a huge subsidy in our system because they're not required to pay for the disposal of waste product, carbon dioxide. Because of that subsidy, fossil fuels and new power plants in fossil fuels are cheaper, generate cheaper electricity than nuclear, at least according to all the studies I've seen. Now, Mr. Hintz talked about building new nukes in the United States. The question is, is industry really going to do that without some incentives? What does the government have to do to strike the appropriate economic balance to make up for the subsidy that fossil fuel is getting?

HINTZ: Well, I don't know if I agree with you that we're making tons of money on the existing plants (laughter) but they are very profitable and that's primarily because the production cost is very low compared to other ways of generating power. But getting back to what it would take for say, Entergy to build a new nuclear plant, I guess it's been about two years ago, I made a presentation. And the title of the presentation was, "The Stars are Aligning" and the theme was that it does seem like everything is starting to come together that would allow us to go ahead and build new nuclear plants.

And the stars I was talking about was, I think the public opinion is continuing to get better. We're seeing plant operational performance not only being better but I think we have a lot of confidence that we can operate them consistently at high performance levels. And I'd say ten years ago we weren't sure of that because it always seemed like you could operate them well but then you would end up with a long-term shut down for some reason or another. The safety record has been extremely good.

We still see that operating costs are decreasing or at least stable and we're seeing most other fuels, the fuel costs are continuing to escalate. And so I mean it looks like everything is coming together that, why aren't utilities jumping at the chance to build a new nuclear plant? Probably the biggest reason I think is that the capital costs are still quite high. And I know the vendors have done a lot of work in trying to reduce the costs and trying to make the plants a little simpler and having more passive systems and things like that.

But the issue is, with the special things associated with nuclear, a lot of capital dollars, it takes a long time to build them and things like that, that the capital costs are still such that the other forms of generating electricity are more attractive. But it is getting close and I get a lot of questions now, when people see what happens to the price of gas. Well, surely, now, that's going to be the final thing that's going to tip it. And I think everybody's got a different view on natural gas and I'll give you Entergy's, which I'm sure is wrong. We've never been right on it in the past, but (laughter) we see natural gas is going to be very volatile. I mean you are going to see \$10 dollar gas and, we used to say, \$2 dollar gas. I don't think you are going to see that again, probably.

But you are going to see, we believe, fairly low-priced gas. You're going to have the volatility. So, when you are building a plant, like a nuclear plant, you've got to figure out, on average, what's the price of natural gas going to be? And we're not convinced on the average that it's going to be greater than \$5 dollars. And if you're somewhere between \$4 and \$5 dollars, these capital costs are still too much. But I think if we got any credit or much credit for the environmental advantages of nuclear, I think that would be enough to tip the table and I'd be surprised if you wouldn't see someone going ahead it.

Let me just say. I know I am taking much too much time. But let me just say one of the problems that you have with building a nuclear plant, besides large capital costs, we can't get debt on them. And maybe we can't today, but we built a gas-fired plant with 90% debt and we're building this nuclear plant with 100% equity. And it could be the greatest technology in the world and vendors can do a great job of getting costs down, but when you're building something with 100% equity, that does change the financial situation of that plant. I think we're close but we're not quite there yet.

CARD: Thank you Don. I think it was important to have that dialogue so that the audience understood that it is not a national policy issue -- why we are not seeing more nuclear plants. It's the financial structure and the thing the Don didn't delve into but I think is a big deal is that since we have liberalized the market and we're in favor of that and Europe is doing the same thing, when you apply corporate rate of return to that capital, it makes it very hard to recognize the long-term investment potential of a nuclear power plant.

Finland, TVO, the buyer of the Fin Five plant was using a 5% rate of return in their calculation, which is a third to a fifth of what Don would have to use for his company.

We have a question down here and then I'll take the next one from over here.

WAGNER: Henry Wagner, Johns Hopkins. I would like to ask the panel what role nuclear energy has in desalination. Fresh water availability is a major, major problem for the future. And sometimes I dream of seeing a nuclear submarine temporarily parked outside the island of Kauai(?) in Hawaii, making enough fresh water for next year and then moving on to another place and producing more fresh water. Could somebody comment on the role of nuclear energy in desalination?

CARD: Since you mentioned submarines, Alain or Skip, do you want to comment on that?

BOWMAN: I see a golden opportunity to use nuclear power in desalinization. I see less opportunity for using a nuclear submarine to do that. First of all, just very quickly, we need all the nuclear submarines that we can get and then some to do what's going on in the world today. It's not that outlandish a proposition, by the way. I've been approached several times in the seven years I've been in this job to back a submarine into the piers in New Hampshire and perhaps feed the energy grid there.

The truth of the matter is, if you look at the size of our reactors and you look at the devotion of the majority of that energy to propulsion power and not to electrical generating power, you will see that it is a non-starter from the standpoint of contributing measurably to any of our deficits. But nuclear energy as a means of desalinization, you're right, we do that onboard our nuclear powered aircraft carriers and submarines today and it certainly, with the advent of new systems, reverse osmosis systems for desalinization, I think it is another thing we should be thinking about.

We talk mostly about cracking water for hydrogen today as out-of-the-box ways to use nuclear power. But I think desalinization is certainly another one.

CARD: Alain.

BUGAT: Yes, I can add some more on the subject. We are studying 300- megawatt electric co-generation nuclear plant for electricity and desalination and it works. The Indian people are studying too. But roughly speaking, with the 300- megawatts you can use 250 for electricity and use 50 megawatts for desalination and with that 50 megawatts you can produce 200 thousand cubic meters by day. So that means that that kind of is able to furnish electricity and water for one million people, an area of one million people.

So it cannot be-- We are not plenty of that kind of population who need the water. That is tropical countries with networks and are able to transfer the electricity. And more of that, what is important, the cost of the kilowatt that is produced is two times the cost of one thousand megawatt plant, which means, how do you build the investment? How do you build the capital for the investment? It was a question on which every company is locked(?) now.

CARD: There is another example that comes to mind that is being mused about. I don't know if anything will happen, but Canada, and its oil sands in Alberta is looking to consume two billion cubic feet a day of natural gas to turn oil sands into oil and produce one to 200 million metric

tons a year of CO₂. So people wonder, would that be a good application. We will see what happens there. Is there a question? Yes.

DOWNEY: Good morning. Lieutenant Colonel Jim Downey. I'm currently a fellow at Harvard University. And I want to ask just a little off question. We've spoken about nuclear power and land and also the sea. I'm interested in the medium of space. NASA has a new program to develop a nuclear reactor based propulsion system for deep space. And what surprises me is so far, it has not received a lot of attention in perhaps the environmental concern arena, although it may in a couple of years.

But I wonder is how any of you might feel about that program and does it inform, help or hinder development of nuclear energy in general.

CARD: Well, Naval Reactors has actually been assigned that mission. So, Skip, do you want to take a first shot at it?

BOWMAN: Yes, Secretary Carter, the truth is we haven't been officially assigned it, but we anticipate that to happen.

CARD: So, no breaking news.

BOWMAN: I'm still developing some understandings. I believe it will forward the cause of nuclear energy. I suggest that your opening salvo may come true sooner than we want, that the environmentalists will notice and we will begin having to answer some questions about it. But the idea would be-- The first idea that NASA is working on is an orbiter unmanned for the icy moons of Jupiter and the JIMO project. It's funded. It has received funding for the past two years in NASA and, indeed, the possibility that Naval Reactors will be delivered another national mandate similar to the two that I discussed earlier, that Admiral Rickover received is very real and we're looking at that even as we speak.

But I think it would be a positive advancement if, obviously, the kinds of reactors that you know we use on our aircraft carriers and submarines are not exactly amenable to space travel, so we would have to branch out and think about other ways to do that and that would involve organizations across the country that have been working in other types of technologies over these years.

CARD: --Space nuclear. Bill, did you want to add anything to that?

MAGWOOD: Sure, I'll just add that I think that whenever you are able to use nuclear technology to take on an activity such as exploring space that the public gets excited about, I think it's something that has potential benefit all over for nuclear power. I often, in talking to school children about nuclear technology, point out the wonderful pictures we've gotten from the planets, from Jupiter, from Uranus and others-- And to be able to point to that and say, "We wouldn't be able to do that without nuclear technology," I think is a real advantage.

And the fact is that as we've worked with NASA over the years about what their future visions are for space exploration, it became extremely clear to them-- We had to sort of drag them into it but it became very clear to them that they couldn't accomplish their mission without nuclear technology. And someone mentioned earlier there needs to be an education process and that is part of the education process because there are things you can do with nuclear you can't do with other things, not just in space exploration power but also in medical treatment and other things and I getting that story out has to be very important.

CARD: We'll begin drifting back this way. Anything else from here? Yes, sir,

BRODSKY: Alan Brodsky again, ...(inaudible)RC and Georgetown University. But I'm speaking for myself. Not even my wife approves very much of what I say. (Laughter) I congratulate the nuclear energy industry and the great safety record and I wonder why they don't-- My question is, why don't they spend more advertising funds to educate the public properly. I've made my own miniscule efforts through professional society and have had very little success.

The President, as opposed to the conditions under which President Eisenhower was able to promote nuclear energy, has to face the possibility that he won't be re-elected because so much of the mis-information that some of the people I know have spread through the media to the public. I have some ideas about the proper kinds of information to be given by the public but have not been able to reach anybody in a leadership position who can present this information.

My question is to Mr. Hintz, why doesn't your Entergy spend more money on advertising the things that have been presented at this meeting?

CARD(?): Yeah, all that money you're making. (Laughter)

HINTZ: Angie(?) Howard is here from NEI and she continually begs for more money to do more advertising. I can't agree with you more that we have a tremendous education undertaking ahead of us and at times we have the discussion whether or not advertising is the best way to do it. It's very expensive but maybe we should do more of it and maybe it is an effective way to get out story out.

You know, I personally think at times we spend too much time educating the people that believe in our product and we're speaking to the choir. So I think we have to look at that more, other ways to educate the public including using more advertising. But, it is costly and when it's been recommended by NEI that the industry spend more money on it, we got sort of mixed support on how much we want to spend on the advertising.

CARD: Okay. I have one back here and then you and-- (simultaneous conversations) Let's take this question and we will come back--

(Unidentified Speaker)___: Great. So, I'm a physics professor at Michigan and like Bart Richter, I work at high energy accelerators. We're not producers of electricity; we're customers. But I'm going to talk about nuclear engineering. President Eisenhower's 1953 "Atoms for Peace" speech,

certainly helped to make nuclear engineering a very exciting field. Therefore it attracted some of the best and brightest young students. As I say, I sure am not a nuclear engineer but for a complex reason, I came to know and admire some of the ex-students about 20 years later in 1973, when there was some problem.

Some of them were ex-nuclear Navy guys, some of the really good ones. However, most of these guys are no longer bright young guys. If some new international crisis comes up, we may have a real shortage of capable people to build all the nuclear reactors that are going to be rapidly needed. And my general feeling was that the guys from the nuclear Navy were the very best.

Is there any plan for DOE or the nuclear power industry to start rapidly providing some scholarships in nuclear engineering for freshman engineers, some fellowships for graduate students in nuclear engineering and some post-doctoral fellowships to keep these young guys occupied so that you can start attracting people? I started talking to some of the kids in my physics class into going into nuclear engineering and I work at it and I got a few. But it's hard when there is not clearly any jobs downstream.

CARD: Burt, is your Nobel Prize inheritable?

BURT: Do you want to borrow it?

CARD: If we could pass that down, Bill, go ahead.

MAGWOOD: We're currently funding about 150 scholarships and fellowships for nuclear engineering students every year. That's not enough. I mean I would like to do twice as many but it's a start and it's a basis to build on. The point you make is absolutely correct. There is a real threat in the United States particularly, that the infrastructure that was built after Atoms for Peace-- It is not just the people. It is the research reactors. It's the program. They're all aging to the point where many schools are abandoning their programs.

We're making a bigger investment. When I first took over the Office of Nuclear Energy, we were spending about \$3 million dollars a year on nuclear engineering. We're now spending about \$20. So we've increased it. I would like to do more. I will do more. But the fact of the matter is there is a limit to how much the government can do unless Don here gets his industry, galvanizes it to build more plants because when we talk to students about the future prospects for nuclear, it's very clear that the people we're seeing are the people really excited by the science and technology.

But when they're thinking about their future careers, they like to know that there really are going to be new nuclear power plants being built in the United States. So I think there is always going to be a limit to what will be successful in accomplishing until there is really a revival of nuclear power in the United States.

CARD: And a follow-up question up here. Can we get the mic up here? I notice in Nobel land we have Mr. Letterman(?) here today also.

IRVINE: I'm Reed Irvine the founder of Accuracy in the Media and I want to say that like Alan Brodsky, I was rather amazed to come and have a panel like this where it has indicated that economic reasons were the reasons that we have not built nuclear plants in this country. And, of course, the ...(inaudible) experience, shows that it is fear that has stopped the building of nuclear plants, the misapprehensions that the public has.

And I give you an illustration of ...(inaudible) well they could advertise. But it isn't necessarily a matter of advertising. It's a matter of getting you message out and there are many ways that that can be done. I'll give you an illustration. A couple of years ago The New York Times ran an article in which they said that thousands of people had died as a result of the Chernobyl accident. How many of people here, I wonder believe that thousands of people died at Chernobyl?

(Unidentified Speaker)___: Not at Chernobyl but as a result.

IRVINE: As a result? Well, so it happened that ten years after the accident, there was a conference in Vienna where all the people that had studied the impact of Chernobyl on health met and it may surprise you to know that they agreed at that conference in Vienna that the number of people who died as a result of that accident was less than 50. You may find that incredible but I invite you to go look at the record, the report of that conference, which you can find on the Internet.

(Unidentified Speaker)___: ...(inaudible)

IRVINE: Yes, except they pointed out that there were a lot of lives lost as a result of the abortions because the mothers feared that the babies would be malformed or something like that. So, what you should do, Mr. Blitz is when you see something like that in The New York Times, you might have done what Accuracy in Media did and that is write them a letter and tell them they were wrong and lean on them to persuade them that they are on the wrong track in terrifying people. I'm sure that the people who were resisting putting that \$7 billion dollar plant at Shoreham(?) into operation, were not concerned about economics. They were not even concerned about their taxes or electrical bills. They were concerned about the danger that they perceived even though the industry has an outstanding record for safety.

CARD: We're just fortunate we don't have anything like Chernobyl here. So, rather than get into that issue, I want to go all the way over and then we will come back and sweep around this way. All the way in the back over there--

CONNOR: Hi, my name is Mike Connor and I'm the President of Nuclear Resources International. But along with Don Hintz, I think I'm one of the few utility people that's here at the conference. I manage the nuclear fuel for the Robert Emmett Ginna power plant outside Rochester, New York. And I just thought after listening to these papers that you might enjoy a small success story. Ginna is 500-megawatt Westinghouse PWR.

It started up in 1969. So we just voted region 33. We did it in 33 days and replaced the reactor head. The plant runs on an 18-month cycle and in the 12 months when it is running continuously,

it has 101% capacity factor. So it is possible, even with old plants, small plants, goodies to keep your heads up high in the nuclear industry and to look forward to more days.

I wanted to call your attention on page four of the program, the first bullet says, Three Mile Island and Chernobyl cast a very dark cloud over the nuclear industry. Now that we have greater historical perspective, how should we view these incidents? What have we learned from these events? It was just published two days ago that the other Three Mile Island Plant just hit a record of 680 days continuous operation before it shut down for its refueling outage. So, that's some perspective on Three Mile Island.

CARD: Any panelist want to comment on any of that? Skip?

BOWMAN: One other-- In the same vein as to the Accuracy in the Media report that we heard. Three Mile Island, of course, I said in my discussion, was a non-event from a radiation standpoint and I truly believe that. The number of the public that received the most radiation from that event was back calculated to have received 37 millirem, which we, in this audience know is not very much, about a little over a tenth of what she would have received in her home anyway, for that year.

Thirty-seven millirem is a little over a third of the allowable non-occupational exposure. The occupational worker who received the most did not exceed the occupational limits on Three Mile Island. So I couldn't agree more with the perspective that more needs to be done in educating the public. I would suggest that along with advertising, we need to, as a group, go ahead and go for the throat and speak to the concerned scientists who are legitimately concerned but need some information, need some education about some of the things that we know that they don't know. Indeed we do sing to much to the choir, preach too much to the choir.

We need to go, maybe to the concerned scientists and sit and walk through some of these facts and figures and we've been in operation long enough now that it might be time that we stop trying to prove the negative and put the onus of responsibility on the other side, bring forward the proof of the bad effects of this rather than challenging me to show that there is no bad effect, that we've been through two and a half generations of Navy nuclear power and there's nothing there; there's nothing to show.

So I think that there is a great deal that can be done in the way of public education outside of full page ads in The New York Times or things that would be, I think, hooted at by the people who hoot today. I think we should go to them and talk softly.

(Unidentified Speaker)__: I think there is one other threat that we haven't mentioned, a threat to the commercial nuclear industry. We talk about threats on public opinion and maybe not having the public educated and we talk about the economics of the new nuclear plant. But I think there is another big threat that industry is dealing with as we speak and that is the consequences of 9/11 and the impact on security on these nuclear plants. I mean we were the most secure major infrastructure in the United States prior to 9/11.

But as a result of 9/11, we are an industry that has been put in the spotlight and we spent a lot of money on security already and it's not over yet. I mean we just have to keep dealing with the bigger bomb and we get that done and we start on something else. And, you know, the industry, we're advocating that at some point in time, we would like to get thrown in with all the other critical infrastructure in this country. And if we were and you compared the threat associated with a nuclear plant compared to chemical plants or any other critical infrastructure, we look, actually, pretty good.

And yet we're spending lots of money and it's not over yet. And, you know, I think we've got to start putting our nuclear plants and the threat from terrorism in perspective with all the other critical infrastructure in this country. And if we can't, we will see that we are going to start seeing some of the small nuclear plants get shut down because of the cost associated with it.

CARD: We're technically needing to go to lunch, but I sense a real desire to respond to the Chernobyl comment so we're going to do that and then we're going to wrap it up.

GARWIN: I'm Dick Garwin again. In January of this year I published with George Charpak a book, Megawatts and Megatons: The Future of Nuclear Power and Nuclear Weapons and we did look at all of the accidents including the 1986 accident and the ten years afterward. And our judgment is that (a) a couple of people probably, unidentifiable, died from Three Mile Island. It's a very safe plant. We advocate the wide expansion of nuclear power.

But 24 thousand people, we anticipate, have died, will die from Chernobyl. It is just a tiny fraction of the population. It does not influence the positive views on the expansion of the nuclear industry but we provide the quotes from Abo(?) Gonzales, from the IAEA who never did the multiplication but says the 600 thousand seabirds, 60 million person rem, would correspond to that number of deaths and that's the cost of doing business. You kill many more people from air pollution from coal-fired plants.

But I agree with the Admiral that the way to go forward is to educate people not to propagandize and make the value judgment that with this technology, we can have great benefits for mankind. The key is, though, to get the capital cost down. We cannot build old plants and have them competitive. We need to bring in the new plants at those numbers.

CARD: Thank you. With regrets to the at least dozen people who are still waiting for a dialogue on this-- I'm thrilled with the interaction. We're going to go to lunch now. There were some logistical instructions. Do any of the hosts want to-- If it's about lunch we'll do it. Otherwise it will have to wait. Anybody want to offer any directions about what we do for lunch other than just go out the door and look for lunch. That's what we're going to do. Yes, Bob. Bob, do you have a mike?

END OF SESSION 2