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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

SUBCOMMITTEE ON ADVANCED REACTORS

Monday,

June 4, 20001

Rockville, Maryland

The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Auditorium, 11545 Rockville Pile, at 9:00 a.m., Thomas S. Kress, Chairman, presiding.

COMMITTEE MEMBERS:

THOMAS S. KRESS

GEORGE APOSTOLAKIS

MARIO V. BONACA

F. PETER FORD

GRAHAM M. LEITCH

DANA A. POWERS

WILLIAM J. SHACK

JOHN D. SIEBER

ROBERT E. UHRIG

GRAHAM B. WALLIS

B. JOHN GARRICK

A-G-E-N-D-A

INTRODUCTION

Tom Kress 4

KEYNOTE ADDRESS

Commissioner Nils J. Diaz 8

DOE PRESENTATIONS

Overview and Introduction to Generation IV Initiative

W. Magwood 29

Generation IV Goals and Roadmap Effort

R. Versluis 53

Near-Term Deployment Efforts

R. Miller 73

Generation IV Concepts

R. Versluis 80

Next Steps Generation III +/IV

S. Johnson 100

GENERATION IV DESIGN CONCEPTS

Pebble Bed Modular Reactor

W. Sproat, Exelon 116

J. Slabber, PBMR, Pty. 119

International Reactor Innovative and Secure

M. Carelli 171

General Atomic-Gas Turbine Modular

L. Parme 204

General Electric Advanced Liquid Metal

Reactor and ESBWR Designs

A. Rao 237

NRC PRESENTATIONS

NRC Response to 2/13/2001 SRM on

Evaluation of NRC Licensing Infrastructure . . 260

M. Gamberoni, T. Kenyon,

E. Benner, A. Rae

Planned RES Activities

J. Flack, S. Rubin 279

PANEL DISCUSSION ON INDUSTRY AND NRC LICENSING

INFRASTRUCTURE NEEDED FOR GENERATION IV

REACTORS 310

CLOSING REMARKS AND RECESS 339

1 P-R-O-C-E-E-D-I-N-G-S

2 9:02 a.m.

3 DR. KRESS: I don't have a gavel to
4 convene this meeting, but I'll pretend I have, so the
5 meeting will now please come to order.
6 This is the first day of the meeting of
7 the ACRS Subcommittee on Advance Reactors.
8 I'm Thomas Kress, the Chairman of this
9 Subcommittee.
10 Subcommittee members in attendance are
11 ACRS Chairman George Apostolakis, Mario V. Bonaca,
12 Graham Leitch, Dana Powers, William Shack, Jack
13 Sieber, Robert Uhrig and Graham Wallis.
14 Also attending is ACNW Chairman John
15 Garrick.
16 The purpose of this meeting is to discuss
17 matters related to regulatory challenges for future
18 nuclear power plants. The Subcommittee will gather
19 information, analyze relevant issues and facts and
20 formulate proposed positions and actions, as
21 appropriate, for deliberation by the full committee.
22 Michael T. Markley is the cognizant ACRS
23 staff engineer for this meeting.
24 The rules for participating in today's
25 meeting have been announced as part of the notice to

1 this meeting, previously published in the Federal
2 Register on May 10, 2001.
3 A transcript of the meeting is being kept
4 and will be made available as stated in the Federal
5 Register notice.
6 We have received no written comments or
7 requests for time to make oral statements from members
8 of the public regarding today's meeting.
9 So that we can effectively manage the time
10 and allow for a maximum member, presenter and public
11 participation in sharing, the Subcommittee has set
12 down some rules of engagement, I guess we can call it,
13 or the following protocols. Please pay attention to
14 these.
15 Number one, the presenters should be
16 allowed to make their presentations without
17 substantial interruptions. Questions from the
18 audience and stakeholders will be entertained at the
19 end of presentation sessions, not the individual
20 presentation. So keep your questions in mind, you may
21 even want to write them down.
22 Members of the public and audience should
23 use question cards that we have supposedly provided to
24 you. The ACRS staff facilitator Mike Markley will
25 collect these and group them as practical and read

1 them into the record, and refer questions and comment
2 to questions to presenters and/or panel participants
3 as appropriate.
4 It may not be possible to respond to all
5 questions and comments, however all questions and
6 comments will be listed in the meeting proceedings
7 following the workshop.
8 Opportunities for direct audience
9 participation will be provided during panel discussion
10 sessions each day. Microphones have been arranged for
11 convenience of the audience during this meeting. So
12 it is requested that speakers identify themselves and
13 speak up with sufficient clarity and volume so they
14 can be readily heard.
15 I would like to remind speakers and the
16 audience that we set down some things that we want the
17 audience and the speakers and the presenters to
18 address. And I'd like to repeat what these are so
19 that we can focus correctly in this meeting.
20 One, we want to describe the design and
21 key safety features and status of the development of
22 the design for the various concepts.
23 We want to provide the planned license
24 application and deployment schedules, if available.
25 We want to identify licensing challenges

1 and opportunities as compared to Gen II reactors. I
2 think that's the major thing we want to get out of
3 this meeting, is to identify the licensing challenges.
4 We want to discuss planned approach to
5 licensing, construction and operation as compared to
6 that currently used for Gen II reactors.
7 And this is another important element,
8 what changes are needed in the current NRC and
9 industry licensing infrastructure? Do the schedules
10 adequately support the planned Gen IV license
11 applications and employments. That's the licensing
12 schedule.
13 And a general comment, what if any
14 additional initiatives are needed.
15 So, with that as a statement of what we're
16 after here, I'll turn to the microphone over to our
17 Chairman Dr. Apostolakis.
18 DR. APOSTOLAKIS: I'm very pleased to
19 introduce our keynote speaker for this workshop,
20 Commission Nils Diaz. Dr. Diaz was serving as a
21 Commissioner of the U.S. Nuclear Regulatory Commission
22 in August 1996. Prior to that time Dr. Diaz had a
23 distinguished career in nuclear and radiological
24 engineering as a scientist, engineer, researcher,
25 consultant and entrepreneur.

1 In the research and development arena,
2 Commissioner Diaz worked for mundane light water
3 reactor safety and advanced designs to more complex
4 space power and propulsion systems and on the
5 conceptual design and testing of futurist reactors
6 like the UF-6, UF-4 and uranium metal fueled reactors
7 for the Strategic Defense Initiative.
8 Commissioner Diaz?
9 COMMISSIONER DIAZ: Thank you. I think I'm
10 going to stand.
11 Well, good morning. That last part of the
12 introduction was just to kind of let you know that,
13 you know, although some of these new reactors might
14 sound advanced, there were other monsters around that
15 were a little more difficult to work with.
16 I am reminded of the time that we actually
17 work with a reactor in which we only had to have it
18 working for minutes. How is that we only had to have
19 that reactor on and for three minutes? So somebody
20 finally said let's make things simple. Let's make
21 things very simple. Let's do away with everything
22 else. We just take uranium metal and start inject
23 into this reactor, it will be vaporized and we'll have
24 a uranium vapor reactor which will run and the core
25 was perfectly fine. It would run, very well for three

1 or four minutes. There was no problem. Looked over
2 all the core calculations, and looked at everything
3 else and everything was fine. It will actually
4 probably run.
5 There was minor detail, one of these
6 practical little details. It was the nozzle to inject
7 the reactor fuel, which of course the reactor was
8 liquid at the time. And no matter where we put it, it
9 will have a density of about, oh say, neutral blocks
10 of 10 to the 18 neutrals per square centimeters per
11 second, which power density will vilify the nozzle,
12 the fuel before it gets to the reactor.
13 So, those were the problems, and those
14 real problems.
15 I'm very really very, very pleased to be
16 talking with you today. This is an issue that, of
17 course, is very important to the country and it is
18 particularly appropriate that the Advisory Committee
19 on Reactor Safeguards is hosting this meeting at this
20 time.
21 The discussion on nuclear power has now
22 fully entered the national debate on the future of
23 America's energy supply and nuclear safety is going to
24 be a priority on everybody's agenda. The Commission
25 relies on ACRS for expert advice, safety of reactors

1 existing or submitted for licensing. The
2 recommendations of the Committee will be of particular
3 value to the Commission as we deliberate the
4 licensing.
5 I will be presenting my individual views
6 today. They do not necessarily represent the views of
7 my fellow Commissioners or the Agency.
8 I want to premise my remarks from a few
9 selected quotes from a "couple" of speeches during my
10 tenure as a Commissioner, just to set the tone from
11 where I'm really going to.
12 So let me start with a quote that I
13 believe is of extreme value.
14 ♦ "There is no credible regulator without a
15 credible industry. And there is no
16 credible industry without a credible
17 regulator."
18 ♦ "It is essential for the regulator to be
19 cognizant of the technology. It is
20 essential for the industry and
21 technologists to be cognizant of the
22 regulations."
23 ♦ "Regulations need to result in a benefit
24 or they will result in a loss." There is
25 no reason to be any regulations unless

1 they will benefit society.

2 ♦ "My goal is to ensure the paths are

3 clearly marked." That has been really

4 kind of what I've tried to do during my

5 years. "A path that is clear of

6 obstacles and unnecessary impediments,

7 with well defined processes, will provide

8 regulatory predictability, equity and

9 fairness."

10 ♦ Again, another one: "We are learning how

11 to define adequate protection in more

12 precise terms, and to define it in terms

13 that make sense to the American people."

14 ♦ And finally, "We have learned from our

15 mistakes and we are bound not to repeat

16 them." This last point, I hope that you

17 prove me right.

18 At the 2001 United States NRC Regulatory

19 Information Conference, I said "We might be asked, as

20 would other government agencies and the private

21 sector, to sharpen our skills, and improve our

22 efficiency to meet the needs of the country." We have

23 been asked. It is worthwhile to try to understand why

24 the President and the Vice President of the United

25 States have brought nuclear power generation center-

1 stage in the debate of the energy policy of our
2 country.
3 Shown in the next figure it's a
4 compilation of important aspects of the debate,
5 summarizing what has changed in 20 years. All of
6 these issues are known to you, both economically from
7 the regulatory side. Everything that had to do with
8 productivity, all of those things have actually
9 changed. A few things have remained the same. For
10 example, it is important to national security that we
11 have a stable generating base that will anchor the
12 electrical generation in this country. But many of
13 the other things have changed as the bottom line
14 changed from low predictability to good
15 predictability. It is our job to change it from good
16 to high.
17 The NRC has been changing to meet the
18 challenge of what must be changed and to strengthen
19 what must be conserved. I submit to you that we have
20 changed for the better, especially the last three
21 years, and that improvements in regulatory
22 effectiveness and efficiency are changing from goals
23 into reality. But it has not been easy, as many of
24 you know, and there are still lessons to be learned.
25 I must say, though, that there is one

1 change that I believe speaks louder than words for the
2 NRC staff and the agency as a whole: Priority is now
3 placed on what should be done better rather than on
4 what was done wrong. And this is a major cultural
5 change.
6 This cultural change is needed to enable
7 the consideration of newer, better and enduring ways
8 to exercise the mandate entrusted to the NRC by the
9 people of this country: To license and regulate the
10 peaceful uses of nuclear energy, with adequate
11 assurance of public health and safety.
12 I believe that we are now capable of
13 meeting the regulatory challenges that we face today
14 regarding advanced nuclear plants. The improve
15 industry performance over the past decade has enabled
16 the NRC to initiate and implement reforms that are
17 progressively more safety-focused. Furthermore, it
18 allowed the industry to concentrate resources on the
19 issues important to safety which provided a sharper
20 focus to regulatory improvements. Safety and overall
21 performance, including productivity, became supporters
22 of each other, with the clear and unmistakable proviso
23 that safety is first.
24 For existing nuclear power plants, the
25 list of profound regulatory changes and

1 accomplishments, many done under the mantle of the so-
2 called risk-informed regulation, would occupy the rest
3 of this meeting. Skip them. But five of them stand
4 out: The revised rules on changes, tests, and
5 experiments, the § 50.59, the new risk-informed
6 maintenance rule; the revised reactor oversight
7 process; new guidance on the use of PRA in risk-
8 informed decision-making (Regulatory Guide 1.174); and
9 the revised license renewal process.
10 The list is growing. About two weeks ago,
11 the Commission approved COMNJD-01-0001 instructing the
12 staff to give priority to power uprates, bring it up
13 the priority list, make it a real purpose of the
14 Agency and allocate appropriate resources, streamline
15 the NRC power uprate review process to ensure that it
16 is conducted in the most effective and efficient
17 manner. All of these and most of the other regulatory
18 improvements conform to the Commission's decision to
19 focus attention on real safety. The resulting
20 improvements in rules, regulations and processes,
21 including changes to the hearing process and enhanced
22 stakeholders participation, are assuring the nation
23 that a fair, equitable and safety-driven process is
24 being used.
25 I mentioned risk-informed regulation, and

1 I can see Chairman Apostolakis a little more lively in
2 here, as an important component of the changes NRC
3 regulatory structure. And I firmly believe it is an
4 important point. I want to be sure you know what I
5 mean, what I personally mean when I use the term risk-
6 informed regulation, so I'm going to present you with
7 my own personal definition of it:
8 Risk-informed regulation is an integral,
9 increasingly quantitative approach to
10 regulatory decision-making that
11 incorporates deterministic, experiential
12 and probablistic components to focus on
13 issues important to safety, which avoids
14 unnecessary burden to society.
15 And I think you know most of these things.
16 I really want to focus on why I am extremely attracted
17 to risk-informed regulation, and it's the last
18 sentence, which avoids unnecessary burden to society.
19 And I firmly believe that that is the test.
20 The definition can also be used for risk-
21 informed operations, risk-informed maintenance, risk-
22 informed engineering, risk-informed design, whatever
23 you want to.
24 For new license applications, much
25 groundwork has been done, and a lot of it is useful to

1 address today's issues. Going back in history in the
2 statement of considerations for 10 CFR Part 52, the
3 Commission stated that the intent of the regulation
4 was to achieve the early resolution of licensing
5 issues and enhance the safety and reliability of
6 nuclear power plants. Nothing wrong with that.
7 The Commission then sought nuclear power
8 plant standardization and the enhanced safety and
9 licensing reform which a standardization could make
10 possible. In addition, 10 CFR Part 52 process
11 provides for the early resolution of safety and
12 environmental issues in licensing proceedings.
13 The statement of considerations for 10 CFR
14 Part 52 goes on to say, and it's a very interesting
15 statement "The Commission is not out to secure,
16 single-handedly, the viability of the [nuclear]
17 industry or to shut the general public out." In
18 essence, it's continuing to quote "The future of
19 nuclear power depends not only on the licensing
20 process but also on economic trends and events, the
21 safety and reliability of the plants, political
22 fortunes, and much else. The Commission's intent with
23 this rulemaking is to have a sensible and a stable
24 procedural framework in place for the consideration of
25 future designs, and to make it possible to resolve

1 safety and environmental issues before plants are
2 built, rather than after."
3 In February of this year, the Commission
4 directed the staff in COMJSM-00-0003 to assess its
5 technical, licensing, and inspection capabilities and
6 identify enhancements, if any, that would be necessary
7 to ensure that the agency can effectively carry out
8 its responsibilities associated with an early site
9 permit application, a license application and the
10 construction of a new power plant.
11 In addition, the Commission directed the
12 staff to critically assess the regulatory
13 infrastructure supporting both 10 CFR Parts 50 and 52
14 with particular emphasis on early identification of
15 regulatory issues and potential process improvements.
16 The focus of these efforts is to ensure that the NRC
17 is ready for potential applications for early site
18 permits and new nuclear power plants.
19 I repeat, the purpose of these efforts is
20 to ensure that the NRC is ready for potential
21 applications for early site permits to certify designs
22 or designs to be certified, and that the NRC does not
23 become an impediment should society decide that
24 additional nuclear plants are needed to meet the
25 energy demands of the country.

1 In this case, let me assure you that the
2 Commission I'm sure will be interested on necessary
3 safety-focused regulations, definitely yes.
4 Unnecessary, not safety-focused regulations, no. The
5 staff is working hard to carry out this direction and
6 I am sure you will hear about some of our efforts over
7 the next two days.
8 Risking being repetitive, I'm going to re-
9 start at the beginning, and I know that I sound
10 strange, but it's really at the very beginning.
11 The U.S. Nuclear Regulatory Commission has
12 a three-pronged mandate:
13 ♦ Protect the common defense and security.
14 ♦ To protect public health and safety, and
15 ♦ To protect the environment.
16 by the licensing and regulation of peaceful uses of
17 atomic energy. I have long advocated that an adequate
18 and reliable energy supply is an important component
19 of our national security. An important component of
20 our national security. And I firmly believe that this
21 three-prong approach is going to endure the test of
22 time because it is good, and because it is balanced.
23 Within that mandate, within that three-
24 prong mandate I am an advocate of change, functioning
25 under the rule of law. As we face the regulatory

1 challenges that are sure to be posed by the
2 certification and licensing of new designs, a series
3 of all too familiar requirements will have to be met,
4 regardless of the licensing path chosen. And this,
5 you know them well:
6 ♦ Public involvement
7 ♦ Safety reviews
8 ♦ Independent ACRS review
9 ♦ Environmental review
10 ♦ Public hearings
11 ♦ NRC oversight
12 I am convinced, and I have white hairs to
13 prove it, by practical experience that the present
14 pathway for potential licensing success of certified
15 or certifiable new reactor applications is Part 52,
16 and I will tell you why.
17 First, it exists; and this is not the
18 minor issue the fact that it's here and available, and
19 is in the books.
20 Second, it contains the requirements for
21 assurance of safety and the processes for their
22 implementation.
23 And lastly, it can be upgraded to meet
24 technological advances that require new licensing
25 paths, without compromising safety.

1 Windows of opportunity can be opened, yet
2 the price is always the same: Reasonable assurance of
3 public health and safety. A new technology, with
4 different design basis phenomenology. In other words,
5 things like single phase coolant that we are talking
6 about, could present the need for a different pathway.
7 Yet, it would have to face the same requirements
8 listed above. What could be different is the manner
9 in which some of these requirements are addressed.
10 There is definitely room for innovation and
11 improvement, within the safety envelope that has to be
12 provided for assurance of public health and safety.
13 I am also convinced that the NRC and all
14 stakeholders need to apply a common criteria to the
15 tasks at hand. Every success path, whatever direction
16 you're coming, however you define success should
17 follow this simple criteria: Every path, every step
18 has to be disciplined, meaningful and scrutable.
19 Allow me to consider widely different
20 roles.
21 The NRC has the statutory responsibility
22 for conducting licensing and regulation in a
23 predictable, fair, equitable and efficient manner to
24 ensure safety. Every step of these processes of the
25 licensing and the oversight has to be disciplined, has

1 to be meaningful and has to be scrutable.

2 Applicants need to satisfy the technical,
3 financial, and marketplace requirements, and meet the
4 NRC and other regulatory requirements. Every step
5 that is taken has to be disciplined, meaningful and
6 scrutable.

7 I have no doubt that there will be
8 objections and opposition and the law of the land will
9 respect them and give them full consideration. The
10 objections will have to be disciplined, meaningful and
11 scrutable.

12 These common criteria are necessary, but
13 they are not sufficient as you all know.It is
14 indispensable that what we have learned, and it is
15 much what we have learned, be incorporated into the
16 science, engineering and technology supporting any new
17 reactors; they have to be as good as the state-of-the-
18 art permits.

19 Let me take a chance and depart from my
20 statement. There is no doubt that we're all creative,
21 we're all innovative, we like to do things better.
22 But this is the time that will not take too many
23 errors. This is the time in which we need to be
24 patient and we need to exercise what we know in a
25 disciplined manner to make sure that errors are

1 avoided. Okay?

2 Things that we do will have to be upscale.
3 And everything applicants do will have to be on
4 budget. Anything else is not good enough.

5 Whatever we do with the technology, we
6 have to match it with the regulatory processes. They
7 have to be as good as the state-of-the-art permits.
8 I happen to believe that risk-information can be a
9 contributor to disciplined, meaningful and scrutable
10 processes and to the underlying science and
11 technology.

12 Someone once wrote a phrase framing how to
13 achieve high performance expectations, which is where
14 we are right now, and it may be appropriate then to
15 just pause a moment and think that a lot of us need to
16 promise to think only the best, to work only for the
17 best, and to expect only the best.

18 Thank you very much.

19 DR. KRESS: At this time I think we are
20 collecting some written questions. Is that true,
21 Mike?

22 MR. MARKLEY: We're working on it, Dr.
23 Kress. At this time we don't have any.

24 I think we could entertain oral questions
25 from the audience at this time while collecting these

1 written ones. They don't have to be written. So, if
2 anyone has a burning question they'd like to ask
3 Commissioner Diaz, please feel free to do so. Use
4 this microphone or this one over here, please.
5 Please identify yourself.
6 MR. QUINN: Commissioner Diaz, it's Ted
7 Quinn.
8 The question I have that the combined
9 operating license part of Part 52 is unproven. We
10 haven't run through that yet, as well as early plant
11 siting. Can you define how the Commission can help
12 the staff to provide, to make this a more stable
13 process as we go through it so that the financial
14 community will help us to get these through?
15 COMMISSIONER DIAZ: It's a very good
16 point. We have it, it's there. We've been looking at
17 it for some time, but it's not been tested. The issue
18 is how do we make sure that it works the way it should
19 be, effectively and efficiently.
20 I think we learned a lot at the license
21 renewal process. And I believe that what I have
22 learned the last few years is that Commission
23 involvement is very, very, very, very necessary in
24 this step. That we cannot let a lot of these things
25 go a lot of the time to perfection.

1 I will use one of the first phrases I used
2 in a meeting down there that the enemy of the good is
3 the better and the enemy of the better is the best.
4 And, therefore, we are going to have to be in very
5 close contact with the staff. And I believe the
6 Commission will actually take an important role in
7 making sure that the processes are timely.
8 In this respect what we have done is many
9 other things the last 3½ years, is we have maintained
10 our doors open. We have allowed stakeholders from all
11 different areas to come and visit and let us sometimes
12 close this little gap that exists, it is vital
13 information to us how stakeholders, whether they're
14 industry or there are other, you know, groups that
15 have an interest in the proceedings, let us know how
16 things are going. And that has worked very well. It
17 keeps the Commission informed early. Sometimes, you
18 know, the staff protects the Commission and shields us
19 from knowing the little problems that are happening.
20 And sometimes that is fine. It's really, you know, I
21 appreciate it. But there are times in which we need
22 to know ahead of time.
23 And I think this process should be very
24 similar as far as the Commission is -- really on top
25 of it all the time.

1 DR. KRESS: Other questions? Do the
2 members of the ACRS wish to ask a question of
3 Commissioner Diaz.
4 DR. POWERS: Dr. Kress, I'd like to phase
5 the issue of nuclear waste, which comes up repeatedly
6 in connection with all the discussions of nuclear
7 power, especially as we go to looking at maybe an
8 increased use of nuclear power.
9 Are we making any progress on this nuclear
10 waste issue? Is there something that the NRC can do
11 or is this totally in the hands of the Department of
12 Energy?
13 COMMISSIONER DIAZ: I think the NRC has
14 done as much as it can do. We have engaged in the
15 process all the way. And we have tried to make sure
16 that everybody understands that we believe there is
17 the science and technology that offers a better
18 pathway that ensures public health and safety.
19 I think the decisions right now are
20 practically at final stages. I cannot comment on them.
21 I think that, you know, we are going to do what we do
22 best; we're going to take whatever the country decides
23 in the Congress of the United States and the
24 President, and EPA and we're going to work with them.
25 We're going to try to make it, you know, an inspective

1 process. And that is what we do best.

2 You know, whatever is coming down, we're

3 going to use it. And if an application is submitted,

4 we're going to try to license working through a

5 process, and that process if not assured. We're going

6 to have to look at it every step of the way. And,

7 hopefully, you know, the Department of Energy will do

8 a good job and will allow us to do a provision of it.

9 And we will like to ensure that the process is open to

10 the public. We need to make sure that this is

11 disciplined, meaningful and scrutable.

12 DR. POWERS: Not to get off point or

13 anything.

14 DR. KRESS: I have a question, Mr. Diaz.

15 With some of the new reactor concepts, I see one of

16 the hard places regulatory challenges to be in the

17 area of defense in depth, which is you know a general

18 guiding principle for regulation.

19 Do you think the concept of defense in

20 depth is sufficiently rigorously defined to quiet some

21 of the newer reactor concepts or will we have to

22 rethink what we think defense in depth is?

23 COMMISSIONER DIAZ: This is a setup.

24 DR. KRESS: I'm sorry about that.

25 COMMISSIONER DIAZ: I think, you know,

1 those of us who work in reactor science know what
2 defense in depth really is and what are its
3 limitations. I think we have actually reached the
4 limitations of defense in depth, and that it is time
5 to move forward and use it in the best possible
6 manner, but complimented with everything else that we
7 can to make sure that we don't make cumbersome, you
8 know, design requirements or cumbersome regulatory
9 requirements. And I go back to that definition, the
10 end of the definition and risk-informed regulation,
11 which avoids unreasonable burden. And that's what we
12 have to do, because the burden eventually will be in
13 the top, you know. The logical thing the burden will
14 be on whoever it is, the burden is eventually in the
15 people of the United States.
16 So, I believe that we need to relook and
17 resharpen our focus. I know the ACRS has been working
18 on this, and I share a lot of your views.
19 DR. APOSTOLAKIS: Well, this is related I
20 think to the use of risk-information in licensing and
21 regulations. And we hear that the agency may, in
22 fact, receive license application in the very near
23 future. Do you believe, Commissioner, that the
24 regulatory system is ready to review such a license
25 application or does it require some fundamental

1 changes, which will take time, of course?

2 COMMISSIONER DIAZ: This is setup number

3 two.

4 Knowing we think we're ready, but we count

5 on the ACRS to make us ready.

6 DR. APOSTOLAKIS: I am speechless.

7 COMMISSIONER DIAZ: We will work hard at

8 it. And you guys are going to need to come and pitch

9 in. I think everybody is getting their attention

10 focused on how can we move in this area, what is that

11 we know sufficiently that will provide within that

12 envelop that I keep referring to provide the

13 protection of all the processes. And I think there

14 are hard decisions to be made, and I'm not kidding

15 that we can revoke our problems.

16 DR. KRESS: Any other questions?

17 Mike, are there written questions that we

18 could entertain?

19 MR. MARKLEY: No, we have no written

20 questions at this time.

21 DR. KRESS: Okay. With that, I'd like to

22 personally thank once again Commissioner Diaz for an

23 excellent keynote speak.

24 As a matter of fact, we're a little bit

25 ahead of time. But at this time I would like to go

1 ahead with our scheduled break. Let's keep it to
2 about 20 minutes, and return about 10:00.
3 (Whereupon, at 9:30 a.m. a recess until
4 10:01 a.m..
5 DR. KRESS: Let's get started again,
6 please.
7 Based on our experience so far, I'm going
8 to go out on a limb and change the mode of operation
9 just a little and do away with the cards as an
10 experiment and allow questions to be entertained after
11 each presenter makes his presentation, so it'll be
12 fresh in your mind what you just heard, and you can
13 give all the questions at each of the microphones. So
14 we'll try that and see if it works better. If it
15 doesn't work, we'll go back to the cards.
16 Now we'll turn to the spot on the agenda
17 in which we will hear extensively from DOE for Gen IV
18 and Gen III. And the first DOE speaker is listed as
19 Mr. Magwood, so I'll turn the floor over.
20 MR. MAGWOOD: Good morning.
21 Are you sure you can hear me? Are you
22 sure you want to hear me?
23 Well, good morning. I'm Bill Magwood, I'm
24 Director of DOE's Office of Nuclear Energy, Science
25 and Technology.

1 Thank you for scheduling a break in a time
2 that I was able to go to the restroom. I really
3 appreciate that. It will make the presentation a
4 little bit longer, but that's a good thing or a bad
5 thing; depends on what you think about what we have to
6 say.
7 First, in the way of introduction, and I
8 apologize. I'm a little behind on what the viewgraphs
9 look like. I know that I saw these about a week ago,
10 but since I've been out of town and then here I am.
11 So, I'll be sort of looking at these a little bit
12 fresh, I think.
13 Of course, I just got paged, and hopefully
14 it's not the Secretary's office. Okay. That can
15 wait.
16 Well, first, let me give you a little of
17 background about the Office of Nuclear Energy, Science
18 and Technology. Our program, as you know, has been
19 around since the beginning of the Atomic Energy
20 Commission back in the late 50s. And we're basically
21 the same program that's existed throughout the '60s,
22 '70s and '80s; the names have changed, the faces have
23 changed but basically we're the Nuclear R&D program of
24 the federal government. We're responsible for
25 advanced reactor technology development, fuel cycle

1 technology, medical isotopes, space reactors; the
2 whole range of federal involvement in nuclear R&D.
3 And over the last decade we've seen our
4 activities plummet to a really, quite frankly,
5 embarrassingly low level. Actually, in 1998 our
6 budget actually for nuclear energy research
7 development and development actually hit zero. And it
8 was kind of an embarrassing situation for us. We had
9 people coming in from Korea and Japan asking what's
10 going on, what does this mean. And it was very
11 difficult to explain to them well, you know, it's kind
12 of like being between jobs. You know, we're between
13 programs right now.
14 What we were doing during 1998, though,
15 was not sitting on our hands. What we were doing was
16 trying to understand what DOE's rule in nuclear R&D
17 really ought to be in the long term future.
18 In the past, DOE's program is
19 characterized largely by the creation of demonstration
20 reactors, very large, very expensive programs like the
21 integral fast reactor program, defense reactor
22 project, things like that. It was pretty clear that
23 we weren't going to be seeing hundreds of millions of
24 dollars anytime soon, so we were going to have to find
25 a smarter, more efficient way to do nuclear research.

1 What we came up with was a variety of
2 things. First, we recognized that we were going to
3 have to base our program much more on international
4 cooperation than in the past. In the past, DOE always
5 had been a large monolith to which other people tagged
6 on. The Japanese worked with us, the French worked
7 with us, other people worked with us, but DOE was much
8 more self-reliant and was more interested in
9 assimilating technology than it was in bringing
10 technology in. That had to change because of the
11 resource issue.
12 The other thing that we recognized was
13 we're going to have to bring in much more outside
14 perspective, much more of an outside peer review
15 approach. So that ultimately became our nuclear
16 energy research initiative, the NERI program which
17 some of you are familiar with.
18 But we also recognized that it was going
19 to require more of a cooperation with our stakeholders
20 such as NRC, which we're now working more closely with
21 than ever before, the industry, our Nuclear Energy
22 Compensation Program, entities like that. And also
23 focusing more on infrastructure, which is something I
24 think you're going to hear a little bit more about
25 over the course of the morning.

1 And one of the parts of research we have
2 been working on a great deal has been our university
3 research reactors and education program.
4 So our program over the last several years
5 has really changed dramatically from what it was, say,
6 five or ten years ago. In fact, I think a lot of
7 people looking at the program from that perspective
8 will probably be very surprised to see (1) how much
9 less money we have, but (2) but in the way we operate,
10 how different it is.
11 What we're going to be focusing on today
12 is what is the future for the nuclear research program
13 both in the federal government, but also more broadly
14 talk about that.
15 See the next slide, please.
16 One of the primary focuses that we've
17 enjoying over the last year or so has been Generation
18 IV systems. You're going to hear largely about that
19 I think this morning. I think that's the focus of
20 this presentation, and I'm going to explain to you
21 what that is.
22 Now, this proves this I haven't seen this
23 because I would never be giving you a talk with little
24 mailboxes on it. And I think these are pencils.
25 They're either pencils or ballistic missiles, I'm not

1 really sure which. Since we're a civilian program,
2 I'm going to assume they're pencils.
3 Generation IV energy systems are systems
4 that can be deployed by 2030. So, I'm going to
5 actually skip this chart and go to the next chart. I
6 think it's much more descriptive. Why don't you give
7 me the next chart. I think I'm right. Yes, okay,
8 much better.
9 Here's how we got to Generation IV.
10 Looking back in the past we had this first generation
11 of systems, such as the Dresden plant, the
12 Shippingport plant, the very first ventures in the
13 commercial scale of nuclear power production. These
14 lead to the most successful energy programs, I think,
15 in the history of the federal government in some ways;
16 today's nuclear power plants, Generation II nuclear
17 power plants. And these make up most of the plants in
18 operation in the world today. These are all the LWRs
19 in the United States and most of the LWRs throughout
20 the world, as you know, which are based on U.S.
21 technology.
22 The very successful program, obviously,
23 has not been entirely successful otherwise we would
24 still be building them, but nevertheless when you look
25 at the fact that 20 percent of our electricity comes

1 from these power plants, it's hard to say it's been
2 less than successful.
3 We did, however, need to do some
4 improvements. And as we learn more about how nuclear
5 power plants operate, we were able to design the next
6 generation of plants, Generation III plants, the
7 advanced light water reactors and the advanced BWR,
8 the System 80+, the AP600 that generation of nuclear
9 power plants. And this is also, I think, on the verge
10 of being very successful. They're already building
11 some of these plants overseas, obviously in Japan,
12 Taiwan, but also parts of the technology are beginning
13 to disseminate elsewhere in Korea.
14 So when we start to think about what the
15 future ought to be, the question really was where do
16 we go from here? Where do we go from the Generation
17 III reactors? Well, there's two steps. There's a
18 near-term step which we either consider to be just a
19 follow on to Generation III or we actually give a
20 little bit of an extra push and call it Generation
21 III+. And then we speak of Generation III+ we're
22 usually talking about slight enhancements to the
23 existing state-of-the-art nuclear power plants.
24 For example, the AP1000 versus the AP600
25 is considered to be a Generation III+. There are

1 others. I'll try not to get too specific about that
2 because you get in arguments about what's Generation
3 III+ versus Generation IV, and it's a pointless
4 exercise.
5 But part of our program is focused on
6 trying to move to this next step, deployment of the
7 state-of-the-art technologies possibly with some
8 enhancements in technology, Generation III and III+.
9 But the more exciting part of our program, I think, is
10 looking at Generation IV reactors. Generation IV,
11 quite frankly, is just characterized in very simple
12 ways: What comes next?
13 Now, we do have some more of a definition
14 then at this point, and I'll talk about that.
15 Let's go to the next slide.
16 What we've done so far is the Subcommittee
17 of our Nuclear Energy Research Advisory (NERAC) to
18 establish specific technology goals regarding these
19 future reactors. I think we're going to get some more
20 detail about this. But when NERAC brought this group
21 together in just October 2000, it's been a very, vary
22 active group ever since. Their job is to help us
23 develop a technology roadmap for Generation IV nuclear
24 power plants.
25 This technology roadmap is going to be

1 lead by a subcommittee of NERAC, which is composed of
2 people from U.S. industry, academia. And now there
3 are laboratory people helping them, but really the
4 core of the group is made up of academia and is co-
5 chaired by Neil Todreas at MIT and Sal Levy of GE.
6 And they provide a lot of leadership in trying to move
7 this process forward.
8 Let's take a look at the new viewgraph.
9 Okay. That helps.
10 The NERAC Subcommittee had as its first
11 action, and we gave it a very, very short term time to
12 do this, to draft these technology goals for the
13 direction for nuclear power plants. As I say, you're
14 going to hear more about this, but to give you an
15 example the technology goal for Generation IV is, one
16 of the goals, and it's my personal favorite states
17 that there should be no operating or accident
18 condition that required an off-site response to an
19 emergency. And that means eliminating the concern of
20 the public, basically, that the operation of nuclear
21 power plant would effect their lives. Whatever
22 happens to the plant stays on site. It becomes an on
23 site issue, but would not have an impact off site.
24 That's a technology goal.
25 Now, we had a lot of discussion about that

1 as a goal, obviously, because a lot of people say
2 "Well, you know, you can't ever promise it will never
3 be outside event. But, you know, we took a philosophy
4 that if it's a technology goal, you work towards that,
5 you see how close you get, you see where the
6 technology leads you. So, that's part of the process
7 and you'll hear more about this.
8 More to the point, these technology goals
9 aren't an end into themselves. They're used to drive
10 an R&D program. And what NERAC's next goal, and this
11 is where we are right now, was to take those
12 technology goals and formulate an R&D program based on
13 them. And how are we doing that?
14 Now, as you're about to hear what we've
15 done is we've reached out to a very, very large group
16 of people out to the international community. We have
17 -- let's skip over to the next one. I'm not going to
18 go on all these viewgraphs.
19 We've brought together something called
20 the Generation IV International Forum, which I expect
21 to be official by the end of this month. We're
22 working with eight other countries; Argentina, Brazil,
23 Canada, France, Japan, South Africa, South Korea and
24 the United Kingdom. We're working with these
25 countries to try to formulate what concepts, what

1 technologies can meet these very, very high level
2 technology goals that were set by NERAC. So the
3 Generation IV International Forum has worked with us
4 to identify approximately a 100 people all over the
5 world, most are in the U.S. but there's about 40
6 percent or so of them are actually international from
7 these various countries, but also including people
8 from the IAEA, people from the OECD/Nuclear Energy
9 Agency and people from the European Commission to help
10 look at all of the various concepts that are out
11 there, all the ideas that come from our NERI program,
12 for example, and put them through a very, very
13 extensive rigorous progress with the goal of arriving
14 at a small number of technology concepts about which
15 the international community including the U.S. can
16 rally about.
17 Our goal is that by the end of -- and I
18 don't know if the next one's got names or not, we'll
19 take a look. No, we'll skip that one. Okay, that'll
20 do.
21 Our goal -- work backwards on this chart.
22 Our goal is by September '02 to be in a position to
23 tell you what handful of concepts, we're aiming for
24 maybe about a half a dozen concepts, hopefully less.
25 But a half dozen is probably the most we can stand.

1 What small number of concepts would be acceptable
2 under the Generation IV technology goals and about
3 which you can write specific R&D plans.
4 Now NERAC's job will be to identify those
5 concepts and then write the R&D plans, and that will
6 constitute the technology roadmap.
7 This has already been a very ambitious
8 project. In fact, I think a lot of people when they
9 first heard about what we were going to try to do,
10 thought we would never be able to get this far. We'd
11 never be able to get so many countries to agree on a
12 process that would narrow so many concepts down over
13 such a short period of time. But so far, we've been
14 very successful.
15 We've been able to keep the Generation IV
16 International Forum together as a unit. In fact,
17 rather than having it fly apart, it's actually become
18 much more close knit, much more integrated than it was
19 when we started off. And we've actually agreed to a
20 charter that each of the countries will sign by the
21 end of this month. So we're very excited about that.
22 Now, in the nearer term, obviously,
23 because of the energy concerns we're experiencing in
24 this country, we do have to think about what can be
25 done this decade. Let me speak about the dates for a

1 moment.

2 One of the things that I said earlier was
3 that Generation IV concepts need to be deployable by
4 2030. That's not to say that if you can arrive at a
5 Generation IV concept it can be deployed next year
6 that we shouldn't go forward with it. But the limit,
7 the outer limit is 2030. That means that we don't
8 have a situation where we're competing with fusion to
9 be the long lead technology for the Star Trek
10 generation, okay? We want to make sure that where we
11 talk about real technologies things can be engineered
12 now and try to arrive as -- projects can be
13 demonstrated within a very, very reasonable of time.
14 So 2030 is the outer limit.

15 In the case of the near-term plans, the
16 Generation III+ technologies for example, we're
17 focused on things that can be done in about 2010.
18 Now, we're a little softer with that date because
19 there may be some things that are more arrival in
20 2012, say, versus 2010. So we're a little squashier
21 about that. About 2010 is the time frame we want to
22 see these new near-term technologies deployable.

23 Our goal is to make sure that we can
24 identify the technologies, the technology programs,
25 the institutional barriers that need to be resolved in

1 time to enable these plants to be built in the U.S. by
2 2010. And we are working very closely with the
3 industry on this. We have a task force under the
4 NERAC Subcommittee that's chaired, I believe, by Lou
5 Long of Southern Company. Is that correct? I think
6 it's Lou Long. Is there a co-chair? Tony McConnell.
7 Okay. And these folks are helping us on an industry
8 basis. In fact we've just come out with a CBD notice,
9 I believe and a Federal Register notice to solicit
10 input from the industry to identify what those
11 institutional barriers are, technology barriers are
12 and to put forward a plan to try to resolve all those
13 barriers in a time frame consistent with our 2010
14 date.
15 This one is a little ahead of the
16 Generation IV side. We expect to have that more
17 completed this September. And actually, most of it is
18 already done. We're really just about there. There's
19 a lot of things that need to be refined, but the
20 larger ideas are really in place. And by next year,
21 September '02 we'll have the entire Generation IV
22 roadmap.
23 So that's what we're pursuing at this
24 point. It's a very, as I said, ambitious activity.
25 It involves a huge number of people.

1 You're going to hear about how we've
2 organized this. Who's giving that? Is that you, Rob?
3 Rob is going to describe how we've organized this. It
4 looks like a spaghetti nightmare, but trust me; it
5 makes sense, it works.
6 Is that the last viewgraph? Okay.
7 With that, let me just summarize by saying
8 that the U.S. DOE has been gratified with the response
9 we've gotten from the international community and from
10 the industry, and from NRC and everyone else that's
11 worked with us on this. It's been a very important
12 activity.
13 And excuse me, John, for turning my back
14 to you. John here is helping us a lot with this, so
15 he's very familiar with what we're doing. And what
16 we're trying to do now is to bring all this home.
17 We've organized it, we've got participation from
18 everybody that we think we need participation from.
19 We're going to reach out a little bit more to
20 stakeholders over the next year, I think. But this is
21 really working and we're going to keep the work, and
22 we're looking forward to your thoughts as we go
23 forward.
24 And I appreciate the opportunity to talk
25 to you today, and I'd be happy to answer any

1 questions.

2 DR. KRESS: We'll entertain questions from

3 the audience or from the members, either one.

4 DR. APOSTOLAKIS: Dr. Magwood, if you had

5 to give us the two most important regulatory

6 challenges for meeting all these wonderful

7 initiatives, what would they be?

8 MR. MAGWOOD: That's a good question. I

9 think that the most -- I think I'll answer the

10 question a little more generic.

11 I think that it's extremely important the

12 NRC move as close to performance based risk-informed

13 regulation as possible. Because these technologies

14 are dissimilar in so many ways, and you're already

15 starting to see it. There's already a large

16 discussion going forward about the pebble bed reactor

17 versus light water reactor technology and how you

18 license those.

19 The only way to do that successful with

20 these different concepts floating around out there is

21 to move to a technology independent regulatory

22 approach. And unless you do that, you're going to

23 inhibit the development of these new technologies

24 because people will not have the confidence that NRC

25 can respond quickly enough to regulate these

1 technologies.

2 I know there's a lot of concern about how

3 long it's going to take to get regulations for the

4 pebble bed reactor. And we're working with General

5 Atomics at DOE with the development of their system,

6 and that presents similar challenges. So I think that

7 that larger issue is the one you have to deal with.

8 In the nearer term I think it's really

9 more a job of demonstrating the pieces are already out

10 there. But even as we look at these newer

11 technologies coming in before now, they present

12 issues, many that you are already very familiar with.

13 So I would say that pushing as fast as

14 possible towards a new regulatory regime that will

15 support new technologies in the next century is really

16 going to be -- should be a high priority.

17 DR. APOSTOLAKIS: In the next century?

18 MR. MAGWOOD: Well, in this century. I'm

19 sorry, I fell back. In this century. I'm sorry I fell

20 back.

21 DR. APOSTOLAKIS: Speaking of long term.

22 MR. MAGWOOD: Well, you know, it's

23 interesting one of the things I mentioned to the

24 international community -- I'll just sort of digress

25 for a moment.

1 One of the things that was very
2 challenging about pulling everyone into this early on
3 was that unlike the U.S., other countries know where
4 they want to be in 20 or 30 years. You know, the
5 Japanese have very specific plans of where they'd like
6 to be over the next 30 years. So, you know, getting
7 countries like Japan and France that know where they
8 want to go to agree to a process like this was
9 challenging, to say the least. But I think that the
10 fact that we're open-minded about where the answers
11 come out gives them confidence that, you know, that
12 their ideas may well fit into whatever comes out of
13 the end of this.
14 Also just for your gratification, one of
15 the things that we were very pleased about with the
16 international community was that they made very clear
17 that they believe that the U.S. was the only country
18 that pulled this together and that without the U.S. in
19 the middle of this bringing all these other countries
20 together, that there's no way you would ever be able
21 to arrive at what they believe, what many countries
22 believe the future really has in store for us which is
23 more common reactor designs international.
24 And so doing this on an international
25 basis is absolutely essential. Having the U.S. go off

1 and do this on its own would be a waste of everybody's
2 time and money. And so, you know, we've been very
3 pleased with the international response. But I think
4 that in the future we're going to see that the steps
5 that you take and the steps the NRC takes towards
6 regulating these new technologies will really set the
7 tone for the rest of the world. So it's very
8 important that we go about that in the right way.
9 DR. APOSTOLAKIS: Is NERAC going to give
10 us any ideas as to how we can have this regulatory
11 system that will not be technology specific?
12 MR. MAGWOOD: We've talked about whether
13 to get involved in that. And I think the main
14 conclusion was that we shouldn't because for two
15 reasons. First, it really is something that NRC needs
16 to deal with. You know, it's something that the NRC
17 has more experience with than we do and very few of
18 the people that we've been working with are very
19 comfortable going off to give NRC a lot of specific
20 advice.
21 And secondly, quite frankly, the time that
22 it would take to do that probably means that it would
23 require a different project than what we're currently
24 doing. That's not to say that we wouldn't have a
25 follow on step where we would try to move in that

1 direction. But for the near-term, I don't think
2 there's anything that NERAC's is going to add to where
3 NRC is going. We just need to encourage them to move
4 forward quickly with what they're doing.
5 In a longer term, it may make sense to
6 bring another group together to look at those long
7 term regulatory issues.
8 DR. APOSTOLAKIS: Thank you.
9 DR. KRESS: Other questions?
10 DR. POWERS: Well, it seems to me that if
11 you're going to encourage people to move to a
12 performance based regulatory system, that must mean
13 surely you're looking at performance indicators for
14 these new generation? Is that the case?
15 MR. MAGWOOD: I think the answer to that
16 is yes. If you look at our technology goals, and I
17 think you're going to get a rundown of that. Is that
18 going to be part of your presentation? You're going
19 to get a rundown of that.
20 You'll see a very high level version of
21 what those performance goals are. On a regulatory
22 space, you're talking about safety. You'll see some
23 indications where we think things should go, but not
24 to the level of detail because these technology goals
25 are very, very high level. You're not going to see a

1 low level of detail, but you will see an overall
2 vision.
3 DR. POWERS: High level and not very
4 specific doesn't make for useful regulation.
5 MR. MAGWOOD: That's a --
6 DR. POWERS: At some point somebody has to
7 come down and say if you want a performance based
8 system, you got to have performance indicators that
9 are used and monitored.
10 MR. MAGWOOD: But what I would say is that
11 what -- what we can provide as part of our process,
12 all these high level goals. These high level goals
13 will very quickly, depending on which technology
14 concept you're looking at, provide some framework that
15 NRC or someone else could use to begin to design a
16 regulatory approach. It's not really -- again, it
17 wasn't our intent to try to set this up to defeat the
18 NRC process. You know we clearly could to do that,
19 but that's not the intent here.
20 Our intent was to drive an R&D program,
21 not separate or instruct. Now, I'm willing to hear
22 some advice. You're an advisory group, so give us
23 some advice. We're part of the program.
24 If you think that we should follow on this
25 activity with an activity focused more to the

1 regulatory side, you know, I would be very happy to
2 work with Ashook and his group to try to put together
3 an appropriate advisory group that will do that.
4 Because I think it's important that it be done. And
5 if takes DOE involvement to get it started, I'm happy
6 to do that. But this isn't the activity to do it,
7 that's my biggest point.
8 DR. KRESS: Okay. Seeing no other -- oh,
9 there's one. Okay. Please identify yourself.
10 MR. LYMAN: Ed Lyman from the Nuclear
11 Control Institute.
12 Bill, I think there is public issues that
13 really have to be thought about before large expansion
14 in DOE's research budget has to be contemplated.
15 Because these days you have to really worry about
16 whether what looks like government subsidization of
17 one energy technology over another, how that will be
18 perceived, especially by small scale generators using
19 other competitive fossil fuel technology and stuff.
20 And in a deregulated environment that's going to be a
21 greater concern.
22 So, I was encouraged when these reports of
23 a task force on near-term deployment that recently
24 reported to NERAC discussed a cost sharing program
25 with industry for near-term deployment. I was

1 wondering if industry had actually made any firm
2 commitments in that regard, since would be a positive
3 step since I don't think they've put any money down so
4 far in these initiatives?
5 MR. MAGWOOD: First, it's important to
6 clarify, and I think you raised a good point. There's
7 two things really important to clarify.
8 First, in general, you know our office is
9 not in the business of corporate welfare. We're not
10 here to make technologies marketable that wouldn't
11 otherwise be marketable, you wouldn't otherwise
12 compete on it. In fact, our goals, and you'll hear
13 about it, for our Generation IV have a lot of built
14 into them about the need to be economically
15 competitive. That's a hallmark of what we're trying
16 to do.
17 And let me say for the record that there
18 should not be a new nuclear power plant that's not
19 economically competitive in this country. It
20 shouldn't be built because we're not going to
21 subsidize it and if industry is not willing to go off
22 and do it because they can make money, it shouldn't
23 happen. It shouldn't be done.
24 Now, regarding the specific point you
25 raised, I think that where we are right now -- well,

1 first it's important to recognize that this is a NERAC
2 advisory group, so we're not at the point where we're
3 making commitments on a policy basis on behalf of the
4 industry. We have asked certain experts in industry
5 along with academia and working with our national
6 laboratories to come together and make
7 recommendations. These recommendations will flow up
8 through the NERAC process and if it comes out the
9 other side, NERAC will make a recommendation to DOE
10 that we should go pursue a program in that vein.
11 But at that stage, if that were to happen,
12 we would be in a position to approach the industry and
13 say "Okay, your people were on this panel, here's the
14 recommendation that they made, Mr. CEO do you want to
15 buy into this?" And if they don't want to buy into
16 it, we don't have to do it. But, you know, it's a
17 recommendation. It's not a commitment on anyone's
18 part, especially ours.
19 You know, with my budget I couldn't commit
20 to anything they recommended at this point. So, it's
21 really a recommendation for the future.
22 The question we asked was if we were going
23 to solve these problems, how would we go about it?
24 And that's what these recommendations gives us. It
25 gives us a way of solving the problems.

1 It doesn't mean that we have to do it. It
2 doesn't mean the industry has to do it, but it gives
3 us a methodology.
4 So the answer to your question is no, no
5 one's made any commitments, nor would it be
6 appropriate to at this point in time.
7 DR. KRESS: Okay. With that, let's move
8 on to the next speaker. But before we do, the
9 question that George asked about what you may think is
10 the two or three most challenging, most difficult
11 regulatory challenges, each speaker might want to
12 consider that as a generic question and feel free to
13 volunteer an answer to it without it being asked.
14 The other item is, I don't have any
15 introductory information or remarks to make about each
16 speaker, so as was obvious with Mr. Magwood, so would
17 each speaker please introduce himself when he gets to
18 it.
19 So, with that, I'll turn it over to the
20 next speaker.
21 MR. VERSLUIS: Good morning, ladies and
22 gentlemen. My name is Rob Versluis. I'm the project
23 manager for the Generation IV roadmap.
24 Now that Bill Magwood has given you an
25 overview of Generation IV process, I'd like to focus

1 on the long term and in my talk summarize the roadmap
2 process and products that we expect.
3 The first objective of the Generation IV
4 roadmap is to identify and evaluate the most promising
5 advanced nuclear energy concepts. And we have three
6 years to do this. We started in October of last year.
7 And expect to be finished September next year.
8 An important role is played by the
9 advisory group. Bill has already mentioned it, the
10 NERAC Subcommittee. Actually, it's better known as
11 GRNS, Generation IV Roadmap NERAC Subcommittee,
12 although that's not actually their official name.
13 They are very much working with us and
14 directing or advising us on the direction for the
15 roadmap work.
16 The actual work is being done by several
17 working groups. The staff consists of about 50 U.S.
18 experts, about evenly divided between industry, labs
19 and academia. And recently we have received 40
20 volunteer experts from the GIF countries. That is a
21 very respectable participation from the international
22 community.
23 The second objective, and really the
24 product we are looking for from the roadmap, is the
25 R&D plan to support future commercialization of the

1 best concepts. And this completed roadmap will do two
2 things.
3 It will identify and evaluate concepts.
4 That is we intend to make a good start in calling out
5 the most promising concepts.
6 And secondly, it will formulate the R&D
7 tasks for the best concepts; that is to find a
8 sequencing and preliminary costs of the R&D tasks
9 required for commercialization.
10 We recognize that even after two years of
11 hard study there will be many questions left about the
12 viability of the most promising concepts. The R&D
13 defined by the roadmap is intended to both answer
14 questions of viability and show the real performance
15 capabilities of the selected concept.
16 And, of course, the final nuclear energy
17 system selection will involve industry and the
18 marketplace.
19 Like any planning activity we start with
20 formulating goals, which was actually done by GRNS.
21 And these goals strive to reflect energy needs for
22 mid-century, and we actually have the date of 2030 on
23 it, but obviously if these plans are going to be built
24 and deployed, they're going to be run for many years.
25 And so we've tried to envision mid-century

1 with its population growth, its growth in standard of
2 living, its world economy and its need for other
3 energy projects besides electricity, such as clean
4 water. This is reflected in the appearance of
5 sustainability goals alongside safety and economic
6 goals. And let me quickly take you through the goals.
7 In fact, this is all I'm going to show
8 about them, because Neal Todreas is tomorrow and his
9 talk will go in more detail about the goals.
10 There are three sustainability goals. One
11 that is concerned with the resource inputs, that is
12 fuel, materials, energy inputs in nuclear energy
13 system. Second with waste outputs. Waste streams of
14 all sorts. And the third is proliferation resistance
15 or nonproliferation.
16 Then there are three safety and
17 reliability goals. One on excellence, one on core
18 damage and one on emergency response.
19 And finally, there are two economics
20 goals: Life cycle cost and risk to capital.
21 These goals, in fact, provide the basis
22 for evaluating the technologies.
23 What do we really mean with a Generation
24 IV system? It is an entire energy production system,
25 including the nuclear fuel cycle front and back end,

1 the nuclear reactor, the power conversion equipment
2 and its connection to the distribution system. It
3 must recognize various energy products, electricity,
4 hydrogen, fresh water, process heat, district heat,
5 propulsion. And also the infrastructure for
6 manufacture and deployment of the plant.
7 Furthermore, we limit to systems that are
8 likely to be commercially viable by 2030. And also
9 the primary energy generators in the system must be
10 based on critical fission reactors. That means that
11 subcritical systems, accelerator driven system, would
12 have a secondary role in the fuel cycle, but the
13 primary energy generators should be critical systems.
14 The next slide shows the roadmap
15 organization. The central part shows the working
16 groups and the integrating functions. And I'll come
17 back to that in a minute.
18 On the left it shows the advisory
19 committee relating, of course, to DOE-NE in the
20 roadmap. And also the technical community, the left
21 bottom, from which both the GRNS and the roadmap draw
22 its resources; that is its staff. Further resources
23 are drawn then from the GIF countries on the right
24 hand side.
25 DOE-NE manages the program. This is where

1 Tom Miller, who will speak next, and I sit. And
2 underneath -- actually it shows the near-term
3 deployment group in orange underneath DOE-NE.
4 Then the next group that it shows is the
5 roadmap integration team, RIT. And look at those
6 abbreviations because they will come back in later
7 slides.
8 The RIT does what it says, it manages the
9 roadmap process and does the final integrating of the
10 roadmap itself. It is composed of two senior managers
11 from Argonne National Laboratory, two from Idaho
12 National Energy Environmental Laboratory and myself.
13 The next group shown is the evaluation
14 methods group, and this is the group that is charged
15 with defining the criteria and metrics by which they
16 evaluate the concepts on their ability to meet the
17 Generation IV goals. They actually start with the
18 goals and they translate them into criteria and
19 metrics, which is a long process, actually.
20 The actual work of identifying, describing
21 and evaluating the concepts is spread over the four
22 groups shown in the middle bottom. They are organized
23 by a coolant technology somewhat arbitrarily, but it
24 lines well up with people's expertise. And so there's
25 a group on water coolant, on gas, on liquid metals and

1 then there is none of the above where the non-
2 classical concepts are being evaluated and described.
3 In addition, we envision forming
4 technology crosscut groups. And that group, you know,
5 standing vertically there on the right is an example
6 of such a group. It draws actually from the same
7 people, from the same working groups, but it lines up
8 the experts in a certain technological area and it
9 puts them together to get a crosscut perspective over
10 all the concepts. And you can envision crosscut
11 groups like fuel cycles, risk and safety, materials,
12 power conversion and others, perhaps.
13 The fuel cycle group was formed early to
14 deal with the common fuel cycle issues for all of the
15 concepts, and also to define the fuel cycle framework
16 for the energy systems. And they have defined four
17 generic fuel cycles: The once through fuel cycle; a
18 single plutonium recycle; multiple plutonium recycle;
19 and a full actinide recycle. And they describe those
20 and provide a framework for the other groups to work
21 within.
22 They also analyze energy demand scenarios.
23 They're not making any new ones, they use the World
24 Energy Council's scenarios and they pick the three
25 scenarios of those to drive the thinking about

1 resources and build up.

2 This shows a high level overview of the

3 schedule for producing the roadmap.

4 Phase 1, the initial work is getting

5 organized and staffed. Phase II, the needs assessment

6 looks at the concepts and identifies the technology

7 gaps. Phase III, the response development defines the

8 needed R&D. And Phase IV, the implementation planning

9 actually finalizes the roadmap. And the slide also

10 shows the time frame when the activities take place

11 and about the product of the phases.

12 Let's step through the tasks. First the

13 goals and plans. First, we drive the technology goals

14 based on industry needs, and that has been done by the

15 GRNS and it's been reviewed and with some comments

16 endorsed by GIF. And it's captured in a technology

17 goals document.

18 Next, plan the activity. We published the

19 Roadmap Development Guide for use by the roadmap

20 participants that describes the overall approach, and

21 the working groups have been convened including

22 international participation.

23 The first time we convened all the working

24 groups was in February in Denver, and it only included

25 the U.S. participants and we described to them the

1 approach of the roadmap, the various responsibilities
2 of the groups and what's expected from them.
3 Then again, in Chicago we had the second
4 joint meeting of all the working groups. That was
5 last month in May. And that included all the
6 international participants. So we had, again, a
7 familiarization stage, but they also actually were
8 there to do work.
9 Then next we determine how to measure the
10 concepts against the goals. We developed a criteria
11 and metrics for each goal and then continue on to
12 develop the evaluation methodology. This is conducted
13 by the evaluations methods group with the feedback and
14 assistance from the roadmap integration team and the
15 GRNS.
16 This slide discusses how we're dealing
17 with the concepts. First, identify the concepts for
18 evaluation. We have now about 100 concepts and they
19 are drawn from the U.S. and a broad international
20 base. And they are now adopted by the technical
21 working groups and synthesized. When I say
22 synthesized, I mean that in many cases a concept was
23 not complete and needed to be synthesized with other
24 fuel cycle systems or parts of the fuel cycle system.
25 The concepts are also being grouped into

1 sets if they show sufficient similarity to increase
2 the productivity. To conceive a 100 concepts we're
3 going to have to package them up a little bit, and I
4 will talk about that later this morning.
5 Then the most promising concepts need to
6 be detailed better, so that's the next step. And the
7 TWGs are now interacting with the concept teams and
8 the advocates to get more information. They actively
9 study and compare the underlying technology. And they
10 are now getting ready for what's basically two
11 screening stages. The first screening is called
12 screening for potential and the EMG has developed
13 criteria, qualitative criteria for that. That initial
14 screening is pretty lenient and it's because it's been
15 based on limited information and we really don't want
16 to throw too many things out at this point.
17 And then a later evaluation next year
18 will be done next year.
19 Let me clarify what I mean with concept
20 and concept sets. Concept, as we use the word, is a
21 technical approach for a Generation IV system with
22 enough detail to allow evaluation against the goals,
23 but broad enough to allow for optional features and
24 trades. And a concept set is a logical grouping of
25 concepts that are similar enough to allow their common

1 evaluation.

2 In the second year we evaluate and

3 assemble. We evaluate the most viable concepts, we

4 compare the concept performance to the goals, and that

5 is really the finally screening. And then we identify

6 the technology gaps. And in this work the TWGs, the

7 technical working groups have the lead. And, of

8 course, the RIT and the EMG looks over their shoulders

9 and make sure that the criteria are being applied

10 consistently.

11 DOE has the approval function here, and we

12 will seek the endorsement of GIF.

13 And then the final stage is assemble the

14 roadmap to support the most promising concept. That

15 means identifying the R&D needed to close the gaps

16 that have been identified in areas of crosscutting

17 technology, assemble a program plan with recommended

18 phases. And that will then contain the sequencing and

19 estimated costs of the R&D tasks. And the groups

20 write here their final reports. The RIT takes the

21 input and integrates this into the roadmap. Again,

22 the DOE has an approval function and will seek the

23 endorsement of GIF.

24 This slide is another cut at the schedule

25 from the perspective of the screening and down

1 selection. A lot of work is actually going into
2 taking these goals, translating them into criteria and
3 metrics and applying them in these screenings. And,
4 as you see, the screening for potential is coming up
5 in July, 2001. Then there is an eight to nine month
6 period before we do the final screening, which will be
7 more strict and based on further developed and have
8 more sophisticated criteria and perhaps in some cases,
9 quantitive metrics.
10 After the roadmap completion, planning
11 becomes more uncertain as you go further into the
12 future because it involves things such as government
13 policy, budget, market, et cetera. But we have
14 indicated there sort of a base scenario that includes
15 the terms of viability and performance R&D. And we
16 have made provision for further down selection using
17 more quantitive metrics to show if the potential can
18 really be realized.
19 At some point we envision to hand off to
20 industry based on their reading of the markets.
21 That concludes my presentation.
22 DR. KRESS: Thank you. Questions anyone?
23 DR. POWERS: Yes, I have a question that
24 comes to mind when I see these plans for Generation IV
25 reactors. My good friends at the Nuclear Energy

1 Institute regularly provide me metrics on the
2 performance of the current generation of plants in a
3 variety of areas, including resources, safety and
4 economics. And they show excellent performance, just
5 outstanding performance in the last ten years going
6 along.
7 In all this roadmapping exercise, do you
8 carry along some representative of the current
9 generation plants as a comparison so you can see if
10 you're really going to accomplish anything with these
11 new plants?
12 MR. VERSLUIS: Well, it's a good question
13 because the initial screenings are really not much
14 more than comparing in a number of different areas
15 with the Generation III technology. So, they are
16 qualitative comparisons, and that's how we approach
17 it, is comparing it with the Generation III
18 technology.
19 DR. POWERS: See, now the Generation III
20 is like the --
21 MR. VERSLUIS: The fast light water
22 reactor.
23 DR. POWERS: The 600 or the 80+ or
24 something like that?
25 MR. VERSLUIS: Yes.

1 DR. POWERS: We don't have a whole lot of
2 performance and data on those Generation III plants
3 the way we do with the existing plants?
4 MR. VERSLUIS: We think at this point with
5 the amount of data that we have on the various
6 concepts, there is no need to be very, very precise
7 about these things. What the schedule, the last slide
8 really showed is that we need to do a certain amount
9 of viability research where we get a better handle on
10 how to measure, how we can measure the various
11 indicators before we can do a more sophisticated
12 screening.
13 DR. GARRICK: Rob, it might be important
14 to point out, too, that GRNS has put a lot of emphasis
15 on the total energy system concept, and that has kind
16 of evolved. When we first got together, that wasn't
17 so much an emphasis. And when you think about
18 performance indicators, you've also got to think about
19 the scope that we're addressing this time, namely the
20 total energy system.
21 So, it would seem that if we're going to
22 go in the direction of performance indicators that are
23 compatible with risk-informed performance based
24 regulatory practice, we'll be talking about probably
25 a different structure and at least a more range of

1 indicators that we've perhaps ever seen before. Is
2 that not correct?
3 MR. VERSLUIS: Yes. I thank you for
4 pointing that out. For example, the base case we're
5 comparing with, of course, has a once through fuel
6 cycle. We have various criteria that have to do with
7 the waste and use of fuel, but particular the waste
8 forms that can be achieved by other fuel cycles.
9 So, you're very right that we are not just
10 looking at the reactor, but the entire system from
11 soup to nuts, so to speak.
12 DR. APOSTOLAKIS: If we go to slide 3, you
13 had the word "excellence" under "safety and
14 reliability goals." What exactly does that mean?
15 That you don't want excellence on the other goals or
16 that this is something special here?
17 MR. VERSLUIS: Actually, it is something
18 special. And I would like almost to defer to Neil who
19 is going to be discussing those tomorrow. But I can
20 say that there is a strong feeling among the GRNS that
21 one of the important issues in improving the
22 technology and also making it safer is practices of
23 excellence in operations, maintenance, design. And as
24 such, they have made a specific goal with that title
25 and it translates into criteria and metrics having to

1 do with safety to the public during normal operations,
2 frequent occurrences all out -- throughout the fuel
3 cycle, not only the reactor but also the other fuel
4 cycle facilities. And so there's a number of metrics
5 that have been defined to implement this goal of
6 excellence.
7 MR. JOHNSON: Mr. Chairman, if I could add
8 to that response? I believe your question actually
9 ties very well into Dr. Powers' question regarding the
10 current operating fleet of reactors and the experience
11 and lessons learned from that, and how that's going to
12 feed into the process.
13 The goal of excellence truly is looking
14 at, you know, what are the best practices. You know,
15 what has led to the success in the current fleet of
16 operating reactors and making sure that the new
17 generation reactors, you know, meet or exceed that
18 level of operational and maintainability excellence.
19 So I think that is the intent of those goals.
20 DR. APOSTOLAKIS: Now when you say
21 reliability goals, I mean are they goals the way we
22 understand them, numerical goals for reliability? For
23 safety I understand it, but reliability?
24 MR. VERSLUIS: That's where we would like
25 to end up, but reliability you can't really put a

1 metric of reliability together until you know the
2 design pretty well.
3 DR. APOSTOLAKIS: Sure.
4 MR. VERSLUIS: And so early on we are
5 really looking at very general indicators that might
6 lead to reliability, but it's not -- as I remember
7 well, it's actually not a screen for potential
8 criteria. It doesn't come into play until later.
9 DR. APOSTOLAKIS: And a last comment, if
10 I may.
11 On the third column, "Economics Goals," it
12 says "risk to capital." That's a very interesting
13 idea. I mean, do you envision at some point in the
14 future that we will have a probablistic risk
15 assessment for a proposed design that in addition to
16 end states that involve various levels of damage to
17 the core, we'll also have other end states that refer
18 to economic losses? I mean, that would be a very
19 exciting thing to do, actually.
20 MR. VERSLUIS: Well, I don't know if we
21 need new methodologies along that probablistic risk
22 assessment line. But, yes, there are now ways of
23 assessing risk for a certain project and what we want
24 to indicate here is that nuclear energy systems when
25 investors look at them, the risk to their capital

1 should be comparable with other projects.

2 DR. APOSTOLAKIS: Which is intimately tied

3 to the second column, right, "Safety and Reliability

4 Goals"?

5 MR. VERSLUIS: Yes. Well, actually, many

6 of the other goals, of course, have an economics

7 impact. Definitely, yes.

8 DR. KRESS: I know you wanted to leave

9 something for Neil Todreas, but under that "Safety and

10 Reliability Goals" you have emergency response. Could

11 I read that as no emergency response?

12 MR. VERSLUIS: The goal is in fact to

13 eliminate the emergency response. And this may be a

14 good time to reiterate what Bill said. These are

15 goals that drive R&D programs. They are not

16 regulatory criteria. In fact, we take pains to point

17 out that it may not be possible to reach all these

18 goals, but we will be evaluating the concepts on how

19 well they get there on a scale from, you know, zero to

20 the goal; how close they get and across how many

21 goals.

22 MR. LEITCH: I'm trying to better

23 understand the level of effort that's going on. These

24 50 U.S. experts and 40 experts internationally, are

25 they involved full-time or only at times of these

1 meetings that you refer to? In other words, between
2 meetings what are they doing? Are they back home
3 working on this full-time or is this just part-time?
4 MR. VERSLUIS: We didn't mean anyone to be
5 working on it full-time, but they are expected to work
6 on these issues between meetings or the work wouldn't
7 get done.
8 DR. APOSTOLAKIS: It's pretty much like
9 the ACRS, I guess.
10 MR. VERSLUIS: Yes, right.
11 Roughly speaking we expect people to spend
12 some 20 percent of their time on the roadmap and in
13 the chairs, the co-chairs of these groups some more
14 time.
15 The international participants, again,
16 they're expected to do the same thing but they are
17 funded by their own organizations. Nevertheless,
18 there is a lot of work to be done here, which they all
19 recognize, and there is a real sense of wanting to do
20 this correctly. So, we are probably getting a little
21 more than we are paying for.
22 MR. LEITCH: And these individuals are
23 sponsored by their parent organization, either
24 industry or academia or labs? In other words, DOE's
25 responsibility is the oversight and management of this

1 program?

2 MR. VERSLUIS: For the U.S. participants

3 we contracted most of the individuals and our total

4 budget is $4½ million for this year.

5 MR. LEITCH: Who do you see as the

6 customer of this activity?

7 MR. VERSLUIS: Well, the customer at this

8 point is DOE, because we are looking for guidance on

9 our R&D program in the long term. And we also are

10 looking for a well-reasoned, a well-organized plan

11 that allows us to discuss our needs with Congress and

12 with other agencies.

13 But ultimately, and this is one of the

14 reasons we have gotten the utilities -- I'm sorry, the

15 industry, owner operators and vendors involved very

16 early on, because we feel that they're ultimately the

17 customers for these efforts. And as I ended up my

18 talk, I said we need to be able to define a hand off

19 to industry at some point.

20 At this point I would say DOE is the

21 customer.

22 MR. LEITCH: Okay. Thank you.

23 DR. KRESS: With that, I think I'll stop

24 the questions and move on to the next speaker to keep

25 us on time. The next speaker is Mr. Thomas Miller.

1 MR. MILLER: Thank you. My name is Tom
2 Miller. I am in the Office of Technology and
3 International Cooperation. I'm responsible for the
4 near-term deployment working group of the Gen IV
5 roadmap effort. I'm also the project manager for NERI
6 and the INERI programs.
7 Very early on in the Gen IV roadmap effort
8 we realized that the effort in the near-term was going
9 to determine a lot of what happens out in the future
10 2020/2030 time frame. We didn't have a nuclear
11 component, a new nuclear component in the 2010, the
12 2020 time frame there probably wouldn't be something
13 beyond that. So we looked at what it was going to
14 take to have new nuclear plant deployment in the U.S.
15 by the year 2010. We picked that target date, and as
16 Bill said we're a little bit flexible on that date,
17 but that was our target date with the intention of
18 having new plant orders by 2005.
19 And the intention was to have not only
20 plant operational, but to see what it would take to
21 have multiple plants in operation by 2010. And by
22 that you can see some differences of how you may
23 approach things if you have multiple plants being
24 built.
25 The participants, and it's a multi-

1 industry oriented organization because of the near-
2 term effort, we have nuclear utilities; the major
3 utilities that are involved in the nuclear power
4 generation to date and those that are looking to the
5 future in nuclear power are participating.
6 The reactor vendors, national labs Argonne
7 and INEEL. We have academia through Penn State
8 University participating. Industry is also
9 participating through EPRI. And we have participation
10 of our NERAC committee on our panel.
11 Early on we identified two deliverables
12 that we felt were important. One was a working group
13 set of recommendations early that we called the near-
14 term actions for new plant deployment. That near-term
15 actions was intended to offer DOE some recommendations
16 based on the experience of the group itself without
17 any outside input, and it was intended to offer up
18 recommendations that could be used by the Energy
19 Policy Committee by the Vice President and DOE and the
20 lobbyists in helping support the department's budgets
21 in FY '02 and '03.
22 The longer term product of this group was
23 a near-term deployment roadmap that's targeted for
24 September of this year.
25 In the near-term actions the things that

1 came out of our group were recommendations involving
2 early site permit demonstration, combined
3 construction/operating license demonstration,
4 certification of the 1000+ MWe ALWR and confirmatory
5 testing and code validation of advanced reactors using
6 new technology. In effect, support code validation
7 and testing requirements that industry might not be
8 able to do for the gas reactors.
9 Supporting this effort we issued a request
10 for information to the general community with targeted
11 directions to specific groups. This RFI was issued in
12 April with a request to have material back in May,
13 with a one month turn around. As it turns out with
14 most RFIs, we're still having some information come
15 in.
16 The RFI was issued to the public through
17 the CBD. We gave a directed submittal to the members
18 of the NEI New Plant Task Force, directly to the
19 reactor vendors to facilitate getting a response back
20 in this one month time frame.
21 What we were asking for was to identify
22 the design specific generic institutional regulatory
23 barriers to new plant deployment, identify the gaps
24 associated with those. And in the RFI we broke it
25 down in various sections that looked at reactor

1 specific design issues and site related activities and
2 generic barriers.
3 We received responses from 12
4 organizations, and right now those are being reviewed
5 by the panel.
6 The RFI requested these designs, the
7 reactor designs to meet six specific criteria. And
8 these were intended to assure that they could meet the
9 2010 time frame, and it was intended to weed out other
10 designs that might have fallen more under the Gen IV
11 category rather than in this near-term deployment.
12 You all have these in the handout, and I
13 don't intend to read through them, but they were
14 focused on things dealing with: How the reactor
15 vendor planned to gain regulatory acceptance; did he
16 have an infrastructure that would support the
17 deployment of his design; what was his plan for
18 commercialization of the design; if he had a
19 particular utility that was interested in or not; if
20 not, how was he going to get it into the marketplace;
21 if there was work to be done and there was a need for
22 government level support, what is the cost-share, how
23 would they want to implement that and what are the
24 specific activities; they had to demonstrate economic
25 competitiveness to assure that they could compete in

1 the marketplace that was there within the next 10
2 years. And one of the most interesting was that they
3 had to rely on the existing fuel infrastructure.
4 Then we also addressed generic gaps. And
5 in the RFI we identified specific gaps that we, as a
6 group, knew already existed and asked the respondees
7 to rank those generic gaps and identify additional
8 ones. And in ranking those generic gaps, we also
9 asked them to identify what they believed were
10 solutions and appropriate levels of funding to reach
11 those solutions.
12 The responses we got in the design area
13 are on the slide. Typical that we expected from
14 Washington and GE responses. We got responsible on
15 gas reactors from Exelon/PBMR and General Atomics.
16 And one we had not expected, but showed up, was from
17 Framatome, the SW 1000.
18 At this point of time the group is
19 evaluating these designs. We're conducting a two
20 level review, one based on the six criteria and then
21 we're going to do a summary level design review of
22 each design and look at it from that perspective.
23 As expected, the generic gap responses
24 that came back pretty much matched what the working
25 group believed as necessary, but there were some

1 additional ones that were identified.

2 The three first ones involve parts of

3 demonstrating Part 52 licensing requirements.

4 Identification now shows up with the risk-informed

5 regulation for future design certification. And there

6 was a specifics identifying emergency planning and

7 plant security issues.

8 The last six were identified by

9 organizations that were not the reactor vendors or

10 your typical utility, but were other inputs we

11 received from the national laboratories and other

12 concerned nuclear industry groups, and they provide

13 some input for the group to consider.

14 Brought up earlier was the idea of

15 economic risk and risk assessment tool, and in fact

16 one of those was identified in our group.

17 As I want to state right now, we're on a

18 track to issue this report in September. The working

19 group is split off in teams right now. They're

20 diligently looking at these designs. Our next meeting

21 is the end of June, and we'll be having an assessment

22 by each of the design review teams given to the

23 working group, and in addition having the reactor

24 vendors come in and demonstrate to the working group

25 how they meet each one of these criteria.

1 And at this point in time I will conclude,
2 because there really is no further information I have
3 to give the committee.
4 Thank you.
5 DR. KRESS: Thank you.
6 Questions?
7 MR. WALLIS: I have a question. A lot of
8 your criteria is the credible plan for gaining
9 regulatory acceptance. Now, presently there's an
10 infrastructure for doing this. Response to things
11 like regulatory guides and standard review plans and
12 so on. In the absence of those from the NRC side, how
13 are you going to have a credible plan for gaining
14 acceptance?
15 MR. MILLER: This criteria was focused
16 towards those industry groups, utilities or vendors
17 that were going to come in with a new reactor design
18 and they had to show how they were going to try and
19 either meet Part 50, Part 52 and have a design that
20 was either accepted by the NRC or design certified and
21 ready to be built and operational by 2010.
22 From the experience we've seen with the
23 ALWR program, there is a timely process. We're asking
24 these vendors to come in and tell us how they had
25 planned to get through that process.

1 DR. POWERS: One of the frustrations, I
2 think, the agency has when it confronts new designs or
3 anything new with the regulations is that the
4 applications tend to come in piecemeal and whatnot.
5 There's some effort here to have more comprehensive,
6 better quality applications coming in?
7 MR. MILLER: We're not addressing that.
8 MR. LEITCH: One of the significant
9 activities that you list is design certification of a
10 1000 megawatt ALWR. Does that suggest a predeposition
11 to large reactors versus smaller modular designs?
12 MR. MILLER: No, that's not a
13 predeposition. That is one of the responses we got
14 back. We also got feedback from the GT-MHR from
15 General Atomics, which is a small design, the pebble
16 bed reactor design, which is a small design. There
17 was also a response back from Westinghouse for the AP
18 600. So, I don't see a predisposition to larger
19 plants.
20 DR. KRESS: If there are no more
21 questions, we'll follow on to the next item on the
22 agenda, which is Mr. Johnson. Mr., Mr. Versluis
23 again.
24 MR. VERSLUIS: Yes, that's me again. Yes.
25 Thank you.

1 I'm going to talk a little bit about the
2 Generation IV concepts that we have received. And I'm
3 going to take you on a whirlwind tour and scare you a
4 little, probably, in the regulatory area.
5 We felt that we needed to take a good look
6 at all concepts that could show promise, particularly
7 since we have built in a good period of R&D, we really
8 want to look at concepts with the proper amount of R&D
9 and can meet the goals or can advance very much
10 through the goals. And we started also with a request
11 for information in March. That request closed
12 sometime last month, a few things have still been
13 dribbling in. It was published in the Commerce
14 Business Daily, the Federal Register and was also
15 distributed very widely in the international
16 community.
17 We now have about a 100 responses, and I'm
18 going to be talking about the key features and the
19 statistics, and basically you're getting this hot from
20 the press without much digestion because we just got
21 them in. But I'll talk about grouping and then the
22 current activities.
23 This is the definition we've already gone
24 through, so next.
25 We received totally 94 concepts, but we

1 also had internally generated some of the concepts and
2 not all of these here were full energy concepts. So
3 we figure we have about a 100 total, and this shows
4 the breakdown by different coolant technologies, by
5 country and by organization type. And I will leave
6 this for you to pursue through at your convenience and
7 go to the next slide.
8 And this shows the variety of concepts
9 that were received. Going to the water group, and
10 these were reported by the water group, the variables
11 that they recognized in looking at these concepts are:
12 The coolant, light, heavy water; phase and conditions;
13 thermal, epi-thermal and fast spectrum; primary system
14 layout - there were a number of integral PWR types but
15 also conventional; the fuel cycle - uranium and
16 thorium once-through various recycles; the thermal
17 output and particularly also the maturity of concepts,
18 different.
19 Some of the crosscutting R&D issues that
20 they immediately identified for all of these are high
21 temperature materials, modular manufacturing
22 technologies, internal control rods and I&C issues.
23 That doesn't mean that these are the only ones, but
24 those jumped out when I first looked at them.
25 In the gas group the variables they

1 recognized are the reactor concepts and the
2 applications of fission heart. And within the reactor
3 concepts there were the gas turbine modular gas cooled
4 reactors, PBMRs, fluidized bed reactors and a gas
5 cooled fast reactor.
6 And there was a great variety of the
7 applications, the energy products for which the
8 fission heat could be used: Electricity generation,
9 both direct and indirect cycle; various process heat
10 applications as well as district heating and
11 desalination.
12 They recognized different fuel forms and
13 fuel cycles with uranium, thorium and uranium
14 plutonium. There are good plutonium burners, the gas
15 reactors, so there were a number of concepts that
16 focused on that.
17 And their generic R&D issues are: The
18 fuel fabrication quality assurance; fuel performance -
19 integrity and fission product retention; lifetime
20 temperature and irradiation behavior of graphite
21 structures; high temperature materials and equipment;
22 and, passive heat decay removal for fast-spectrum
23 concepts. Fast-spectrum concepts have less of a
24 thermal capacity because many of the lighter elements
25 have to be removed.

1 The liquid metal coolant, the variables
2 are: the size - large/monolithic designs, modular
3 designs, transportable designs - and targeted clients.
4 And I think I'm not sure what they meant through that,
5 but I think it means a transportable reactors that you
6 can take to less developed areas of the world with
7 less stable grids and less of an infrastructure.
8 Different coolants, sodium, lead and lead
9 alloys.
10 Fuel type, oxide, metal, nitride,
11 composites meaning the entire spectrum that you can
12 think of.
13 Primary system layout, look and pool.
14 BOP options and energy products also
15 there.
16 Energy conversion options that include
17 some pretty advanced things like Mtech, the thermal
18 electric conversion and other high technology MHD was
19 also in there. And fuel recycle technology, aqueous
20 and dry recycling.
21 Now in the non-classical concepts we may
22 have to ask assistance from Commissioner Diaz because
23 so many different things came in and he has a lot of
24 experience with some pretty way out designs.
25 The focus of this group is on adequately

1 defined concepts with significant potential, and the
2 variables there are: The cooling approach; the
3 coolant itself, molten salt, organic; the fuel phase,
4 solid, liquid, gas and vapor; electricity generation
5 technology conversion including a direct fission-
6 fragment energy conversion; alternative energy
7 products or services; and also the fuel cycle.
8 The crosscut issues that they identified
9 are: Modular deployable; hydrogen production and very
10 high temperature systems; advanced fuels and fuel
11 management techniques; and energy conversion systems,
12 especially non-Rankine.
13 Now, I'd like to say something about the
14 grouping, because that's really the first step of our
15 work is to look at this entire group and organize
16 them, and get them ready for the first screening.
17 All the TWGs, all the working groups have
18 taken a first cut at the grouping them into concept
19 sets that share a technology base and a design
20 approach. And rational for the grouping is, first of
21 all, the efficient division of the analysis effort,
22 but also the streamlined evaluation process and an
23 avoidance of premature down-selection at this point
24 when there's so little information available about
25 some of these concepts and we run the risk of throwing

1 out the baby with the bath water.

2 For the water group we found we have three
3 PWR loop type reactors. These are, in fact, the sets.
4 Three PWR loop reactors, a set of three. Integral
5 primary system PWRs, six. Integral BWRs, six.
6 Pressure tube reactors, three. High conversion cores,
7 11. Three supercritical water reactors and then 14
8 advanced fuel cycle concepts of various types, you can
9 read.

10 The gas group there were five pebble bed
11 modular reactor concepts. Five prismatic modular
12 reactor concepts. One very high temperature reactor
13 operating at ~15003°C. Five fast-spectrum reactor
14 concepts, and four others including fluidized bed and
15 moving ignition zone concepts.

16 The liquid metal group looked at four
17 major categories and concepts: Medium-to-large oxide-
18 fueled systems of which there were six; eight medium-
19 sized metal-fueled systems; eight medium-sized Pb/Pb-
20 Bi systems; and six small-sized Pb/Pb-Bi systems.

21 They're also examining three supporting
22 technology areas: oxide, metal and nitride fuels;
23 different coolants; and different fuel cycle
24 approaches.

25 And in the non-classical group, as you can

1 see, they were not real successful in creating a lot
2 of economy here with the grouping, but there are some.
3 There are two eutectic metallic fuel
4 types, four molten salt fuel concepts, a gas core
5 reactor, a molten salt coiled/solid fuel reactor, an
6 organic cooled reactor, a solid conduction/heat pipe
7 reactor and two fission product direct conversion
8 systems.
9 Okay. I hope this didn't scare you too
10 much.
11 The current activities now with the
12 concepts in the working groups is to analyze these
13 candidate concepts for performance potential relative
14 to the technology goals and to start working and
15 identifying the technology gaps.
16 And this fiscal year a report will be
17 prepared to describe these concepts and we have laid
18 out a format for that. We want all the concepts to be
19 described in a similar manner. The R&D needs will be
20 covered in that report. And the results of the
21 initial screening for potential evaluations.
22 And that's where we are.
23 DR. KRESS: Questions?
24 DR. SHACK: One of the things I noticed
25 this morning in the whole discussion of the Generation

1 IV thing was that the word "severe accident" never
2 appeared anywhere. Do you envision that as being a
3 technology need that will have to be addressed in the
4 R&D program?
5 MR. VERSLUIS: Yes. One of the goals, the
6 second safety and reliability goal has to do with core
7 damage. And then the third goal has to do with the
8 emergency response. So in both of these goals severe
9 accidents are an issue.
10 And the second goal will assume the
11 performance of a PRA. And the third goal will have to
12 involve all the severe accident that could lead to a
13 release off-site.
14 Does that answer your question?
15 DR. SHACK: I guess so. You know, I guess
16 my question is are you going to handle it by
17 essentially your PRA argument that core damage is so
18 unlikely that I don't have to address a severe
19 accident, per se? Or do you really envision a need,
20 for example, to determine source terms for some of
21 these reactor concepts?
22 MR. VERSLUIS: Well, for those concepts
23 that are selected that make it through the early
24 stages of the screening, there will have to be a
25 better description of source term and the various

1 scenarios leading to the source terms, yes. But early
2 on, as you can see by this wide variety of concepts,
3 we're going to have to use surrogates and indicators
4 with potential and severe accidents.
5 And we are looking at physics parameters,
6 at heat capacity at the typical things that you would
7 look at to determine whether or not it's likely to --
8 and what the passive severe accident would be.
9 DR. FORD: We've been told earlier on that
10 risk-informed regulation is going to be a part of your
11 strategy, and yet we're looking at a whole lot of new
12 systems here for which we have no experience at all in
13 terms of time dependent degradation. So as you're
14 going through your screening process, does the time
15 needed for R&D to resolve those questions, does that
16 enter into your timing, your decision making?
17 MR. VERSLUIS: Yes, it does. And
18 certainly we hope or we intend but in early on in
19 particular to focus on those issues where there's a
20 large amount of uncertainty and try to reduce that
21 uncertainty. That's how we will focus what we call
22 the viability R&D, so that we have a better idea of
23 what the potential is to really meet --
24 DR. FORD: And have you also taken into
25 current the question of manpower capable of doing that

1 research?

2 MR. VERSLUIS: Well, there will of course

3 be as part of the roadmap an estimate of required

4 manpower, resources and infrastructure. But we are

5 certainly aware that there is a lot of work needed

6 there and a lot of investment needs to be made. I

7 should probably let Bill Magwood talk to this issue,

8 because this is wider than just the Generation IV.

9 You want to say anything about that?

10 MR. MAGWOOD: Well, I think it's always

11 important to think between time and maybe the

12 distinction wasn't made as cleanly. But when Tom was

13 talking about the near-term deployment, we're aiming

14 for systems, and I think you can tell from the types

15 of technologies Rob was talking about, that on Tom's

16 side will be deployable before 2010. And then the

17 case that Rob was talking about, we're talking about

18 systems that will be deployable by 2030.

19 So, clearly once we make a selection of

20 the concepts that should be pursued, the roadmap will

21 lay out what the R&D programs should look like. And

22 that actually is a little -- to some degree. You know,

23 rather than simply saying we need to maintain a

24 healthy university system, we need to maintain a

25 healthy infrastructure to make sure that we'll be able

1 to develop advanced concepts, we'll be able to point
2 to the technology roadmap and say we can't do that
3 because the infrastructure doesn't look like the
4 following, we don't have the kinds of professionals
5 available.
6 One really good example in the United
7 States, and I think some of you are aware of this, is
8 that we're in pretty poor shape when it comes to
9 nuclear chemists. There just aren't very many left
10 and a lot of them are retiring. And the universities
11 aren't putting out any more nuclear chemists. So, you
12 know, as we get into some of these areas, especially
13 molten salt reactors and things like that, you know,
14 you're going to have to know that you have nuclear
15 chemists available to go off and do this research over
16 the next, you know, ten or 20 years.
17 So clearly the roadmap itself will become
18 a vehicle for us to get a better handle on the kinds
19 of requirements we need. Right now it's very
20 speculative, it's very high level, there aren't a lot
21 of specifics.
22 For example, NERAC has rolled out a long
23 term R&D plan to cover the wide area, but it doesn't
24 focus on specific concepts. This will do that. So I
25 think that there's time to respond to the need.

1 But Rob was right, the much bigger issue
2 is support.
3 MR. WALLIS: When you were listing all
4 these concepts, it reminded me of the '50s and '60s
5 when there was a blooming of dozens of concepts,
6 rather like these ones and only two or three survived.
7 So, there's a sort of a redoing about this and I'm
8 trying to think about what is it that's going to make
9 a difference this time? Are there some breakthroughs
10 in technology or are there some changes in criteria,
11 or something which will make a difference this time
12 around?
13 MR. VERSLUIS: Well, I think you answered
14 your question partially yourself. There are indeed
15 new materials.
16 I also think that there has been an new
17 recognition among policymakers and the public that
18 we'd better start some planning for our energy future
19 and issues like sustainability, climate issues they
20 now play a much bigger role than they did 40 years ago
21 when we designed the first round of technologies.
22 But, yes, in fact when you look at the
23 technologies that have been submitted, many of them
24 are really not new. But it is time to look at them
25 with the eyes of today, or actually the eyes of mid-

1 century and the need for hydrogen production and the
2 need for clean water, and the need for other energy
3 products.
4 And in addition to that, of course, there
5 is the change in the market structure. There is
6 deregulation of the energy markets. There is the
7 internationalization of the vendors as well as the
8 owner operators.
9 So, really the environment for judging
10 these technologies has truly changed and it is worth
11 looking at them again.
12 DR. BONACA: Yes, going back to the
13 question of severe accidents, we call today severe
14 accidents those accidents which were not considered as
15 part of the original design basis of the plans. Are
16 you going to have designs that address all kind of
17 severe accidents, or something akin to what we had in
18 the past?
19 MR. VERSLUIS: There really is no doubt
20 among the roadmappers that the concepts that are
21 selected for the development as we get further into
22 the development and designs are becoming more
23 specified, that they have to be shown to be safe. I
24 mean, there's no way around that. And I'm not sure
25 how to answer your question other than, we're not

1 looking for cutting corners on safety. In fact, we
2 are hoping to make advances towards safety.
3 DR. BONACA: So essentially the design
4 basis of the plan will include consideration of severe
5 accidents?
6 MR. VERSLUIS: Yes.
7 DR. BONACA: What we call today severe
8 accidents?
9 DR. GARRICK: Rob, one of the things that
10 bothers me a little bit about this program is that if
11 I look at other programs like the Apollo program, the
12 atomic bomb program, et cetera, et cetera and ask what
13 was the real driver, where was the real cadre of
14 activity and creativity, and they of course had very
15 specific groups that constituted the think tank and
16 the nucleus of where everything kind of emanated from,
17 and I'm also thinking of the model that I think is a
18 very good one, the Lockheed Skunkworks. Here was a
19 small number of people that just generated immense
20 breakthroughs in terms of solving these kinds of
21 problems. I don't see that here.
22 I see a lot of review groups and I see a
23 lot of proposals from different organizations, but I
24 don't see -- and I don't know what this has to do with
25 regulatory challenge, but it might because they should

1 be part of that team, too. But I don't see the kind
2 of inspiration and drive that comes from a Von Brun
3 group that is putting together the rockets that are
4 going to get us to the moon. And yet the time
5 constant here is much longer than any of those
6 programs.
7 How is this all gelled together in terms
8 of a first rate group of people that we really look to
9 make it happen? Maybe Bill has to answer that one, I
10 don't know.
11 MR. VERSLUIS: Well, let me take a first
12 crack at it. I mean, I'm not sure I understand --
13 DR. GARRICK: I'm looking for the core
14 group.
15 MR. VERSLUIS: Right. What I wanted to do
16 at least is to point out that we're not only working
17 with the U.S. expertise, one of the things that Bill
18 has insisted in, and he's very right about that, is to
19 expand this into the world, and particularly into the
20 nuclear community with credible programs. The people
21 like the Japanese and the French that bring a lot of
22 resources and expertise to the table that we are just
23 kind of hanging on to.
24 So, I think that looking at taking a wider
25 view, there is a lot of resource or a lot of

capability available.

You were saying how can you focus it to --

DR. GARRICK: Right. Right. Where is the Robert Oppenheimer group? Where's the Skunkworks group? Where's the group that really is the driver?

MR. VERSLUIS: Well, they need money, and this is -- and Bill can correct me if I'm not representing this correctly, but this is a way to in a fairly transparent manner make a strategic plan where you start with all the concepts that you can find and you narrow down to the most promising ones, and then you focus your R&D on those.

So, perhaps the answer to your question is we will get a focused effort, we will get a -- I don't know if it's a small group, we hope it is, with enough resources there to do the R&D that needs to be done. But it will be focused and it will be done on a small number of promising concepts.

MR. JOHNSON: John, if I could take a shoot at answering your question. With all respect, I'm not sure the analogy is an appropriate one because those former federal programs were really single objective oriented in terms of creating the bomb, putting a man on the moon. What we're talking about here is developing the enabling technologies and

1 getting those technologies to a point for a hand-off
2 to industry and industry to make a decision on whether
3 to take those technologies and commercialize them and
4 apply them. We're not advocating the United States
5 get into -- the federal government embark on a reactor
6 design deployment mission here.
7 DR. GARRICK: Yes, and I'm not even saying
8 it has to be the federal government. Because, you
9 know, the Skunkworks model was not necessarily a
10 government program. But, yes, go ahead.
11 MR. JOHNSON: Oh, I was finished, John.
12 DR. GARRICK: Okay.
13 DR. KRESS: Seeing no other questions,
14 let's move on to --
15 DR. APOSTOLAKIS: Just a minor comment.
16 DR. KRESS: Oh, okay. Comments,
17 questions.
18 DR. APOSTOLAKIS: I wonder whether for the
19 new concepts we should also rethink the terminology
20 that we've been using, which is of course water
21 reactor driven. There was a discussion on severe
22 accidents a few minutes ago, and I don't know that we
23 really want to carry over this terminology and other
24 similar stuff.
25 So, I know this is a detail at this point,

1 I mean you're thinking about much bigger things. But
2 it seems to me that's something to have in the back of
3 our minds, whether we want to continue using some of
4 the terminology of the past, especially since one of
5 the earlier goals that were stated was public
6 acceptance.
7 MR. VERSLUIS: I think it's something that
8 we should think about. We really haven't delved into
9 severe accidents much at this point, and it may well
10 be a good time to review the terms. Thank you.
11 DR. KRESS: Yes. That's a concept that
12 comes about because we have been used to design basis
13 accidents. And in order to separate the two, we'd
14 call them severe accidents. And it almost seems like
15 an arbitrary separation.
16 I don't know. My question is are you
17 going to try to fit -- well, I guess it may be
18 premature to ask this, but fit the licensing of this
19 into a design basis concept to fit it into the current
20 regulations or are you going to try to develop PRAs
21 that are sufficiently acceptable that you couldn't go
22 completely a risk-informed route? I guess that's my
23 question: Are we going to stick the design basis
24 concept?
25 DR. BONACA: The reason why I think is

1 important, however, is that we're still having to deal
2 with credibility of an accident. What is the most
3 limited credible accident. I mean when the current
4 design basis was defined, is because it was believed
5 that that was the most credible accident, the most
6 limiting ones. And so in good faith people put limit
7 to the -- and that yet is going to be challenging in
8 the course of --
9 DR. KRESS: There's a whole issue of how
10 do you go about defining design basis accidents.
11 DR. BONACA: Exactly.
12 DR. APOSTOLAKIS: Yes, it's very
13 interesting because the first paper on risk in 1967 by
14 Reg Farmer raised the same question; is it logical to
15 consider to have a distinction between credible and
16 incredible accidents.
17 DR. POWERS: And I think we have found the
18 limitations on the maximum credible accident kind of
19 concept. I was fairly excited when one of the
20 speakers said that the approach was that once they had
21 refined down their list of viable concepts down to a
22 more trackable few, that they would then look more
23 carefully at the source driven. It seems to me that's
24 where you'd look rather than the accident scenarios.
25 And I think this is a place where we need to come back

1 and revisit what we discussed in the past on frequency
2 consequence curves, which is actually coming back to
3 your man Farmer a long time ago that this may be a
4 much more valuable direction for us to take than the
5 classic level one, two, three kinds of approaches and
6 design basis accidents versus beyond design basis
7 accidents.
8 I mean, it's a much better continuum to
9 look at rather than these categorizations.
10 DR. APOSTOLAKIS: So you were excited
11 earlier, Dana, and now I'm excited.
12 DR. POWERS: Well, we actually find some
13 use for those probablistic things that you do, but
14 we'll get into some really good metallurgy stuff here
15 in a little bit.
16 DR. KRESS: With that, I'd like to move on
17 to the next speaker, please. Mr. Johnson, you're
18 next.
19 MR. JOHNSON: Yes. Thank you.
20 Good morning. My name is Shane Johnson,
21 and I'm the Associate Director for Technology and
22 International Cooperation for the Office of Nuclear
23 Energy at the Department of Energy. And what I'm
24 going to do briefly is just try to summarize what you
25 have heard over the last hour and 45 minutes from our

1 discussion this morning. And that is, where do we go
2 from here?
3 You've heard us talking about our
4 Generation IV activities, our Generation IV activities
5 being defined as both the near-term deployment
6 activities as well as our technology roadmap
7 development.
8 Before I embark on summarizing that, I
9 would just like to say to get back to a question that
10 the Chairman put early on relative to the regulatory
11 challenges. And that is we have recognized that in
12 both our near-term and our longer term activities that
13 there is an inherent regulatory facet to the programs.
14 For example, these two activities, both
15 our near-term deployment as well as our longer term
16 Generation IV technology roadmap, while we have got
17 them linked to under a single program, they are
18 somewhat as you've heard significantly different in
19 terms of their objectives and the time frames.
20 Our near-term deployment group really is
21 focused on identifying regulatory and institutional
22 barriers that exist in the United States for
23 deployment of new nuclear assets. And we have also
24 approached that in looking in terms of technologies
25 that require no or little further development. So our

1 near-term deployment activities are really focused at
2 the regulatory environment in the United States and
3 has very little in terms of a focus on technology
4 development.
5 Our Generation IV technology roadmap is
6 really just the opposite end of the spectrum of that,
7 and that is we're looking at in terms of the
8 Generation IV technologies is truly technology
9 development. Looking at technologies that are,
10 hopefully, stretching our current knowledge of reactor
11 design and operation. But simultaneous with that,
12 while we don't want to lose sight of regulatory
13 implications, again it's a technology development
14 program and the regulatory aspects of deploying that
15 technology are going to come, again, in the future.
16 The Department, as the Committee well
17 knows, is the federal government's technology agency
18 as opposed to the NRC, which is its regulatory body.
19 But in our activities we have been
20 working, in both the near-term activities and our
21 longer term Gen IV activities, with the agency. We
22 have been working with the Office of Research here,
23 Ashok Thadani and his staff, in both the near-term
24 deployment activities as well as our Generation IV
25 technology activities and having a representative from

1 the Office of Research involved especially with our
2 Generation IV International Forum. John Flack, one of
3 Ashok's staff here, has had the privilege of trotting
4 around the globe with us as we engage the
5 international community in the Generation IV
6 technology arena.
7 Quickly to summarize, first I'd just like
8 to address those things on the near-term deployment
9 activities, as Tom Miller went over earlier. And that
10 is our goal in our near-term activities is to complete
11 our near-term deployment report by September of this
12 year. The report will identify primarily generic
13 issues that the government could pursue in a cost
14 share cooperative basis with industry to establish an
15 environment that will enable industry to step out and
16 make informed decisions on the deployment of new
17 nuclear assets in the United States. Those issues as
18 it appears right now primarily are going to be related
19 to early site permitting, going through that untested
20 process, as well as the combined construction and
21 operating license process.
22 We are also working with the NRC in
23 helping them to get started in the development of
24 generic advance gas reactor regulatory framework,
25 because as everyone knows it's an area that needs some

1 work and there are organizations in the industry who
2 are coming forward and having those discussions with
3 NRC, so it is a responsibility of the federal
4 government to be prepared to address these technology
5 concerns. And we're glad to be working cooperatively
6 with the NRC in aiding them as they develop these
7 generic reactor technology regulatory framework.
8 With respect to our Generation IV
9 technology roadmap really our near-term actions, as
10 Robert Versluis has summarized, is to take the almost
11 100 concepts and to go through a systematic evaluation
12 of those concepts and identify those concepts which
13 are most promising which to the extent at which we are
14 able to make such an evaluation at this time, meet the
15 technology goals that have been established by our
16 nuclear energy research advisory committee as well as
17 our Generation IV International Forum. And after
18 identifying those most promising concepts, is to put
19 together the comprehensive research and development
20 plan that will, hopefully, lead to the development of
21 these technologies and bring them to a point at which
22 time in the future they can be handed off to industry
23 for further and eventual commercialization.
24 And with that, I believe our discussion on
25 the Generation IV activities is complete.

1 Mr. Chairman.

2 DR. KRESS: Questions for the speaker or

3 any of the previous speakers? I guess we must be

4 hungry. Ah, there's one. Please identify yourself.

5 MR. LYMAN: Ed Lyman again, Nuclear

6 Control Institute.

7 I just have to follow up from my earlier

8 question, because I think what we've just heard is a

9 list of activities which I don't think it's

10 appropriate for the government to be funding. These

11 are activities which are associated with providing a

12 regulatory climate or easing licensing advanced

13 reactors. And I think in today's context, that's a

14 cost that really should be born by the applicants.

15 Licensing is expensive, but that is part

16 of the package for trying to develop a new nuclear

17 reactor and market it. And so I think it raises real

18 questions whether DOE should be involved in trying to

19 facilitate or come up with ways of easing the site

20 permits and other regulatory activities.

21 I'm also concerned about DOE proposing a

22 licensing framework for reactors and then a way of

23 meeting those licensing criteria. I think there

24 really has to be a separation maintained between the

25 licensing standards and the actual applicant. Because

1 otherwise these criteria could be gerry-rigged to
2 justify or to facilitate the particular reactor you're
3 pushing.
4 MR. MAGWOOD: Again, Ed raises an
5 important point and I think it requires a little bit
6 of distinction drawn.
7 What we're doing, Ed, and for everyone
8 else who had concern about this, is we're focusing on
9 generic issues, and this is something that DOE has
10 done basically throughout history.
11 For example, in the case of gas reactors
12 there are some very generic issues related to the
13 implementation of gas reactor technology in the United
14 States whether it's a pebble bed or GT-MHR or
15 something else, you have to deal with, for example --
16 and this is something that we've had a lot of very
17 important discussions about. If in the case of a case
18 reactor you're relying very heavily on the quality of
19 the fuel, how does one go about thinking about fuel
20 manufacturing in concert with the design of a power
21 plant? You can't separate it as easily as you can in
22 the light water reactor. That's a very, very broad
23 generic technology issue. And I think it's entirely
24 appropriate for DOE to be involved in that.
25 What we will not be involved in are the

1 specific -- and NRC, by the way I'll point this out,
2 NRC's Office of General Counsel has been very, very
3 diligent about keeping both NRC and DOE straight about
4 this issue.
5 We will not contribute to the specific
6 design related regulatory activities NRC will be
7 participating in with the vendors. There will be a
8 separate activity that will probably be coming on in
9 the next year or so. We expect that Exelon, or
10 whoever, will come to the NRC and will be obligated to
11 pay for those activities. We don't anticipate being
12 involved in that.
13 But the generic activities are things that
14 we think the government ought to be involved in and
15 should be involved in. And I'll be happy to talk with
16 you more about that later, but I think it's entirely
17 appropriate what we're doing as long as you stay on
18 this generic level. I think there has to be a
19 distinction.
20 DR. UHRIG: There's a number of rather
21 exotic materials involved in the various concepts that
22 have been talked about this morning. Is there any
23 consideration or any time being spent looking at the
24 availability of these? Even something as common as
25 hydrogen -- I mean helium, excuse me, there's a

1 limited amount of that unless you want to produce it
2 artificially. And I just wondered if this is an issue
3 that's going to be brought into the consideration?
4 MR. MAGWOOD: That's a really good
5 question, and something that I've actually started to
6 worry about myself. The answer to the question is no,
7 we haven't done this stage. And the reason we haven't
8 is because we haven't reached this 2002 target of
9 narrowing down the number of options. When we know
10 what concepts we're really going to spend our energies
11 on, we're going to really have to deal with those
12 materials issues.
13 And I can't talk too much about this, but
14 we are expecting in the next few weeks to really
15 strengthen our materials activities within the DOE
16 infrastructure and start to have more focus on these
17 issues. Because I think they're too disperse right
18 now. We need to really focus our energies there, and
19 we're going to be doing that very soon. We'll make
20 some announcements about that.
21 But your question is really good one, and
22 we're worried about it but it's too early for us to
23 really go a whole lot further.
24 MR. UHRIG: I guess my point was that this
25 could e an issue that would eliminate an otherwise

1 attractive concept.

2 MR. MAGWOOD: Well, that's a really good

3 point. I mean, for example if we don't have enough

4 helium for the helium cooled reactors --

5 MR. UHRIG: I think that's not a major

6 issue, but it's something that certainly should be

7 looked at.

8 MR. MAGWOOD: Yes. I think it's something

9 that will have to be looked at in concert with the

10 evaluations that NERAC is doing. I mean, I'm not

11 aware of any major materials limitations. If someone

12 has some exotic material that, you know, it's just not

13 available, I expect that will become one of the

14 technology issues. And if it is such an issue that

15 you simply can't rely on being able to build numbers

16 of plants, I would expect it would be kicked out on

17 that basis. So, I think that's something we ought to

18 take back to the group and make sure they're conscious

19 of that. So, I appreciate that thought.

20 But so far I've never heard of any exotic

21 material that would simply eliminate a concept being

22 considered.

23 MR. UHRIG: Thank you.

24 MR. FEINROTH: My name is Herbert

25 Feinroth.

1 As I listened to some questions from the
2 ACRS and also the DOE presentation I sort of see a
3 different -- there's a gap between what the DOE is
4 focusing on, which is the entire fuel cycle not just
5 the reactor and their interest is in these goals that
6 they've described to achieve safety and public health
7 for the entire fuel cycle. Whereas the ACRS is
8 focused, I believe, in the past and I think still on
9 reactors only. And it seems to me that this is more
10 of an observation than a question, because I don't the
11 question has an answer that the regulators need to
12 look at the whole fuel cycle as well and not just the
13 reactor as they provide advice or input to the DOE in
14 their section process.
15 The gentleman asked about the source term.
16 Well, the source term of importance to public health
17 is not just what's in the reactor, but what gets
18 transported, but gets recycled, what gets sent to a
19 repository. So I think the context that DOE is
20 looking at this is correct. And I think the regulatory
21 agency needs to figure out how to address the
22 imbalance, the public health from the different parts
23 of the fuel cycle. And my concern is the ACRS just
24 looks at the reactor.
25 I don't know if anybody has a response to

1 that, but I think that's an issue that needs to be
2 addressed by the regulatory agency.
3 DR. POWERS: Well, we'll comment quickly
4 that we do have the Chairman of the Advisory Committee
5 on Nuclear Waste look at the waste portion of it. And
6 that ACRS does also look at the fuel fabrication part
7 of the problem as well, though we probably haven't
8 focused on it very much in the discussion today
9 because the fuel cycle has only been mentioned briefly
10 here as being changed.
11 DR. KRESS: I think the questioner had a
12 good point. I did want to point out that the ACNW
13 also focuses on regulations related to sensitive
14 materials and materials applications.
15 Perhaps ACRS could do a little more on the
16 fuel cycle parts, but our conception, at least our
17 feeling is, the real risk part of the thing is in the
18 reactor or perhaps in the fuel fabrication.
19 George, did you want to say anything?
20 DR. APOSTOLAKIS: And we also have joint
21 committees with the ACNW when the issues warrant it.
22 But it's certainly a good thought.
23 MR. CLEMENTS: Yes, I'm Tom Clements with
24 the Nuclear Control Institute.
25 I was a little confused during the DOE

1 presentation about the relationship between the
2 roadmap and the review you're doing and what's
3 happening with the Exelon pebble bed reactor. From
4 what I hear, depending on what happens in South
5 Africa, they plan to start construction in 2004 and
6 have a reactor operating in this country 2006. It
7 sounds to me like you're behind the curve on what's
8 happening with that reactor. Are you going to ask
9 them to slow down their decision process in pursuing
10 this with NRC? You're behind the curve on what
11 they're doing here on the ground with the NRC or do
12 you assume that you're going to include this reactor
13 in your roadmap? I'm just confused about the
14 relationship between what you're doing and the pebble
15 bed.
16 MR. MAGWOOD: The pebble bed, that's a
17 good question because I saw something and I thought
18 someone would ask that question.
19 The pebble bed reactor that Rob spoke to,
20 he spoke to a class of PBMRs, those are not
21 necessarily , in fact may not really all be the
22 reactor that Exelon is interested in and is now being
23 discussed in South Africa. That specific design is
24 being discussed as part of the near-term deployment
25 activities. And, as I've mentioned, those activities

1 are largely complete and will be final -- scheduled to
2 be final through the NERAC process in September, and
3 include largely institutional issues that are being
4 raised by NERAC that are fully in concert with the
5 schedule that PBMR corporation is on.
6 And, in fact, there are representatives of
7 Exelon on some of the working groups that are
8 providing information about the schedule and trying to
9 keep everything in concert.
10 So that PBMR is slated for near-term
11 deployment as opposed to being in the longer term
12 Generation IV activities. And that's simply because of
13 the fact that it's of near-term interest to a utility
14 and, therefore, it's appropriate that we look at it as
15 something to be deployed by 2010. And whether it
16 actually gets deployed by 2010 or not is up to Exelon
17 and others.
18 MR. QUINN: It's Ted Quinn.
19 Bill or Shane, we've read the Vice
20 President's report -- or the President's report and it
21 addresses investment in new technologies for
22 renewables, for coal for example, and some of the 105
23 recommendations address advance nuclear. Can you
24 advise in FY '02 and beyond how those recommendations
25 will come into DOE planning?

1 MR. MAGWOOD: No. To expand on no, nein.
2 Let me just say that, obviously, certainly and our
3 international partners are all very pleased with the
4 outcomes that were in the Vice President's review and
5 have every hope that eventually there'll be more
6 resources devoted to nuclear research and development
7 by the government. Certainly there would have to be
8 to do any of the things that we've talked about today.
9 What will happen in specific fiscal years,
10 2002 in particular, I simply don't have an answer for
11 you. I think that as the government continues digest
12 results of the review, we'll begin to talk more in
13 terms of what do we have to do to actually implement
14 those things, and those discussions have already
15 started moving.
16 But I wouldn't expect to hear any specific
17 implementation announcements other than what you may
18 have already heard from the Secretary. I think he
19 made some announcements recently about specific things
20 in non-nuclear aspects. But on the nuclear aspects
21 it's going to take a while to adjust it, move on it
22 and to formulate those implementation activities.
23 So I would expect that over the course of
24 the next few months those would start to come out.
25 DR. KRESS: With that, I'd like to thank

1 all of our speakers this morning for getting us off to
2 an excellent start. And remind everyone that we have
3 some good things this afternoon on specific designs
4 and some of the regulatory activities that are
5 underway to get ready for this, and some very
6 interesting panel discussions on regulatory
7 challenges.
8 With that, I'll recess for lunch and ask
9 people to be back at 1:00 please.
10 (Whereupon, at 12:07 p.m. the Subcommittee
11 was recessed, to reconvene at 1:00 p.m.)
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1 today for Exelon and PBMR to come to give you a
2 briefing on the pebble bed modular reactor project
3 currently underway in South Africa.
4 My name is Ward Sproat. I'm the Vice
5 President of Exelon Generation in charge of
6 international projects, and I represent Exelon's
7 interests on the board of directors of PBMR, the joint
8 venture in South Africa.
9 Today's presentation is going to cover
10 three areas. One is I'm going to give you a brief
11 introduction and project update about where the
12 project stands.
13 Second, I'm going to introduce by co-
14 presenter, Dr. Johan Slabber from PBMR Pty in South
15 Africa, who arrived yesterday afternoon with several
16 of his colleagues, and he'll be talking about the
17 design philosophy of the PBMR.
18 And then finally, I'm going to come back
19 on and talk about the licensing issues that we see
20 trying to license the PBMR here in the U.S.
21 Well, I'll keep talking and we'll move
22 forward.
23 Let me just start off with giving you a
24 project overview about where the PBMR project stands.
25 There's been a lot in the press, obviously, about the

1 project some of which is correct, some of which is not
2 correct. And I want to make sure that the ACRS has a
3 full understanding of where the project and where the
4 Exelon stands regarding this technology.
5 The project is completing the preliminary
6 design stages in South Africa at this point in time.
7 And we are currently finalizing what is called the
8 detailed feasibility report. That report is being
9 generated by the project team in South Africa as well
10 as several contractors, as well as with us, the
11 members of the joint venture. And that feasibility
12 report will be completed sometime probably this
13 summer, at which time then all of the investors in the
14 joint venture will make their own individual decisions
15 regarding whether or not to proceed to the next phase
16 of the project.
17 The next phase of the project is to move
18 forward with the detail design and the construction of
19 a demonstration PBMR in Republic of South Africa near
20 Capetown on the site of the Kuberg Nuclear Station.
21 The other investors in the project at this
22 stage of the game, besides ourselves, are BNFL,
23 British Nuclear Fuels Limited, SCOM, which is the
24 electric utility in South Africa and the Industrial
25 Development Corporation of South Africa.

1 So each of those investors will, in turn,
2 make their own decisions about whether or not to
3 proceed with the project, as well as the South African
4 government needs to make their decision regarding
5 whether or not they'll approve the instruction and
6 operation of the plant in South Africa.
7 Assuming all of those decisions are
8 favorable, which is not an assured outcome by any
9 stretch of the imagination at this stage of the game,
10 but assuming they are favorable, then construction
11 would start on that demonstration PBMR in South Africa
12 probably in late 2002 and would then take
13 approximately 36 months to complete construction with
14 then a one year start up test program in South Africa.
15 That's the program in South Africa. As
16 far as Exelon's decision making process and Exelon's
17 involvement, clearly we are pointing to make a
18 decision as to whether or not to continue to proceed
19 as a member of the joint venture in South Africa by
20 the end of this year. We'll make that decision
21 primarily based on economics; do we think that Exelon
22 can make money operating these reactors in a
23 deregulated electric utility market in the U.S. And
24 if so, then obviously we would have to require board
25 of director approval to proceed that way, but it would

1 be our intent to try and make a decision on whether or
2 not to proceed with the joint venture in South Africa
3 by the end of the year.
4 We probably also make a decision sometime
5 in that time frame, whether or not it's the end of the
6 year or early next year, to begin the licensing
7 process in this country for the first set of PBMRs
8 here in the U.S. And I'll talk a little bit later
9 when I come back on about what some of the obstacles
10 and challenges would be if we decide to move forward
11 with that. But that decision, I think, would also be
12 made sometime around the end of the year, nearly next
13 year as to whether or not to begin the actual
14 licensing process for the PBMR.
15 So, with that that's the current state of
16 both the project in South Africa and Exelon's
17 involvement in the project.
18 With that, I'd like to introduce Dr. Johan
19 Slabber, who arrived yesterday from the Republic of
20 South Africa along with several of his colleagues.
21 Hopefully, we have the right people here to answer
22 some of your questions as we go through this. And
23 I'll let Dr. Slabber introduce himself and explain his
24 background.
25 DR. SLABBER: Thanks, Ward.

1 Mr. Chairman, ladies and gentlemen. This
2 is a very nice privilege for me to be able to speak to
3 you. And I would like to give you some preliminary
4 information, and then go deeper into the design and
5 the important things regarding the safety as well
6 licenseability status.
7 Something about myself. My name is S-L-A,
8 although it is pronounced in South Africa as Slabber.
9 In America, if you pronounce it it sounds like
10 Slobber, and that I don't mind. You can say Slabber
11 or Slobber or Slabber.
12 Something about my background. I was
13 graduated as an electrical engineer with a physics
14 degree. And I did my Ph.D in mechanical engineering,
15 but between those two times, graduations, I spent some
16 nice years in Oak Ridge and I was fortunate to be able
17 to have attended the last -- in the U.S. So I am
18 really indebted to the U.S. for really wetting my
19 appetite for nuclear technology.
20 I also spent a short time, brief time, at
21 IAEA in safeguards. So in the matter of nuclear
22 nonproliferation, I am also in a position to highlight
23 to you the attributes regarding that aspect of our
24 plan.
25 The design actually started evolving when

1 I was an employee. I was General Manager Reactor
2 Technology at the South African Atomic Energy
3 Corporation. But at that stage the Board of Directors
4 said the climate is wrong, the money isn't there, so
5 please let's not look at something although it might
6 be very promising. So that was the point when I
7 departed the Atomic Energy Corporation to a systems
8 engineering company who still today is involved in the
9 project.
10 This, what I'm going to present to you,
11 was actually developed from the initial concept of a
12 direct cycle turbine generating electricity.
13 What we have as the philosophy and we,
14 right from the outset, have set as goals inherent
15 safety features employing passive means. It must be
16 modular in size because in South Africa we've got a
17 relatively small grid, but we want high efficiency.
18 And the possibility to eventually supply fresh water
19 for South Africa, it's a semi-desert country. So in
20 25 years we might run out of water, so that was the
21 focus for the first initial design.
22 And you will see on the screen there the
23 three bullets which are actually some of the
24 cornerstones of our initial ideas.
25 Employ passive and active engineered

1 features, but I would like to qualify this. Because
2 active might sound funny in this context. Active
3 there should be seen in the context of keeping the
4 facility, the reactor, operating within the normal
5 boundaries. In other words, supply cooling, supply
6 ventilation, et cetera. But the passive is to keep it
7 within the limitations which does not lead to
8 radiation release.
9 The second bullet is rather saying what it
10 is, just that you can mitigate but that you do not
11 have cliff edge effects like suddenly you've got time
12 built into your system.
13 And then the third bullet actually
14 supports that, reduce dependence on operator actions.
15 Can I have the next slide? This is,
16 unfortunately, you must see this drawing as it stands
17 at the moment drawn on unigraphics and modeled. But
18 just to show you the width is 25 meters. The length
19 is 50 and the height is 50 and 25 is below grade. But
20 what I would like you to concentrate at this stage on,
21 and it will become clear when we evolve from this,
22 that we have the reactive vessel sitting in an area --
23 and it's not very clear here -- which is we call the
24 reactive cavity. And we've got the power conversion
25 sitting in a volume called the PCU area and this total

1 strengthened section around the reactor and the PCU we
2 call the citadel which, in fact, is containing, acting
3 as a containment around all those high pressure
4 radioactive components. But I'll come back to that
5 later.
6 Can I have the next slide, please? This
7 is the complete stuff taken away. What we have here
8 is the reactor vessel of 20 meters high and 6.8 meters
9 diameter. And we have the PCU, and I think I must just
10 explain slightly the workings.
11 This was the initial concept of changing
12 from a single-shaft turbo generator to a multi-shaft
13 turbo generator employing a high-pressure turbine,
14 turbo compressor, a low-pressure turbo compressor, a
15 turbo generator.
16 And in the reactor cavity, which we have
17 the reactor cavity cooling system and then below grade
18 we have the spent fuel tanks which can house --
19 contain the fuel for 40 years of operation, 35
20 effective years of operations.
21 It is also designed to store the fuel for
22 another 40 years during the formal decommissioning
23 phase.
24 The fresh fuel is in the fresh fuel
25 building, and that area we've got the so-called helium

1 inventory control system which employs -- which uses
2 the helium to increase the thermal hydraulic power
3 taken up by the gas in the reactor. And due to
4 coupling of the heat processor co-efficient and the
5 negative temperature co-efficient, the neutronics is
6 just about following the request for semi-hydraulic
7 power.
8 And then we've got the fuel handling
9 system, which is loading spherical fuel into an
10 angular core in the reactor and graphite spheres into
11 the central and a central reflector. So the core
12 itself consists of an angular pebble bed core with a
13 central column of graphite spheres. And this was
14 necessitated because no control rods -- the design
15 objective was not to have control rods in the core
16 itself, but to have a system where the reactor physics
17 of the core pushes out the flux towards the reflector
18 region for reactivity coupling.
19 So we've got the fuel handling system,
20 we've got fueling tubes as well as graphite tubes.
21 And we've got -- and we've got some separation of fuel
22 and graphite at the bottom. So this is the PCU. This
23 is the spent fuel, the fresh fuel and the helium
24 control system and the reactor cavity cooling system.
25 Just at this point we are also taking note

1 of the proliferation resistant aspects that needs to
2 be built in a facility like this. So the reactor
3 safety design principles is actually highlighted in
4 these three bullets.
5 An objective of the design, to start off
6 with, was to focus the design around existing proven
7 German spherical fuel fabrication and testing
8 technology. That was a go, that was a given. No
9 deviation from that.
10 And then in the design apart from the
11 microsphere providing the primary barrier, multiple
12 fission product barriers to the environment, to the
13 public outside. And this is not really a safety
14 issue, but we put it under these, and I highlighted it
15 in the previous slide.
16 Can everybody hear me? Okay.
17 The fuel itself is a 6 centimeter diameter
18 graphite sphere with containing in the fueled region,
19 which is 50 millimeter diameter, 15,000 microspheres
20 of -- it's got a core of UO_2, it's got a porous region
21 around the microsphere which acts as a fission product
22 buffer, something like the buffer region in a LWR.
23 Then we've got three layers, pyrolytic carbon, high
24 density pyrolytic. The silicon carbide and then other
25 layer of pyrolytic carbon. And the diameter is just

1 under one millimeter.

2 So 15,000 of these in there and in there

3 the enrichment is 8.1 percent for the equilibrium core

4 and 4.9 percent for the burning core. And the amount

5 of material in that little ball is 9 grams heavy

6 metal.

7 And around the 50 millimeter diameter

8 sphere we've got a five millimeter unfueled section to

9 take care of abrasion and while this is moving through

10 the core so that you don't expose and allow

11 microspheres to come out.

12 The first bullet, next slide, to assure

13 fuel integrity. So, as I said the baseline as far as

14 proven technology German fuel and we have been given

15 the opportunity to access and purchase into the total

16 German database which they have developed for their

17 high temperature reactors. And it's been in the

18 process -- for South Africa. And we are actually

19 planning, and I'll come back to that a little bit

20 later, to replicate critical experiments and

21 qualification experiments and tests that were done in

22 the German program.

23 The next sub-bullet is because it's an

24 onload refueling system, you've got to good control

25 over excess reactivity added to the reactor core under

1 various conditions, and also to ensure under all
2 conditions normal operation as well as upset events
3 you assure removal, heat removal from the fuel by
4 means of passive means.
5 And prevention of chemical attack, which
6 is one of the events defined as one of the licensing
7 based events, and prevent excess of burnoff.
8 Now, in the development project we had to
9 structure the project very definite according to
10 certain rules. And for that we have developed the so-
11 called integrated design process in South Africa.
12 It's a PBMR integrated design process which embodies,
13 and we call it the PIDP, the upfront evaluation of any
14 structure system or component, SSC, in its role to
15 mitigate or to cause events leading to the release of
16 radioactivity. And those components are then
17 evaluated and classified according to a scheme which
18 is in line with our national nuclear regulator, the
19 NMR, prescriptions of failure frequencies versus
20 consequences.
21 And we have the three regimes that we are
22 using in the development of this facility. Events
23 having a frequency higher than 10 to the minus 2, in
24 other words one in a 100 years, we call the
25 anticipated operational occurrences.

1 And the events lying between -- into the
2 minus 2 and into the minus 6 is the licensing base
3 events. And then the occurrences with a lower
4 frequency than ten to the minus 6, those are the
5 extreme events or the unlikely event.
6 So what do we do to design a facility in
7 these regimes? The two, the first ones, the ten minus
8 two and -- plus ten minus 2 and between 10 minus 2 and
9 10 minus 6 we design for all those events. Below 10
10 minus 6 we analyze for and see what the consequence
11 are.
12 DR. APOSTOLAKIS: I have a question. I
13 don't understand what you mean by event. Do you mean
14 a sequence or do you mean what we call initiating
15 events?
16 DR. SLABBER: Yes. Yes. I was explaining
17 the integrated design process, so I interrupted myself
18 just to say what we're focusing at. But it is a
19 sequence. It is initiating event that can lead to a
20 sequence, that can lead to a --
21 DR. APOSTOLAKIS: So the 10 to the minus
22 2 refers to this initiator or the whole sequence?
23 DR. SLABBER: It's the initiator.
24 DR. APOSTOLAKIS: Now, given that the
25 concept of an event is not really well defined --

1 DR. SLABBER: Yes.

2 DR. APOSTOLAKIS: -- I can imagine an
3 event that has a frequency of 10 to the minus 4,
4 therefore I have to design for it, as you said, but
5 then I can break it up into a 100 little pieces each
6 one having a frequency of 10 to the minus 6, so now I
7 don't have to design for it. So, how do you avoid
8 this kind of -- I'm sure you don't it that way.

9 DR. SLABBER: Oh, no, we don't do it. But
10 we're looking at the logic also. In other words,
11 there are some enveloping frequencies which is also
12 the initiator plus the consequence, the total chain in
13 looking at all the events in between.

14 I wouldn't be able to completely reply to
15 your question because it's in the process of being
16 done at the moment, but a similar philosophy.

17 DR. APOSTOLAKIS: But it seems to me when
18 you have to go with the cumulative frequency at some
19 point?

20 DR. SLABBER: Yes.

21 DR. APOSTOLAKIS: Because just where you
22 consider in sequences, you know, this is not a well
23 defined concept.

24 DR. SLABBER: But in any case, thank you
25 for that comment.

1 DR. KRESS: As you will notice, we've
2 departed from our usual procedure and we'll allow
3 questions that interrupt the speakers. It's just the
4 ACRS can't seem to avoid -- control himself.
5 DR. APOSTOLAKIS: It was pain from this
6 morning.
7 DR. SLABBER: In any case, after we have
8 now identified these events, we can for that specific
9 SSC identify a preliminary classification. And then
10 for that specific SSC, we also classify the various
11 loads that it will achieve during its operational and
12 upset lifetime, and we develop a loading catalog. And
13 using the classification which drives the quality
14 assurance requirements as well as the loading catalog
15 and the codes and standards to which the SSC will have
16 to be developed and designed, we call that suite of
17 documents; the design rules for that specific SSC.
18 The QA requirements, the loading catalog,
19 the classification and the codes and standards, and
20 maybe some other additional things which must -- could
21 come into play like safeguard issues, et cetera. And
22 those are the suite of documents which are the design
23 rules. And then from there, there might be some
24 situations to improve the SSC design, so we can go
25 back to square one. Typically if the failure

1 frequency is too high.

2 So in the total development of the reactor

3 we have given priority to looking at the fuel first of

4 all. Next slide.

5 So we look at the fuel quality here and

6 the fuel design which we have chosen has been proven

7 internationally. And another feature that we also

8 embody in the design is that we do not want to develop

9 new material. We will be sticking at qualified

10 materials for all the structure systems and

11 components. This is one component which we have

12 decided we will, as far as practically possible and I

13 agree there will be a question that how do you prove

14 equivalence on such an important issue. This will be

15 done by laboratory tests, PBMR specific tests and

16 irradiation tests, as well as maybe taking part in an

17 international irradiation program.

18 And this is actually what is said here in

19 this sub-bullet. The fuel qualification program will

20 follow and the fuel performance testing program and

21 the fuel fabrication quality assurance program which

22 is still at the moment already starting to be based.

23 DR. KRESS: The performance testing

24 program.

25 DR. SLABBER: Yes?

1 DR. KRESS: Excuse me for interrupting.
2 Is that under irradiation conditions?
3 DR. SLABBER: Yes. Yes.
4 DR. KRESS: So you do this in a reactor?
5 DR. SLABBER: In a reactor. We will do it
6 stepwise and it will be going beyond the design basis
7 burnup of 80 megawatts, which is presently the design
8 target. But it will be irradiated beyond that.
9 DR. KRESS: Did you say there were 15,000
10 of these pellets in the --
11 DR. SLABBER: 15,000 microspheres in one-
12 sixth centimeter fuel sphere.
13 DR. KRESS: And how many of those
14 centimeter --
15 DR. SLABBER: Pardon?
16 DR. KRESS: How many of those 6 centimeter
17 spheres are in the core?
18 DR. SLABBER: 330,000. So there's a total
19 of 4.8 to the nine small pressure boundaries, primary
20 pressure boundaries in the core.
21 Then in the facility, in the reactor there
22 will be an operational fuel integrity assurance
23 surveillance program which will monitor operational
24 release in the primary coolant and to compare it with
25 predicted value.

1 Next slide, please. One of the other
2 bullets which we've seen is the first one was fuel
3 quality and control of excess reactivity. The reactor
4 is designed to be load following, and to be able to do
5 load following we will use the inventory, called
6 helium inventory control system to pressurize the
7 helium in the primary circuit so that your heat pickup
8 in the core and the heat deposition in the bell
9 conversion unit is in-phase.
10 Now, to enable you to load follow one
11 needs to also to some extent -- Xenon buildup fission
12 products developed or Xenon developed during the
13 operational cycle. If you reduce your neutronic
14 power, the poison increase. So you've got to cater
15 for during load following operations for a certain
16 amount of reactivity that could be added by means of
17 the control rods. And we have limited that amount to
18 1.3 delta k effective. In other words, 1.3 niles and
19 this was chosen so that in the event of a stepping out
20 of a control rod without anything checking it, you can
21 add in a random fashion 1.3 delta k to the reactivity.
22 And this is a value of power that will limit you
23 inherently to a temperature, a maximum fuel
24 temperature below the maximum defined limit. I'll
25 come back to that.

1 We have also provided a measure to design
2 the system so that for all credible pressurization
3 events and reactivity events, if there are anything
4 which will raise the power suddenly, like a control
5 rod injection, the core geometry is always maintained,
6 even in a depressurization event where you could have
7 for a short time a pressure differential across the
8 core barrel.
9 The core is also, although it's tall it's
10 quite a long core. 8.5 meters high and 3.7 meters
11 diameter with a central column. Although it's tall,
12 it's still within the window which precludes Xenon
13 oscillations. In other words, a critical area at the
14 top uncontrolled and a subcritical area and swinging
15 of the flux. So the geometry precludes Xenon
16 oscillations.
17 And then due to the nature of the reactor
18 physics of the core, we've got a very high negative
19 temperature coefficient of reactivity. It's minus 4.5
20 times 10 to the minus 5, delta k over 33 centimeters.
21 And then we are designing an inherently
22 safe critically safe spent and used fuel tank.
23 Next slide. The material properties in
24 the core at end of life, and this is now talking about
25 thermal volatility and emissivity is all assumed to be

1 at the risk point and in a static condition with no
2 forced cooling. These material properties are
3 sufficient that the heat can be taken away from the
4 core into the outer side where it's taken away by this
5 passive heat sink provided by the reactor cavity
6 cooling system for an extended period.
7 The reactor cavity and its structures will
8 maintain its geometry. In other words, during a safe
9 shutdown earthquake, the reactor vessel will stay in
10 tact. It will stay or so be cooled. The reactor
11 cavity cooling system will still function. And this
12 goes for that third bullet there, the reactor cavity
13 including its structures will maintain geometry during
14 all credible events.
15 DR. KRESS: Does this heat removal depend
16 on having the helium in place pressure, or how does it
17 work --
18 DR. SLABBER: Can I explain the reactor
19 cavity cooling system?
20 DR. KRESS: Oh, sure.
21 DR. SLABBER: Yes. The reactor cavity
22 cooling system consists of three independent cooling
23 tanks. The ultimate heat sink is the C or air coolers
24 on the roof of the reactor for all three tanks. It
25 consists of two loops each. In other words, the

1 primary coolant flows through a heat exchanger which
2 then dumps its heat into the ultimate heat sink. So
3 there's an intermediate loop.
4 The cooling system consists of three tanks
5 of 50 percent in the cavity surrounding the reactor
6 vessel. Each tank is 60 centimeters diameter and
7 covers the total length of the reactor core plus an
8 area about 2 meters, 2½ meters above the reactor
9 vessel.
10 The sequence of events could be seen now
11 during a loss of cooling event in that if for instance
12 something goes wrong in the primary cooling, because
13 primary cooling is done by means of the primary -- the
14 conversion unit. The turbo compressor is running
15 because it's a break in cycle, it's in a bootstrap
16 operation; they must be running to circulate. We've
17 got a -- what we call a starter blower system which
18 must bootstrap the breaking cycle to start off with.
19 So if something should go wrong and we
20 should lose this cooling loop in the primary circuit
21 to cool the core, because heat rejection is done in
22 the intercooler and precooler at the turbo compressor;
23 If that heat rejection mode is lost, then we've got a
24 core conditioning system which can run parallel to
25 that. And that is forced convection. That's active

1 component. But should that all fall away, then the
2 reactor cavity cooling system will be capable of
3 handling the decay heat coming from the core exactly
4 after shutdown, in other words 1.3 megawatts of heat
5 which could be dissipated to the reactor cavity
6 cooling system.
7 The reactor cavity cooling system has got
8 a few layers. It's an active system consisting of
9 these loops, the primary loop, the secondly loop which
10 is backed up with the cooler on the roof, and then if
11 that fails, then we go into a boil-off mode and the
12 tanks will boil-off if it's not being replenished by
13 means of operator action. After a couple of days,
14 even, it will boil-off in something like four days.
15 We believe that operator intervention will
16 take place in that time. However, if that even fails
17 the concrete structures are sufficient to eventually
18 dissipate. Obviously, in such instances, the reactor
19 -- the concrete will be heated up to a value which we
20 are still determining at the moment and we're
21 engineering some methods, but we believe that we will
22 not damage the concrete unnecessarily.
23 Does that answer your question?
24 DR. GARRICK: Can I go back and ask a
25 question?

1 DR. SLABBER: Yes.

2 DR. GARRICK: Out of curiosity, on the
3 Xenon oscillation issue. I can see with this annular
4 design where you would have good neutron coupling in
5 the radial direction.

6 DR. SLABBER: Yes.

7 DR. GARRICK: But it is not so obvious in
8 the axial direction.

9 DR. SLABBER: We have looked in it because
10 for Xenon oscillations there is a reactor height which
11 takes you out of the safe region of oscillation.

12 DR. GARRICK: Yes.

13 DR. SLABBER: And we are still within that
14 limit.

15 DR. GARRICK: Okay. But there is a limit?

16 DR. SLABBER: There is a limit, yes.

17 DR. GARRICK: Yes, okay.

18 DR. SLABBER: Any more questions?

19 Next slide. Skip that one. I'll come
20 back to that.

21 In the German program, the licensing was
22 completed for the HDR model and Xenon's developed a
23 curve which they used to convince the regulators that
24 the reactor is safe from a release point of view, and
25 they generated this curve, and I must explain to you

1 because this curve you might see also in our safety
2 analysis report.
3 We do not, and I stress do not intend to
4 just follow this slavishly. And I would like to
5 explain this and, please, we must take note of the
6 importance of this. It is so important in Germany
7 that they have coined the word "the holy curve." And
8 they didn't want to deviate from this at all.
9 Now, what we've got on this axis, we've
10 got the failure fraction of practical and we've got
11 temperature here. And then we've got three lines
12 representing beginning of life, fresh fuel. We've got
13 a life cycle and end of life.
14 What they've done to develop this curve,
15 they took 212 microspheres to get good statistics and
16 they did, on fresh fuel, they did a burn leech test.
17 In other words, as code fuel freshly produced they
18 just measured the unclad uranium friction by means of
19 a leeching test to see which of these microspheres are
20 cracked. And they found it to be 6 times 10 to the
21 minus 4. That is a very important baseline for them.
22 That is why, yes -- to the minus 5.
23 What they've done is that they took that
24 and then they irradiated all those 212 out of the same
25 batch, although it was the same batch, they took 212,

1 they took another batch 212; they irradiated it and
2 they didn't find any failed particles, zero. So they
3 were faced with a dilemma how to now extrapolate from
4 that result what is the end of life of failure
5 fraction. And what they then did, they applied
6 Poisson statistics for zero failures at the 95 percent
7 confidence. And they found that to be 2 times 10 to
8 the minus 4. And then they slapped on that some
9 conservatisms and they added that to the original 6
10 times to the minus 5 and they came up with that 2.6
11 times 10 to the minus 4.
12 And then what they did, they wanted to do
13 the same at 1600. They assumed that those values
14 stayed constant, because from a methodological -- the
15 graphical consideration is no reason for
16 disintegration of the cladding between those two
17 values. They extrapolated the same values and they
18 took a sample. And this is where we will be deviating
19 from their approach. They took only a sample of
20 65,000 and because of the statistics and they couldn't
21 find any broken particles after heating it up, so they
22 just used zero failure statistics and that pulled up
23 because of the uncertainty, the failure fraction to
24 that high values.
25 We in PBMR are planning to replicate this,

1 but we will be keeping the sample sizes constant. And
2 we expect that our fuel failure fraction will be
3 around 10 to the minus 4, and it will be relatively
4 constant up to 1600.
5 Can I have the next slide?
6 DR. KRESS: Excuse me, George. I was
7 surprised to see this as a failure fraction rather
8 than a failure fraction rate. Do you think there is
9 a rate involved here?
10 DR. SLABBER: Well, what is assumed, and
11 this is also our approach, is that we are not assuming
12 any rates the fusion constant, et cetera, because that
13 will put us in a maze of uncertainties.
14 DR. KRESS: Yes.
15 DR. SLABBER: We assume that if the fuel
16 reaches a specific temperature, the content is -- that
17 takes us away from proving experimentally that a
18 certain isotope like silver or cesium or strontium
19 defuses at a certain rate through the microsphere.
20 DR. KRESS: That's what General Atomics'
21 model does.
22 DR. SLABBER: That's right. And we
23 believe in South Africa that it puts you in a maze of
24 uncertainty, and we have done the analysis and we have
25 seen that with releases in a big depressurization

1 event, the containment performance -- and I'll come to
2 that a little bit later -- is sufficient.
3 DR. APOSTOLAKIS: So do I understand
4 correctly that these curves were produced from zero
5 failures?
6 DR. SLABBER: The rest. That was produced
7 from experimental we determined on means that were
8 done on the leech test. And everything was based on
9 that specific one.
10 We will be repeating this, but we will
11 allow us to be criticized at every point.
12 DR. POWERS: I guess what I don't quite
13 follow is that you're testing -- you're assuming that
14 just temperature is the variable. Does that mean that
15 you're not running these fuel particles through
16 operational events?
17 DR. SLABBER: Such as?
18 DR. POWERS: Shutdown, restart, abrasion?
19 DR. SLABBER: No. Abrasion we will be
20 testing in the fuel handling system, the diameter. And
21 if it goes below a certain value and that leaves you
22 a very big margin because thickness of the unclad --
23 of the unfueled section is five millimeters, we will
24 allow the diameter to go down to 58 --
25 DR. POWERS: What I'm asking you is there

1 no synergism between temperature, irradiation and fuel
2 motion as well as normal cycling operation on the cool
3 failure rates?
4 DR. SLABBER: I'm talking about fuel
5 failure rate in terms of microsphere failure rate.
6 DR. POWERS: Yes, I understand. I
7 understand.
8 DR. SLABBER: Yes. We believe it's
9 uncoupled.
10 DR. POWERS: And is there any
11 substantiation to that uncoupling?
12 DR. SLABBER: Substantiation for
13 uncoupling?
14 DR. POWERS: Yes. I mean, what I'm really
15 trying to understand is why is it the temperature is
16 the only variable to consider here?
17 DR. SLABBER: It has found that in the
18 German test that the temperature is the driver of the
19 cracking if there is something. And the
20 manufacturing-- the pressure, though, the ramp rate
21 because the temperature gradient through microsphere
22 integration has not been considered, and it was
23 believed that it's uncoupled.
24 Next slide, please. The previous --
25 sorry. The previous slide.

1 This is a artifact which we have developed
2 from German literature showing, and this is the -- if
3 you noted at this stage that it's showing the
4 tendency, what happens beyond 1600 without saying that
5 this is what we expect, because this was extrapolated
6 back from releases. Real releases back to failure
7 fraction.
8 Now what is happening here at 1600, the
9 silicon carbide coating on the microsphere slowly
10 starts thinning due to reactions with fission
11 products. And you get this slight increase in failure
12 fraction -- I say you're going this way now -- they
13 look back from a release rate. And then there is a
14 gradual increase, and then at 2200 degrees Centigrade
15 there is quite a gross dissociation of the silicon
16 carbide microsphere coating. And that's the reason
17 for this rapid increase.
18 So this is silicon carbide thinning and
19 degrading, and this is actually the disintegration.
20 This is the reason why I brought this, because this
21 will also be part of the testing.
22 Skip the next slide.
23 Our conversion unit is interfaced in the
24 coolers with an auxiliary cooling system which
25 interface directly in the coolers with a helium

1 coolant. What happens is that the pressure in the
2 primary system is always higher than the coolant in
3 the auxiliary cooling system. So if there should be
4 a leak, the water should leak out into the auxiliary
5 system and there are instruments that detect any leak.
6 If we are doing maintenance on the reactor and the
7 system is depressurized, then there is the only
8 interface with the primary -- with the core is by
9 means of the core conditioning system, which has got
10 a very limited volume of water circulating through the
11 heat exchangers. And then the primary coolant system
12 is always monitored from a radiation point of view to
13 see if there is any contaminants like fission
14 products, especially in this case, moisture and air.
15 The physical design of the core itself is
16 such that in the event of even a beyond licensing
17 based event, that the establishment of a established
18 flow regime of air through the core is not feasible,
19 but this is being modeled by means of CFD at the
20 moment. We believe we think our difficulty could be
21 to -- and this is also time dependent, and it's got a
22 temperature limit beyond -- 400 degree average
23 temperature, it is not possible even with gross
24 ingress of air. So, it's really an event which gives
25 you time.

1 Next slide, please.

2 The physical core design for the
3 prevention of excess burn-up, because a fuel has got
4 a limit and licensed to a limit of burn-up. And we
5 will be licensing our fuel for 80,000 megawatts and
6 it's got that limit. And we will -- the core is
7 designed that a ball could not be trapped like in the
8 German reactor program, there were certain of these
9 spheres that were trapped somewhere in the core,
10 pressed into the graphite for some long time. It did
11 not give rise to a rise in activity, but our core
12 design is such that the flow is so well defined that
13 we do not expect that.

14 And then we've got on-line spectrometric,
15 gamma spectrometric measurements because we need to
16 evaluate -- is it fuel or is graphite. And if it is
17 fuel, by means of gamma spectrometry we determine if
18 the burn-up has reached the limit or can it be
19 recycled.

20 So, these are those attributes.

21 Next slide, please.

22 So if we now look at the barriers to the
23 environment from the kernels, we have beyond -- before
24 that we've got the UO_2 kernel which provides some
25 degree. I say some, but we do not take credit. And

1 then we've got the three -- the pyrolytic graphite,
2 we've got the silicon carbide and we've got the other
3 pyrolytic carbide. But credit is only -- we're
4 looking from a qualification point of view only at the
5 silicon carbide. We listed those three layers because
6 that is the reality.
7 And then we've got our high integrity
8 primary pressure boundary, and we are learning and
9 we're using information from the light water reactor
10 people which has developed materials, steels, et
11 cetera, and we try not to deviate from that developed
12 and evaluated envelop.
13 So we will be using pressurized water
14 reactor reactive pressure vessel and the pressure
15 boundary we will take note of developments.
16 And coming to the containment, which we
17 have been defining in the past, and it's a debateable
18 question, as confinement but we are using the term
19 containment. But at this stage let me just explain to
20 you what is happening during a event when release
21 takes place.
22 You get a rupture of the primary pressure
23 boundary, and we've got 10 millimeter breaks analyzed,
24 we've got 65 millimeter because that is the size of
25 the fueling tube. And then we've got big breaks like

1 the control rods or the bottom unloading shute or the
2 PCU pipes. And we've got graded pressure releases.
3 And for each of these we've got a system, a pressure
4 release system by means of ruptured panels which
5 release from specific cavities in the containment to
6 a pressure relief stack which automatically opens and
7 closes again after this puff goes out. And then it's
8 got a backup which could be closed if it does not
9 close automatically by an operator.
10 And then if there's an excessive event
11 like a 10 minus 6 and lower event like the rupture of
12 the big manifold pipes, in addition to this pressure
13 relief, there are -- if we think back to the first
14 slides of the building that can lift up above the PCU
15 and release into a big plenum. And then if the
16 pressure is still in excess, panels will blow out, but
17 remember, of the wall. But remember this is an
18 analyzed event.
19 The containment is designed to relief
20 through the pressure relief stack and be closed
21 automatically with operator backup. So we define for
22 the performance requirement that we need this
23 containment has a high leakage vented containment,
24 because we've got also the HVAC. And the HVAC is also
25 automatically closed off during such a

1 depressurization and could be opened again later to
2 filter light releases at a low pressure.
3 So we've got a concrete structure which is
4 a citadel, but actually it is high-leakage vented
5 containment. We've got a filtered vent path for later
6 releases. And we've got hold up of fission products
7 in plate out in the system, et cetera, which is not
8 lifted out. And the auto-close blowout panels. And
9 then we -- by means of this HVAC later releases from
10 these particles if there are any additional.
11 Thank you.
12 Just coming back to the nonproliferation
13 aspects.
14 Mr. Chairman, I'm sorry, I'm taking a
15 little bit longer.
16 There is a number of attributes. It's a
17 closed -- it's an on-load fueling system. The IAEA
18 can install flow monitors to see where fuel is and
19 track the fuel movement. And the burn-up is 80,000
20 megawattage per ton which gives a plutonium mix which
21 is very unfavorable for weapons manufacture. And then
22 the fuel produced during the operational time of the
23 reactor is all stored in the facility under the
24 surveillance of IAEA.
25 DR. POWERS: It seems like it's a design

1 that's well suited for producing 239 because of the
2 on-line fueling/defueling at the facility.
3 DR. SLABBER: Yes, it is. But if you look
4 at the amount for even the first cycle, you must
5 divert about 212,000 spheres continuously out of your
6 system to produce a favorable mix. So what we have
7 during a ten cycle, which is from a -- point of view,
8 the optimum at the moment we're thinking about five,
9 it gives some problems -- not problems, but a higher
10 flux higher up in the core. At discharge the mix is
11 66 percent 239 and compared to either --
12 DR. POWERS: Change your cycle. Lots of
13 239 --
14 DR. SLABBER: You need only one force of
15 fuel sphere to give you a very small -- and you've got
16 to take them all out into the diversion path. And
17 this is not difficult to detect.
18 MR. SPROAT: Thank you, Johan.
19 What I'd like to do is just briefly close
20 and address the issues. So now you understand a
21 little bit about the technology itself and the
22 preliminary design of the PBMR itself, what about
23 getting it licensed here in the U.S.?
24 As part of Exelon's decision making
25 process, we are currently evaluating and doing a

1 license ability assessment on the PBMR. And I want to
2 talk about very quickly the key issues that we see
3 both technical and nontechnical.
4 And on the technical side, obviously right
5 now most of the regulations existing in the U.S. are
6 focused on light water reactors. And if we were to
7 come in today with an application for this technology,
8 the NRC reviewers would sit there and they'd use what
9 we call the "two finger approach;" one finger on the
10 regulations and one finger on the submittal and say
11 "Okay, how did you meet this, how did you meet that?"
12 In some cases that'll be very appropriate and in some
13 cases it won't be appropriate at all given differences
14 and uniqueness of this technology.
15 So, working with the NRC staff over the
16 next 18 to 24 months, we hope to develop a regulatory
17 framework that they can use and that we can use to
18 design against, they can to review against so that
19 we've got a credible regulatory framework that we can
20 try and license the PBMR with if we go forward.
21 The second area is fuel qualification and
22 testing. Johan talked about that. The key thing about
23 the fuel is that, you know, this isn't new. You know,
24 trico-coated practical fuel was used back as early as
25 1967 in the dragon reactor in the U.K. So there's a

1 great body of information out there. We need to be
2 able to tap that and use it as part of our licensing
3 basis and not have to reinvent the wheel.
4 But the other aspect of this is the first
5 fuel loads for the PBMRs in the U.S., if we do go
6 forward, would come from South Africa. So the role of
7 the NRC in reviewing that fuel plant down there and
8 licensing it or not licensing it but certifying the
9 end product for use in a U.S. reactor is a whole area
10 that we really haven't explored yet and will need to
11 be addressed.
12 DR. KRESS: When you talk about fuel
13 quality, are you talking about that fraction of
14 particles fail versus temperature curve?
15 MR. SPROAT: Yes. Knowing how the fuel
16 will react under various conditions that's consistent
17 with the safety case for the reactor licensed in this
18 country.
19 DR. KRESS: Does that include any trapped
20 uranium that might get trapped in the --
21 MR. SPROAT: Yes, obviously the test
22 program takes a look at what the -- not only what the
23 failed fuel fraction is, but also the trapped uranium
24 that's on the outside of the particles as a result of
25 manufacturing process.

1 DR. KRESS: You have a goal for how many
2 particles can be failed within the core before you
3 violate 10 CFR 100 --
4 MR. SPROAT: I'm not sure we're that far
5 along in the analysis at this stage of the game.
6 DR. KRESS: Okay.
7 MR. SPROAT: Clearly an issue that we're
8 going to have to wrestle with the staff, once we
9 decide ourselves how we think the appropriate way of
10 addressing it, is what's the source term? Is it
11 mechanically mechanistically determined source term
12 or deterministically determined source term --
13 DR. KRESS: Well, it's the answer obvious
14 there?
15 MR. SPROAT: Pardon?
16 DR. KRESS: Isn't the answer obvious
17 there?
18 MR. SPROAT: No, the answer's not obvious.
19 I know what we would like to do, but the issue of how
20 good are your goods analyzing your diffusion
21 coefficients and being able to provide an analytic
22 framework for migration of fission products from the
23 core to the environment is going to be a challenge.
24 It's going to be a challenge.
25 Obviously, containment performance

1 requirements, Johan talked about the containment
2 design and whether or not a zero leakage or a LWR type
3 containment would be required versus moderate to high
4 leakage filtered containment would be required is
5 obviously an issue that's going to be discussed at
6 some length.
7 DR. KRESS: And that would be linked to
8 the fuel quality?
9 MR. SPROAT: Absolutely, and to the source
10 term.
11 The issue of the various computer codes
12 that are being used in South Africa to design this
13 plant, how they're verified and validated and how
14 they're benchmarked against the other existing codes
15 will be an extensive effort associated with that.
16 The PRA itself that's being developed in
17 South Africa that we're advising them on, it's kind of
18 interesting. You know, if you have -- what's your
19 endstate if core melt isn't a valid endstate for your
20 reactor? And what is your endstate? What are you
21 initiators and how do you determine your uncertainties
22 of your various accident sequences?
23 DR. KRESS: Your endstate is quantity of
24 fission products. Frequency of fission products.
25 MR. SPROAT: It might be. But the point

1 is that we're exploring some new ground here and,
2 obviously, there'll be some discussions with staff
3 about how we go and do that.
4 The regulatory treatment of nonsafety
5 systems and how we classify the SSCs, the safety
6 system components, will really be a key issue.
7 And then finally, an issue that I lumped
8 in the technical area, but it's a real practical issue
9 is there aren't a lot of people left in the U.S. in
10 the NRC, in the national labs or in DOE that have gas
11 reactor experience and understanding. And so,
12 obviously, I think you've gotten a sense as we go
13 forward with this, if we submit an application having
14 people who understand the technology, understand the
15 science and can provide good independent review of the
16 submittal is going to be a real challenge.
17 On the last slide I have is the
18 nontechnical, what I'll call the legal licensing
19 challenges. And I personally believe we have a very
20 good chance at satisfactorily resolving a number of
21 the technical issues that I showed on the previous
22 slide. I'm not as confident about some of these,
23 because some of these are potential deal breakers for
24 moving forward with merchant nuclear power plants in
25 this country. And that's what we're talking about

1 here; this is not a power plant or nuclear plant
2 that's going to go into a rate base somewhere. This
3 is a merchant plant where the shareholders are going
4 to take the risk of building and operating this plant
5 and whether or not it makes money in the deregulated
6 marketplace is solely dependent on the technology and
7 the company that runs it.
8 So, the first issue up here is Price
9 Anderson. The current law and the way it's currently
10 interpreted by the NRC is that each reactor in the
11 country is assessed a retrospective premium of $90
12 million per reactor in the case of an accident
13 anywhere in the U.S. associated with any reactor.
14 Well, if I've got a 2200 megawatt light water reactor
15 plant, like our Limrick plant, that means my
16 retrospective premium at risk due to a reactor
17 accident somewhere in the U.S. is $180 million
18 retrospective premium associated with that plant.
19 If I have the same capacity of pebble bed
20 modular reactors under today's law, my retrospective
21 premium would be $1.8 billion for that same amount of
22 capacity. Even I would have difficulties selling our
23 board of directors to take that kind of a risk
24 associated with that kind of retrospective premium
25 associated with an accident from a reactor that we

1 don't own or operate. So that's got to be addressed
2 somehow.
3 The second issue up there is the NRC
4 operational fees. Right now the operational fees are
5 approximately $3 million per reactor. Again, say at
6 our Limrick plant, that means about $6 million a year
7 for the two reactors. The same size for 2200
8 megawatts, you're talking about $60 million a year in
9 NRC licensing fees for a 2200 megawatt set of string
10 of PBMRs. Really excuse the economics of a merchant
11 nuclear plant significantly.
12 The decommissioning trust fund is another
13 issue that's clearly going to have to be addressed.
14 The law gives a number of different alternatives, but
15 those alternatives have presupposed that generally the
16 plant is going to be operated by a regulated utility
17 and that in the rate base in which the plant is based
18 rate, you have a set aside income stream that goes and
19 funds the decommissioning trust fund. In our case
20 that won't be the case. These plants won't be in a
21 rate base. How we fund the decommissioning trust
22 fund, how much we have to put up front and what we can
23 put into a sinking fund needs to be resolved. The law
24 is not clear on that at this point in time.
25 Clearly, Part 52 licensing process which

1 is, we think, the right way to go is untested at this
2 point in time. Nobody's actually done it. So the
3 staff will be learning, the applicants will be
4 learning, and how we actually work our way through
5 that and how long it takes is going to be a key
6 challenge for us.
7 And then finally, I have up there up the
8 potential number of exemptions. As I talked about
9 earlier, there is no gas reactor licensing framework.
10 And if there's not when we go with an application, the
11 staff might decide that a number of the things we're
12 asking for are very appropriate to license this plant,
13 but will require exemptions from the existing
14 regulatory framework. And, obviously, it would be
15 undesirable to all of us to have the first advanced
16 reactor in place with a significant number of
17 exemptions. It just doesn't work.
18 So, those are the key issues and
19 challenges we see on the licensing side, both from the
20 technical side and the legal side. And, as I said, we
21 are considering all that and now we'll go into our
22 decision making process as to whether or not to
23 proceed with both the venture in South Africa and the
24 licensing process here in the U.S. by sometime around
25 the end of the year.

1 DR. KRESS: These appear to me like mostly
2 policy issues rather than technical ones related to
3 the reactor design?
4 MR. SPROAT: A number of these will
5 require some policy statements and decisions by the
6 Commission itself, yes.
7 DR. KRESS: Very good. Is there any
8 discussion or questions for either of our two
9 speakers?
10 DR. APOSTOLAKIS: Yes, I have a question.
11 As I recall in one of your communications to the staff
12 in addressing these issues, the key legal licensing
13 issues, you proposed that a site with ten units be
14 considered as one reactor?
15 MR. SPROAT: One facility.
16 DR. APOSTOLAKIS: One facility.
17 Now, if this is accepted by the staff,
18 then should we also be applying the same idea to
19 various safety goals and say, assuming that the
20 concept of core damage makes sense here, that if the
21 goal is 10 to the minus 4 and that would apply to the
22 facility, so each unit then would have to ten to the
23 minus 5. And given the fact that you have ten of
24 them, you have some synergistic effects, maybe it'll
25 have to be even lower than ten to the minus 5.

1 MR. SPROAT: Well, synergistic effects is
2 not intuitively obvious to me that there are
3 synergistic effects when in fact the risk from one
4 reactor to the other. I'm not ready to concede that
5 point at this point.
6 DR. APOSTOLAKIS: Okay. Fine.
7 DR. KRESS: Some common mode.
8 DR. APOSTOLAKIS: Some common mode,
9 perhaps. Anyway, but I mean how about the thought
10 process here that you would apply stricter criteria --
11 DR. KRESS: Yes, instead of calling it
12 core melt, call it fission product release --
13 DR. APOSTOLAKIS: Call it something else.
14 Yes, fission product release.
15 If we treat 10 PBMRs as one facility with
16 respect to these five bullets that you showed us,
17 shouldn't we be doing the same when it came to risk
18 and treat it as one facility and apply the goals to
19 the facility, in which case of course we will have
20 much lower goals for each individual unit?
21 MR. SPROAT: Well, we certainly haven't
22 done that for two and three unit light water reactors.
23 So, I hesitate to do that for a smaller, supposedly
24 safer reactor.
25 DR. APOSTOLAKIS: Well, safer of course is

1 something that you would approve of.

2 MR. SPROAT: Sure.

3 DR. APOSTOLAKIS: But for a two unit
4 reactor there are some PRAs where they look at these
5 things. But a factor of two in the goals really
6 doesn't mean anything. But when you talk about ten,
7 a factor of ten, then you're beginning to see some
8 difference.

9 So it seems to me that if we are to apply
10 this idea to the five legal licensing challenges you
11 mentioned, maybe we ought to think about doing the
12 same thing to the goals. Now, you don't have to
13 answer right now, but --

14 MR. SPROAT: I would probably disagree
15 with that, but that's okay.

16 DR. POWERS: Explain why you would
17 disagree other than the fact that you wouldn't like
18 the numbers when they came out.

19 MR. SPROAT: No. What would the basis be
20 for doing that? For example, in airline travel
21 there's a certain risk associated with flying on an
22 airplane. Now, the fact that there are increasing
23 numbers of airplanes in the air doesn't necessarily
24 mean that your risk of being killed on an airplane has
25 proportionally increased.

1 DR. APOSTOLAKIS: The societal risk has.
2 DR. POWERS: Right.
3 DR. APOSTOLAKIS: The individual risk has
4 not.
5 DR. KRESS: You don't fly the same number
6 of people on the airplanes. What you have is a site
7 with a given fixed population around it, for example.
8 And that population is exposed to either one module or
9 ten modules who could fail independently of each
10 other, and in fact that's probably the assumption.
11 But the risk of being on that site and associated with
12 those reactors is, in my mind, ten times when you have
13 ten modules over one module.
14 DR. POWERS: Tom, isn't it even higher
15 than that because you've got a mode failure with the--
16 DR. KRESS: Yes. And then if there's
17 common mode failures, it's even higher.
18 DR. POWERS: Especially if you go up --
19 DR. KRESS: And that would be the
20 reasoning behind --
21 DR. POWERS: -- to a centralized control
22 room?
23 DR. KRESS: Yes. So you treat it as one
24 reactor, but in order to accommodate the ten of them
25 you have to do something to one end; you either up the

1 frequency by ten or the lower safety goal by --

2 MR. SPROAT: Well, then clearly you have

3 to take into account in that kind of an analysis the

4 concept of coincident events happening in multiple

5 units at the same time.

6 DR. KRESS: No, no, that's not --

7 DR. POWERS: It's just common mode failure

8 is what we are talking about here.

9 DR. KRESS: But that's not what I had in

10 mind.

11 MR. SPROAT: Assuming there is a common

12 mode failure that --

13 DR. POWERS: But that's not what we're

14 saying.

15 DR. KRESS: Yes, but that's not what we're

16 saying. I mean, that's another issue, coincidence

17 events and common mode failures. No, I'm not just

18 talking about an independent frequency of something

19 happening to one or something happen to the other

20 independently.

21 DR. SHACK: Of course, now he does get

22 something back because he probably has a smaller

23 source term.

24 DR. KRESS: Oh, I think that's a -- for

25 this concept, that's --

1 DR. APOSTOLAKIS: I didn't say anything
2 about the assessment.
3 DR. KRESS: Yes. He said --
4 DR. APOSTOLAKIS: I'm just talking about
5 the goals.
6 DR. KRESS: I'm sure they could meet the
7 ten times or the ten percent --
8 DR. APOSTOLAKIS: You don't use a facility
9 of ten PBMRs only on these things. I mean, and the
10 goals have to be reflected.
11 MR. PARME: George, I might add in the
12 mid-80s submittal on the MHTGR where there were
13 multiple reactors coupled to a common steam plant, it
14 was viewed as a plant and we took the safety goals and
15 the release limits that we were analyzing it and
16 considered multiple reactors. And, in fact, if you
17 look back in the mid-80s submittal you'll see there is
18 at least one event that has all four MHTGR models
19 leaking simultaneously without cooling. And it was
20 handled that way.
21 It's not quite the case where his reactors
22 are truly independent, but we did consider the four
23 modules to be a plant consistent with your thinking.
24 What you would do with truly independent modules, I
25 guess, is something that one might want to think of.

1 DR. APOSTOLAKIS: If we decide, for
2 example, that as we were saying earlier that the
3 appropriate way to look to formulate the goals here
4 would be through frequency consequence curves, then it
5 seems to me that you would have one such curve or a
6 family of curves for the facility.
7 DR. GARRICK: Yes. Well, why wouldn't you
8 have a CCDF for the facility?
9 DR. APOSTOLAKIS: For the facility, that's
10 what I'm saying.
11 DR. GARRICK: And every time you add a
12 module, you get a new CCDR.
13 DR. KRESS: Yes, absolutely.
14 DR. APOSTOLAKIS: Yes.
15 DR. GARRICK: Yes.
16 DR. APOSTOLAKIS: But the goal would be
17 one. And then what you do under it, you know,
18 assuming you're acceptable is your business.
19 DR. GARRICK: Right.
20 DR. APOSTOLAKIS: Anyway, that's just a
21 point.
22 DR. KRESS: But it's a thought.
23 MR. SPROAT: Understood.
24 DR. KRESS: Other questions? Okay. Please
25 use the microphone and identify yourself for the

1 record.

2 MR. GUNTER: Paul Gunter, Nuclear

3 Information Resource Service.

4 Obviously fuel integrity is a big question

5 here. And what I would like to get a little better

6 idea of, is have you looked at the THTR that was a 300

7 megawatt PBMR in Germany? I believe there was an

8 event there on May 4, 1986. And I'd like to know what

9 your assessment is of the fuel failure mechanism that

10 occurred there?

11 DR. SLABBER: I do not have at this stage

12 information about that specific occurrence. But what

13 I can tell you is that due to the uniqueness of the

14 THTR core where they had control rods and shutdown

15 rods of this size pushing vertically into effect

16 pebble bed during shutdown, that caused some of the

17 pebbles themselves to break, although no evidence was

18 ever found that they found loose coated particles

19 somewhere in the fueling system. But that gave rise

20 to a bigger than normal fuel sphere breakage, the

21 specific design itself.

22 MR. GUNTER: It was the graphite that

23 broke apart or was it the pyrolytic coating that

24 broke?

25 DR. SLABBER: It was the graphite, the

1 matrix that kept all these coated particles in a
2 configuration.
3 MR. GUNTER: Right. So just for my
4 understanding from what I've been able to ascertain is
5 that the fission products are to be retained inside
6 the pyrolytic coating, though?
7 DR. SLABBER: Inside the silicon carbide.
8 MR. GUNTER: Right. So if there was a --
9 so it would seem like there was some kind of failure
10 mechanism on that pyrolytic coating as well. I mean,
11 was the coating crushed as well as the graphite
12 sphere?
13 MR. SPROAT: What we know from that event,
14 and I haven't gotten all the details of the German
15 government review, is that as Johan said that the
16 pebble bed that's in the THTR in Germany had its
17 control rods inserted directly into the pebble core.
18 That broke a number of pebbles. So and then when they
19 tried to come out through the bottom for the fuel
20 handling system; if the ball's round, then it goes
21 through the system really well. If it's broken into
22 pieces, it gets stuck. And evidently what the German
23 operators did is they found they had some broken and
24 stuck particles -- not particles, but pieces of the
25 fuel spheres in the handling system that got stuck,

1 and they had to clear them out of there.

2 MR. GUNTER: And that was done with back

3 pressure of helium or --

4 MR. SPROAT: Well, I know that back

5 pressure of helium is one of the methods they used to

6 clear some of that fuel handling system, but they also

7 I think in that case you're referring to is they used

8 some mechanical force where they tried to either hit

9 things with either hammers or with rams to free that

10 piece. And it appears what happened in that case is

11 that a number of the little particles from that

12 mechanical impact were ruptured, and that released

13 some of the fission products from inside the spheres.

14 But it was basically mechanical damage to the fuel

15 particles itself due to operator interaction.

16 MR. GUNTER: Okay. If I could ask one

17 more question. It's also my understanding that the

18 Germans abandoned the technology because of problems

19 with quality control on unused fuel. Have you looked

20 into that as to what the failure mechanism was for the

21 unused fuel?

22 DR. SLABBER: The only records we have is

23 that the German program would have continued, but

24 there was some other political pressure to terminate

25 any further investigations. But the database that we

1 have access to do not address any of such problems
2 that you're highlighting now. In fact, they have
3 still available for evaluation some of their unused
4 fuel spheres and we intend to do some pre-irradiation
5 evaluation of those spheres.
6 MR. GUNTER: Of course, if there was
7 evidence of damage to unused fuel, you would be
8 interested in seeing that
9 DR. SLABBER: Of course, yes.
10 MR. GUNTER: Thank you.
11 DR. SLABBER: Can I just make another
12 comment. The design, the German design which had the
13 control rods in the bed directly in the core was one
14 of the reasons why pebble bed design deviates totally
15 from that design. And the decision was made, control
16 rods only in the reflector, sides reflector.
17 DR. KRESS: Okay. I'd like to move it on
18 because we are running behind now, and move to the
19 next topic, which is, I believe, the IRIS by
20 Westinghouse representatives.
21 MR. CARELLI: Good afternoon. I'm Michael
22 Carelli from Westinghouse Science & Technology
23 Department. And among the many things we do is the
24 leading edge support of the business units, also
25 heavily involved in Generational IV reactors, and

1 especially on IRIS.

2 Now, I have to tell you a couple of things

3 before I start. And the first one is you have in the

4 passouts some viewgraphs that aren't exactly right.

5 Last week I at IA meeting in Cairo and I

6 was trying to do very much control. This presentation

7 is terribly efficient. But we have the right package,

8 and if you need it you see me and I'll get you a copy.

9 And with that, I think my time is up now,

10 right?

11 DR. KRESS: Yes.

12 MR. CARELLI: Okay. Nice meeting you.

13 Okay. IRIS. Can I have the next one?

14 IRIS is International Reactor Innovative and Secure

15 and the key word there is international, and you'll

16 see in a second why.

17 If I can have the next, please? I'll try

18 to move fast as I can.

19 Is the new kid on the block. We've been

20 in business for about 18 months, so what you see is

21 about we started at the end of '99 this work, and so

22 in trying to compress in about a half of hour the work

23 we've done on a new design, I had to skip a bunch of

24 items. And I'll be happy to answer and expand them

25 during the session this evening. So right now I try

1 to kind of streamline on the key things and then hit
2 the issues, because for this new reactor thing that's
3 what you want to hear most.
4 So I'm going to have a brief overview; our
5 team, the funding, the objectives. I'm going to tell
6 you about a few designs. It's plural, it's not a
7 typo. It's few designs, plural. And then the
8 configuration of the integral vessel. And I'm going
9 to spend quite some time -- well, "quite some time"
10 relatively speaking on the safety design because I
11 think that's kind of a trademark of IRIS. They
12 approach the safety we have together with the
13 maintenance optimization. These are the two things
14 IRIS, I believe, does different. And then, as I say,
15 I hope to spend some time talking about the issues.
16 Let's move to the next one, please.
17 Overview, keep going. I have a bunch of fillers. At
18 least you know where we are.
19 Okay. This is a capsule on IRIS, just to
20 give you a kind of best view what the reactor is.
21 What you have on the right is an earlier version, it's
22 100 megawatt electric that we designed until around
23 December of last year. It's an integral system.
24 Integral means everything is inside the vessel; steam
25 generators, clamps, pressurizers -- pressurizer,

1 singular, is inside the vessel. Is integral, integral
2 configuration. And it has a lot of advantages. It is
3 really an excellent configuration for safety and we're
4 going to touch on that, as a straight bell core, no
5 shuffling to refueling. You put the fuel in, take it
6 out at the end of life.
7 And we have two designs for five years, an
8 ATS lifetime. And you'll see in a second, in a couple
9 of seconds.
10 It utilize LWR technology. In the new
11 engineering burnt is a proven technology. This is a
12 key point when you look at development schedule, this
13 is a new engineering. We are not demonstrating a new
14 technology. Also the integral configuration for the
15 light water reactor is not the first time. There is
16 a surface ship in Germany has been running along the
17 seas with an integral reactor like this, and of course
18 all of you know the submarines, they are running on
19 that. And also there's been experience -- on integral
20 reactors.
21 Safety is and most action initiators are
22 handled by design. And I'm going to go into safety by
23 design issue and what we do -- we do on that.
24 Potentially the cost, is the cost
25 competitive with that options both in nuclear and non-

1 nuclear and the development, the construction, the
2 deploying and everything from the very beginning is by
3 international team. This, by no means, suggest
4 Westinghouse -- this international team that is
5 designing IRIS.
6 And we are projecting the first module
7 deployment in the 2010-2015 time frame. 2010 is kind
8 of widely optimistic, 2015 is probably conservative.
9 And this morning you heard about 2020/2012, and this
10 is about the time I think we are targeting.
11 The way IRIS started was in answer to the
12 Generation IV RFI that we had from DOE. And basically
13 we were trying to look at satisfying the goals of
14 safety and unsafety, sustained development.
15 What you have on the left are the various
16 design features of IRIS, and you can read. And
17 basically what we found that those design features,
18 the way we started the design, was they were to
19 satisfy safety and to satisfy the waste minimization
20 issue. And then we found that every single one also
21 has a positive effect on economics.
22 Next slide. Thank you. So I said every
23 single one does end up on the positive column of
24 economics. So at that point to say, gosh, you know,
25 we had quite a good design for commercialization.

1 And, please, the next one. And that
2 basically what happens. And what happened was that we
3 started building a consortium of organizations where
4 they're interested in joining IRIS. So the first
5 thing we did was to have a colorful logo, and then
6 after that we went to work.
7 Next one please.
8 DR. KRESS: Is that Latin?
9 MR. CARELLI: Yes, that's Latin. From the
10 Italian, what do you expect? This is a Latin motto,
11 and I think even the translation has to do with
12 nonproliferation. Believe it or not.
13 So what we did, we had the initial team
14 was from Westinghouse, two U.S. universities,
15 California Berkeley and MIT, and from Milan. We
16 wanted the work published. We started having phone
17 calls other people wanted to join. And what you have
18 here is chronologically. This is the organizations
19 that joined IRIS in time.
20 At the beginning, it was mostly
21 development. Then what we did recently in the last
22 few months, we added an organization as a supplier
23 site because we had the design that is moving very
24 well along. Now who is going to fabricate, who is
25 going to be the manufacturer and so forth? So we have

1 additions to the size -- which from the very
2 beginning, an addition like Ansaldo, Spain and Brazil
3 to do the components.
4 And now what you see now is that we have
5 also team members from developing countries. IRIS is
6 very attractive for developing countries and, in fact,
7 I'm coming back from Cairo and had a very, very good
8 reception from developing countries. It's 100 to 300
9 megawatts and it doesn't clog up the -- of developing
10 countries like 1,000 megawatts does, so this is quite
11 attractive. Next please.
12 Now, you heard the question this morning,
13 John. It said what is a dedicated enthusiastic team?
14 Yes, you have. You have a dedicated enthusiastic team
15 that's designing IRIS and it's very enthusiastic that
16 this is the money we're getting from the UE. This is
17 the money over three years from Westinghouse,
18 California Berkeley, and MIT. This is the money that
19 the other participants are putting in on their own.
20 This is in kind contributions. People they're putting
21 to work. They're working on. Right now we're running
22 around this. So that's enthusiastic when you put out
23 that type of effort. Next.
24 Okay. One of the questions was what's the
25 schedule? The schedule was at the end of the first

1 year, this is the end of our first year of life, we
2 wanted to assess the key technical and economic
3 issues. Basically rather than going through the old
4 thing, we just pick up the key issues and resolve
5 them, and we have done that. Right now we're filling
6 in the blanks. We're doing the conceptual design and
7 the preliminary cost estimate and at this point is the
8 end of the NERI grant in 2002. At that time, we're
9 going to have the preliminary design completed, the
10 preliminary cost estimate completed. Sometime in
11 between now and then there is the pre-application
12 submitted to NRC. We're in the preliminary stage now,
13 we have been talking with the staff a few weeks ago.
14 I'm talking with you now and it's in the process.
15 I put a question mark because really I
16 can't say it's going to be July, August or so. But
17 it's going to be definitely soon that we're going to
18 talk.
19 Now here is where lightning is going to
20 strike. At the end of the first three years, the
21 consortium is going to sit around the table and say,
22 okay, now we have a design, we have a market, are we
23 going to proceed with commercialization? Right now
24 every indication is that the answer is yes but at that
25 point then it goes on a quantum step in terms of

1 effort. It's no longer $8 million or $12 million.
2 It's going to be quite a lot more. So if that happens
3 -- right now, of course, we're not doing this for the
4 fun of it. We are working assuming that is going to
5 happen.
6 Then our schedule calls for a complete SAR
7 by 2005, design certification by 2007 and first-of-a-
8 kind deployment beyond this. And I'm going to have
9 some discussion on these dates at the end. Next
10 please.
11 DR. KRESS: Would your SAR follow the SAR
12 process that we use now for light water reactors?
13 MR. CARELLI: Yes. When the issue is
14 safety, I think it should be simplified. Should be a
15 simplified SAR. We'll see.
16 Okay. Here now the cores. Originally we
17 worked on this. The proliferation resistance -- the
18 idea is you have a core and you put in no shaft and no
19 refueling. The host country doesn't have access to
20 the fuel. The longer you keep there, the more
21 proliferation resistance you have. So we found that
22 eight years we could have burn-up around 70,000 -
23 80,000 and we worked two designs with UO_2 and MOX
24 interchangeable so essentially with the same IRIS
25 design exactly the same, you can put whatever fuel

1 core you want. So that's what we have done.

2 But then what you have, you have IRIS

3 requires eight percent enrichment. Right now we don't

4 have a licensed eight percent production facility and

5 we don't have the database for the burn-up and so

6 forth of the eight percent. What we said at that

7 point, we say why do we want to complicate the life

8 and let's say the first core with a five years design,

9 same thing straight through for five years, same

10 principle, nothing different. But this is 4.95

11 percent enrichment.

12 Our facility in Columbia can fabricate it

13 to model as exactly the same design and the same

14 configuration as the PWR assembly. So if you say that

15 you can't recognize the difference between a regular

16 PWR and an IRIS assembly.

17 It's well within the state of the art

18 because the average burn-up we're projecting is around

19 45,000. So at this point with this we have taken out

20 completely any licensing issue because this is a PWR

21 assembly. The only thing we are doing different,

22 instead of shuffling every three months, we let it

23 cook for five years. That's it.

24 At the same time, we are going to look at

25 this and we have here our university team members that

1 keep working on this and we're going for the licensing
2 extension while we're working on and eventually we ask
3 for licensing for this in the time frame of 2015 to
4 2020. So right now I want to say this is the IRIS
5 core. That's what we're focusing now. Next please.
6 The configuration. This is the 300 mega
7 version, 335 actually. You see here is the steam
8 generator and this is different from the pass outs
9 because in the last couple of weeks we changed the
10 pumps. What we have now, we have a pump which is
11 called a spool pump is inside the vessel and there is
12 no penetration. The only thing it takes is a couple
13 of inch line for the power, and that's about it. It's
14 already inside the vessel, high inertia and actually
15 I was told this morning there has been examples of
16 this with insulation. It doesn't even need cooling.
17 Now, the point is why we didn't have this
18 in regular reactors. Why this coming out of the
19 woodwork for the first time? And there is an answer.
20 This pump works with 18 PSI head and in present loop
21 reactors you never have an 18 PSI. In IRIS with the
22 very open core and the open configuration we have, our
23 pressure drop is less than 18 PSI. So in IRIS we can
24 take advantage of this thing, eliminate the
25 proliferation device and all of the stuff associated

1 with the pumps, LOCA -- and so forth is all gone
2 because we have a design that can take advantage of
3 this. I think IRIS take advantage.
4 These here are internal shields. What you
5 have here, you have here the core, here the steam
6 generators and you have a design rate of nothing. If
7 you put shields which doesn't cost much, just a bunch
8 of plates maybe with some boron carbide or even steel,
9 whatever. Next slides, please.
10 This is what you have. It's a gift of the
11 integral configuration. You get busy for free. The
12 rate outside the vessel is this. Is nothing. You can
13 touch the vessel. The vessel is cold. It has two
14 advantages. One, if you had to send the workers in
15 the containment, you don't need to put scuba diving on
16 them. They can go in there in t-shirt because there
17 is no radiation outside the vessel. The other thing
18 is simply -- decommissioning because you take out the
19 fuel and everything inside the vessel remains there
20 and the so the vessel is like a sarcophagus and this
21 is especially important if you want to deploy IRIS in
22 developing countries. You take IRIS in. At the end
23 of life, you take it back. And there is no
24 decommissioning, no cost left in the host country.
25 Next.

1 DR. KRESS: When you change out the core,
2 do you also change out the steam generator?
3 MR. CARELLI: No. I'm coming to the steam
4 generators. The steam generators, what we have, we
5 have this nice lady which you can see, but is in
6 Italian, and this is a picture at Ansaldo. Ansaldo
7 built the helical steam generators for Super Phoenix
8 and they tested the steam generators and this in fact
9 is a huge steam generator. I think it's a 20 megawatt
10 -- steam generator. They tested it. In next slide I
11 have what they tested. But what I wanted to give you
12 here because the steam generator, the perception is we
13 have so much trouble with steam generators now. This
14 crazy guy wants to put the steam generator inside the
15 reactor and this makes even worse. And there are
16 things you have to think.
17 First of all, if you put a steam generator
18 inside, now the primary fluid is outside the tubes so
19 the tubes are in compression instead of traction. And
20 so now you don't have any more of the tensile
21 distress, corrosion, so forth. Our IRIS doesn't have
22 a bottom so the chemistry is much better. Okay. The
23 other thing is you don't have -- so the bottom of the
24 deposit of the steam generators is the bottom of the
25 vessel. So there are a bunch of things that the steam

1 generator has a different environment in an integral
2 reactor versus a loop reactor. So don't think I have
3 all the problems of the loop, I am compounding them.
4 This is a different animal. We're talking different
5 animals.
6 Now, what they did in Ansaldo, they tested
7 the steam generators. Next slide, please. First of
8 all, there is experience with Super Phoenix and the
9 MFBR experience. In terms of LWR, as I said before,
10 the auto-on was running on helical steam generators.
11 The one you just saw in the picture before. So they
12 fabricated, tested, they confirmed the performance
13 with all the performance we have and by some stroke of
14 luck, our device is such that we can put eight steam
15 generators practically identical to the models Ansaldo
16 has fabricated. So now we have one thing and that
17 thing is important. What we have now, we have eight
18 steam generators for 300 megawatts. So we're not
19 talking redundancy. That's exactly what we want to do
20 because the steam generator have a very critical
21 safety function and you are going to see in a second
22 what it is.
23 Next. That's the safety by design. Next,
24 please. Okay. Now on the safety by design. Just
25 doing a little bit of background. The way we see on

1 the philosophy. You take a Generation II. You have
2 an accident and you have cope with active means, like
3 you have a loss of coolant accident and you dump --
4 emergency coolant system and make up water, all that.
5 On Generation III you do the same thing like you do
6 with passive means. So inertia is going to help you.
7 But still you are doing something to handle the
8 consequences. On Generation IV what we looked at is
9 rather than coping with the consequences, since we
10 have this new geometry, let's take advantage and
11 prevent the accidents through safety by design. Next,
12 please.
13 And that's basically what we've done. We
14 spent quite a long time looking at the integral
15 configuration and saying how can we exploit this? How
16 can we exploit the IRIS characteristics which is the
17 integral configuration long-life core to eliminate the
18 accidents from occurring. Number 1. Two lessen the
19 consequences and three, decrease their probability.
20 Next.
21 DR. APOSTOLAKIS: If you physically
22 eliminate the accidents, aren't you decreasing their
23 probability?
24 MR. CARELLI: No. No, no. Yes.
25 DR. APOSTOLAKIS: Are there different

1 accidents?

2 MR. CARELLI: That's different. Go back.

3 Could you please go back.

4 DR. APOSTOLAKIS: I understand.

5 MR. CARELLI: What I'm saying is that of

6 course the first thing you eliminate. You do that.

7 Fine. End of the story. Second, if you can not do

8 that, you decrease -- you lessen the consequences.

9 Fine. If you can not do that either, you decrease the

10 probability. So this is a kind of -- Next.

11 What we did, this is the one, we're not

12 passing out -- kind of messed it up and I'm not going

13 to this in detail because otherwise you're here until

14 midnight. But what we have on this column is

15 essentially the design characteristics. These are all

16 the design characteristics of IRIS. Just look at the

17 geometry, long-life core, all this stuff. Then I say

18 here what is the safety implication of this design

19 characteristic? Okay. I can't read it. This is --

20 and what happens here?

21 Now, the first thing is the most obvious.

22 You don't have the large LOCAs and it doesn't take

23 much -- you don't have any piping going from the

24 vessel to the steam generators, so no piping, no large

25 piping, no large LOCA. That's obvious. Everybody

1 does that.

2 But then we went to other steps and one

3 thing that we worked on, and I think this is something

4 that is interesting, is the small LOCAs. I still have

5 the two inch pipe break, could have, and historically

6 the large LOCA has never been a problem. All the

7 problems came from the small LOCAs. Next. Sorry.

8 Before doing that, out of that table we said, okay,

9 what happens now to the Class IV accidents that were

10 handled for AP600? And we look with the IRIS approach

11 of safety by design and we can eliminate the LOCAs.

12 We can eliminate the range of the actual accident if

13 we put the control rods and CDRMs inside the reactor

14 because then you have nothing to shoot out.

15 And all the others really, because of the

16 combination of the integral configuration, the steam

17 generators in compression, all this stuff, could be

18 reclassified as a Class III. The only one we have

19 left is the refueling accidents. It's still a Class

20 IV but the probability is between one-third to one-

21 fifth less. So that's what I'm saying here. First

22 you say you eliminate, then you lessen the

23 consequences and, for this, you lessen the

24 probability. So essentially out of eight Class IV

25 accidents of AP600, with IRIS you're left with one and

1 even that one with less probability. Next.

2 DR. KRESS: But you're only going to

3 handle this fuel once every eight years.

4 MR. CARELLI: Yes.

5 DR. KRESS: Doesn't that give you an

6 additional margin, rather than just this one-third and

7 one-fifth lower probability. The time gives you much

8 less risk due to fuel handling because you're not

9 doing it as often.

10 MR. CARELLI: Yes. The other thing, too,

11 and as I said, I didn't want it to stretch, but the

12 other thing, too, when you're fuel handling, you start

13 moving things around. You move this assembly from

14 here to there and you drop one or drop the other one

15 and so forth. In the case of IRIS, you don't move

16 anything. You take the old tank and the block -- not

17 the full tank. We try not to move each assembly at a

18 time because they are pressure resistant, we like to

19 have them in big chunks. So you can count. Big

20 chunks.

21 So then you don't move one assembly at a

22 time. You move chunks. So as you said, you're

23 absolutely right. Reduced probability even more. I

24 think I had a very good story so I didn't want to

25 really stretch it any further. But it is.

1 On the containment. This is the best
2 part. The containment we have, first of all, it
3 performs a containment function like every good
4 natural containment. But we're doing an additional
5 thing. Since we have the containment, we make the
6 containment working together with the vessel to
7 essentially eliminate the other LOCAs, the small
8 LOCAs. So the small to medium LOCAs in IRIS are gone.
9 Now, how that comes. If you think why you
10 have a LOCA? You have the vessel and you have a break
11 and you have high pressure here, low pressure here,
12 and that differential pressure drives the coolant
13 across to the hole. Right. Now, if I decrease the
14 pressure in the vessel and I increase the pressure in
15 containment, I have a zero delta P and nothing comes
16 out. And that's exactly what you can do in IRIS.
17 First of all on the containment. We can increase the
18 pressure because we have a smaller containment. It's
19 about half the size of AP600 which gives a factor of
20 two on tensile stress. It's vertical which gives
21 another factor of two.
22 So now we have a factor of four. So for
23 the same thickness, for the same stress, you can have
24 four times the pressure in IRIS that you have in
25 AP600. Increase the pressure in the containment.

1 In the vessel what you have, you have,
2 first of all, a larger volume which means less
3 pressure. Also you have heat removal from the steam
4 generated inside the vessel which means a lower
5 temperature. So higher volume, lower temperature
6 means lower pressure. And that's exactly what
7 happens. If I can have the next one.
8 These are the pictures of the
9 containments. These are pictures inside the
10 containment. This is IRIS containment for 100
11 megawatts, this is the IRIS containment for 300.
12 Three hundred is about the maximum size you can have
13 with IRIS. You're not going to see an IRIS of 500
14 because there is a point where the thermodynamics
15 breaks and 300 is about the largest size you can go.
16 Next.
17 DR. KRESS: The trade-off on having the
18 smaller more compact stronger containment is you have
19 to pay more attention to the normal leakage rates
20 through penetrations?
21 MR. CARELLI: In the containment?
22 DR. KRESS: Yes.
23 MR. CARELLI: Yes. That's what we have to
24 look at. And again, it's high pressure containment.
25 Yes, that's something you have to look at. But the

1 economics is terrific because you have much smaller --
2 and besides, besides the economics, with our
3 containment, it chokes off the LOCA. That's a key
4 thing.
5 What we have done to prove that, we have
6 performed an IRIS with different break size, different
7 elevations, and this is no water make-up, no safety
8 injection, and we ran three codes. That's the beauty
9 of having an international team. We ran one at
10 Gothic, at Westinghouse, one by POLIMI, Milan and we
11 provided code and there was one at University of Pisa,
12 FUMO. All three codes predicted the same results.
13 Next one.
14 This is the pressure differential across
15 the vessel. What happens is after the first quick
16 build-down, for about an hour in the early part of the
17 transient the pressure in the containment is higher
18 than the pressure in the vessel because I'm removing
19 heat like hell inside the vessel while the containment
20 is cooled by air. And so essentially containment
21 temperature goes up. So essentially the pressure and
22 containment is higher than the pressure in the vessel
23 and actually the steam condenses and is pushed back
24 through the break. This is kind of quick. Okay. I'm
25 not counting on this but it's kind of quick for the

1 100 megawatt, actually for a part of the transient.
2 You have a coolant going back into the vessel.
3 But the bottom line is the next one. This
4 one shows that after two and a half days this is the
5 level of the water in the core with a 4" break, 12 1/2
6 meters high, which is the worst place where you can
7 have a break, and we didn't do anything. No core
8 make-up, no emergency coolant system, nothing. In
9 fact, IRIS does not have an emergency core cooling
10 system. What we have in IRIS, we have a bunch of
11 tanks which are used as pressure pools because you
12 have to keep essentially the pressure in the
13 containment up to a point and those, if necessary, can
14 be used for core make-up. But this analysis was done
15 without a core make-up.
16 So the 72 hours essentially for the LOCA
17 in IRIS, it goes and you do nothing. So I think we
18 have a very good study in terms of LOCA. So for all
19 practical purposes, LOCA for IRIS are gone. The next
20 one.
21 This is very important because there is
22 people still that doesn't know what are the advantages
23 of an integral reactor. This is a quote that I took
24 from *Nucleonics Week*, actually was in the article two
25 weeks ago. It was the lead article. Second one was

1 a presentation of IRIS for NRC. Basically they're
2 saying that the pebble bed can meet its challenge on
3 having all these things missing but you can not do
4 that for LWR. The point here is not to compare IRIS
5 with pebble bed. It's comparing the LWR.
6 What the perception is, with LWR you can
7 not take a loss of coolant, a loss of residual heat
8 removal system, and also measures the core cooling
9 system. That is true until you know IRIS.
10 In case of IRIS, IRIS can do that because
11 the loss of coolant accident is resolved by the safety
12 of the design. Large LOCAs do not happen, small LOCAs
13 are taken care essentially with no consequence. For
14 the residual heat removal system, we have a three
15 independent diverse system. We have the steam
16 generators, we have the residual heat removal
17 interchangers and we have the containment because the
18 containment is coupled thermodynamically with the
19 vessel so removing the heat from the containment
20 essentially goes on removing for the vessel. And the
21 containment is cooled both by air and water, depending
22 on the size.
23 In the case of the emergency core cooling,
24 core cooling is not needed. We don't have any CCS.
25 What you really want is, anyhow, the gravity make-up

1 is available. So that shows that really IRIS is a new
2 breed of a light water reactor with a much, much
3 better safety. It's a new dimension. Next, please.
4 Maintenance is the next thing. In the
5 case of IRIS, since we're refueling every four years
6 or so or five years, eight years, it doesn't make much
7 sense to stop and make maintenance refueling every
8 three months. Economically it doesn't make any sense.
9 Besides, it provides access to third world country
10 proliferation resistance. So what we looked at is to
11 say let's have maintenance shut down synchronized with
12 the refueling which means every four years, every 48
13 months. Next.
14 This was work done by our team member from
15 MIT and basically this is the philosophy on the
16 surveillance. "Defer if practical, perform on-line
17 when possible and eliminate by design where
18 necessary." Next one.
19 Essentially, what we look at is be
20 accessible on-line or do not require any off-line
21 maintenance and the first thing is have high
22 reliability. So this is the beauty of doing the
23 design now from scratch. We're designing all our
24 components to have on-line maintenance or a
25 reliability that exceeds the 48 months. That is built

1 in our design. It's not done after. We're doing that
2 now. Next, please.
3 In the case of the MIT work, a couple of
4 years ago they looked, actually, it was five years
5 ago. They looked at PWR and BWR to extend it to 48
6 months and this is 18 month cycle. These are the on-
7 line, off-line. What they did, they say let's go to
8 48 months. What happens is you're increasing the
9 number of on-line. These are the ones off-line that
10 can be extended beyond the 48 months. And they had 54
11 they couldn't handle. So 54 could not be handled for
12 regular PWR in either way, either on-line maintenance
13 or extended off-line.
14 When we look at IRIS, these are regular
15 loop of PWR. Now let's do for IRIS. Fifty four
16 became seven. So we now have seven items of
17 maintenance out of 4,000. We have seven items. If we
18 resolve them, we have maintenance every 48 months.
19 And we are working on that. We have several members
20 of the team are working on that. Next.
21 This is the one I really wanted to talk
22 because I gave a very brief rundown. I cut out a lot
23 of stuff. I'd be happy to answer all the questions
24 either now or later on. But this is our approach.
25 The first one is important. We do not need a

1 prototype. When people say, when are you going to
2 have the IRIS prototype, I hit the roof. I don't need
3 a prototype. A prototype is for new technology. A
4 prototype of a ship import or the prototype for the
5 leaking matter reactors. IRIS does not break any new
6 technology. it's light water reactor technology, it's
7 only good engineering. All you need is good testing,
8 not a prototype.
9 So what we have in IRIS is a first-of-a-
10 kind and, again, we believe that around 2010 or soon
11 after we can deploy the first of a kind. Future
12 improvements can be implemented in Nth-of-a-kind.
13 What we have with IRIS is not a static design. A
14 module doesn't cost that much. You're talking a
15 couple of hundred millions or so we're not talking
16 billions. So we can easily put improvements in next
17 modules. For example, the extended core reloads will
18 be in a second or third module. Next.
19 So you ask, what are licensing challenges
20 and opportunities versus the Gen IV reactors? First
21 of all, the first fuel core is well within state of
22 the art. So we have no challenge whatsoever. It's
23 just a regular PWR. The reloads and higher enrichment
24 fuel and they have to be handled through a licensing
25 extension. We're talking post-2015. So it's not an

1 issue now. That will come later. IRIS does have a
2 containment and this containment, in addition to the
3 classic function, is thermal-hydraulically coupled and
4 chokes off the LOCA. You've seen that.
5 The safety by design eliminates some
6 accident scenarios like the LOCAs, if we have internal
7 CRDMs and diminish the consequences of others. So
8 here is a chance for significant streamlining. When
9 I say the SSAR, simplified safety analysis, I hope I
10 don't have to go through -- of LOCAs because that's a
11 waste of time. So that's something that we have to
12 discuss. How can we simplify because some things do
13 not happen?
14 And here is a risk informed regulation.
15 Commissioner Diaz said this morning one thing that it
16 just hit me. He said it was deterministic,
17 experimental and probablistic. But the first word was
18 deterministic. Deterministically, our accidents for
19 LOCAs is zero deterministically. So we are starting
20 with IRIS, we are starting from a very strong basis.
21 So if we take the safety by design basis of IRIS and
22 we put on top the risk informed regulation, I think we
23 have a very, very good safety study which means that
24 with improved safety we can improve the licensing
25 position and we can really have that zero emission or

1 so that we are talking for Generation IV. It was a
2 lofty goal for 2030.
3 I believe with IRIS that goal is in the
4 next 10 years so when we are able to build one because
5 with this, I think we have a very good chance to go
6 with no evacuation of the staff.
7 And here is one question. Our maintenance
8 is every 48 months rather than 18 months. There are
9 some regulations that are tied into 18 months. So we
10 say are there regulatory changes necessary to
11 accommodate extended maintenance? That's just a
12 question. I don't think it's a measured thing. And
13 there are things that was already mentioned before
14 with the PMBR. We had modules with common parts like
15 control room and so forth which, of course, have no
16 intention to be the one control room for each module.
17 So we've got to have one room for several modules and
18 so those are things that has to be addressed. Next,
19 please.
20 The other question you had was what is
21 approach to licensing, construction and operation
22 versus Gen II? First of all for licensing. We do not
23 see at this time any unique major changes. It's
24 simplification, streamlining. We don't see any major
25 changes. There is, however, one thing. The testing

1 to confirm IRIS unique traits. For example, the
2 safety by design and the LOCA is great, is based on
3 first principle. We have three codes independently
4 producing the same results but we want to have
5 testing. We want to have experimentally confirmed
6 data. We do not have to have prototypic testing.
7 That doesn't make any sense.
8 We can do scale testing and properly
9 scaled testing with the proper parameters and so forth
10 and look at the parameters. That's something that has
11 to be done as soon as possible because that takes
12 time. That's a long lead item.
13 So the safety of the design, the integral
14 components like the stem generators and some of those
15 have already been tested, maybe some of the tests have
16 to be done for the IRIS conditions. But most of the
17 tests have been already done.
18 The maintenance optimization, the
19 inspections. Again, we have the components in the
20 core for 48 months or so where inspections are
21 required.
22 In terms of construction, IRIS is modular.
23 It's modular fabrication. It's modular assembly. So
24 it's a different ball game from the Generation II.
25 You have big items on-site and so forth. Bechtel is

1 one of our team members and Bechtel has the most
2 advanced of the EPC tools and we're going to take
3 advantage of Bechtel EPC for doing our construction.
4 We've already been talking. Bechtel is already
5 planning on putting that to full speed on IRIS.
6 Here is one thing that's interesting. It
7 is the multiple parallel suppliers. What we have with
8 IRIS, we have several suppliers all over the world.
9 For example, out steam generators can be fabricated by
10 Ansaldo, by Ansel, by MHI. Three different countries.
11 So what we have here, we have redundancy
12 of suppliers and something that obviously is an
13 advantage. If properly managed, it's definitely an
14 advantage. We have a staggered module construction.
15 Cost-wise, it makes a lot of sense. What we did --
16 economically for three IRIS modules and three years
17 stagger it. Basically, when we started building the
18 third one, the first one already is producing
19 electricity and has return. So with the module
20 reactor you can do that. It's nothing different. No
21 pebble beds to sit in, any modular design is a logical
22 thing to do. We stagger it.
23 In terms of operation, we have an extended
24 cycle length with a straight burn and we have the
25 maintenance no sooner than 48 months. That is

1 different, of course, from Gen II. And we have
2 refueling shutdowns. Right now it's five years.
3 Eventually after the reloads we can push up to eight
4 to 10 years.
5 These things combined means there's a
6 reduced number of plant personnel. We're not going to
7 have 1,000 people at IRIS. No way. You're probably
8 talking one-tenth of that. So it really has quite an
9 effect on O&M costs. And we have a multiple modules
10 operation which again is different from Gen II. And
11 I'm not talking a twin you may think a part of three,
12 five or more IRISes.
13 Next, please. Now what about the
14 schedule? This was your question. Okay. The two key
15 dates for the 2005 SAR. A little more important is
16 the 2007, 2007 is an ambitious objective.
17 Now how can we meet that? Several things
18 have to happen. First of all, the lead testing we are
19 to initiate by early next year. The testing takes
20 time. If we don't start at least the planning, the
21 analysis, all of that by early 2002, essentially this
22 date is going to slide to 101 because obviously we can
23 not have signed certification until we have the test
24 results. In testing, you can't accelerate this up to
25 a point. So this is one key thing.