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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Title: BRIEFING ON EPRI ON THE STATUS OF THEIR ADVANCED LIGHT WATER REACTOR (ALWR) PROGRAM PUBLIC MEETING

Location: Rockville, Maryland

Date: Friday, June 5, 1998

Pages: 1 - 54

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NUCLEAR REGULATORY COMMISSION

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BRIEFING ON EPRI ON THE STATUS OF THEIR

ADVANCED LIGHT WATER REACTOR (ALWR) PROGRAM

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PUBLIC MEETING

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Nuclear Regulatory Commission
Room 1F-16
One White Flint North
11555 Rockville Pike
Rockville, Maryland

Friday, June 5, 1998

The Commission met in open session, pursuant to notice, at 10:06 a.m., the Honorable SHIRLEY A. JACKSON, Chairman of the Commission, presiding.

COMMISSIONERS PRESENT:

SHIRLEY A. JACKSON, Chairman of the Commission
GRETA J. DICUS, Member of the Commission
NILS J. DIAZ, Member of the Commission
EDWARD McGAFFIGAN, JR., Member of the Commission

STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

STEVE BURNS

JOE COLVIN, CEO and President of the Nuclear Energy Institute

GEORGE HAIRSTON, CEO and President of the Southern Company

ROBIN JONES, Vice President for Nuclear Power, EPRI

PAT McDONALD, Executive Director, Advanced Reactor Corp.

JOHN TAYLOR, Vice President Emeritus for Nuclear Power, EPRI

ANNETTE VIETTI-COOK, Assistant Secretary

PROCEEDINGS

[10:06 a.m.]

CHAIRMAN JACKSON: Good morning, everyone. I would like to welcome EPRI and NEI to brief the Commission on the status of the Advanced Light Water Reactor Program. The Commission also appreciates receiving copies of the U.S. Nuclear Industry's strategic plan for building new nuclear power plants and we look forward to your briefing the Commission on any aspects of this topic that you wish as well.

The Advanced Light Water Reactor Program was launched jointly by industry, the nuclear power industry, and DOE to revitalize the nuclear option. The plant designers undertook the responsibility of applying for NRC certification of their advanced designs and implementing utility-specified design and performance requirements.

In order to provide for a more predictable stable process for licensing, the NRC issued 10 CFR Part 52 which provides an opportunity to resolve siting and design issues before large commitments of resources are made to construct and operate new nuclear power plants. Early resolution of licensing issues is achieved through the design certification and licensing process under Part 52.

The NRC review and acceptance of the EPRI utilities requirements document has provided a sound basis

for NRC certification of standardized designs. The utilities requirements document specifies owner operational requirements at a fundamental level covering all elements of plant design and construction.

I would note that the NRC issue design certifications in May 1997 for the 1350 megawatt General Electric Advanced Boiling Water Reactor and the ABB Combustion Engineering System AD-plus standard plant designs. The NRC decision on the final design approval for the 600 megawatt Westinghouse AP-600 is expected later this year, this fall. The final design approval is a prerequisite for design certification. A certification of a fourth Advanced Light Water Reactor design has been deferred.

My understanding is that copies of the slide presentation are available at the entrances to the meeting and so unless my colleagues have any introductory remarks, Mr. Jones, I understand you are going to lead off the discussion.

MR. JONES: Thank you, Chairman, and good morning. Thank you very much for this opportunity to review the status of the industry's efforts to establish the option to build new nuclear power plants here in the U.S. Our main focus today is on the technical elements of the effort.

I would like to start by identifying myself and my

fellow presenters. I am Robin Jones, Vice President of Nuclear Power at the Electric Power Research Institute, EPRI. The three fellow presenters are Joe Colvin, the CEO and President of the Nuclear Energy Institute; George Hairston, CEO and President of Southern Nuclear; and John Taylor, my predecessor at EPRI. With us is a key industry leader who has been with us throughout the entirety of the program, Pat McDonald.

Pat has two titles in this particular effort because part of the ALWR effort is directed by the Advanced Reactor Corporation, of which Pat is the Executive Director, and the rest is directed by EPRI's ALWR Utility Steering Committee, of which Pat is the Chairman. Pat is here to answer all the questions.

Our efforts have been guided by a plan established by INPO nearly a decade ago, titled "The Strategic Plan for Building New Nuclear Power Plants." The plan identifies the technical institutional issues that have to be addressed to establish this deployment option, and the final report on the plan has just been issued. Copies of that final report have been sent to you recently.

As indicated in this overhead, Joe Colvin will review industry's follow-up plan titled "A Strategic Direction for Nuclear Energy in the 21st Century" a little later on, and you have copies of that plan before you.

Before Joe's presentation, John Taylor and I will address the status of the technical elements of the strategic plan and George Hairston will summarize the utility support and involvement in executing the plan to date.

CHAIRMAN JACKSON: Let me ask you a question. Do you have estimates of plant cost and construction cost for the evolutionary and passive designs?

MR. JONES: Yes.

CHAIRMAN JACKSON: Are you going to talk about that today?

MR. JONES: I will give you a couple of numbers, yes.

CHAIRMAN JACKSON: Okay.

MR. JONES: We have them for the passive design as well.

Your staff's feedback to us during preparation for today's meeting indicated particular interest in the passive designs and John Taylor's presentation will be devoted entirely to what is being done in support of that design concept.

Our program's other technical elements, all of which are essentially complete, will be briefly summarized in my presentation.

Before I get to that, I would like to note that

from EPRI's perspective at least, today's briefing provides an opportunity for us to jointly celebrate the successful outcome of our collective efforts in this area. We are very pleased at the way that the technical parts of this program have turned out and we truly appreciate the support that has been provided by this Commission and its predecessors and we thank you very much for the dedicated efforts of the staff.

Starting with the top-tier goals of the program as originally formulated, the overall top-tier goal has been to define future standardized Advanced Light Water Reactor designs. The word define in the context means define in the depth necessary to obtain regulatory approval, including the detailed supporting information necessary for that purpose.

We also mean by define the additional detail necessary to support solid estimates of plant cost and construction schedule. And throughout, our intent has been to ensure that the designs include those features most valued by the nuclear plant owner operators.

By standardize, we refer to the whole structure of standardization, starting with the substantial degree of replication that accrues from the regulatory process itself. To build on that, our goal has been to develop industry commitments, infrastructures and processes that extend standardization through the design detail and through subsequent construction, operation and maintenance of a

family of plants. We are convinced that a high degree of standardization maximizes economic competitiveness, reliable operation and management effectiveness.

Another top-tier goal has been to incorporate the vast experience gained worldwide in the design, safety evaluation, licensing, construction, operation and maintenance of existing plants. This has required pulling together the experience of different entities, including designers, regulators, constructors and operators. You are, of course, fully aware of the regulatory involvement and the encompassed regulatory experience that we have brought together in this effort. You can also visualize the effort needed to pull in the experiences of a large number of owner operators worldwide and the other entities that are involved in the nuclear industry.

Although our initial focus was on evolutionary plants, quite early in our program we include the passive design concept and established a goal to bring it to the position of being an available and competitive deployment option by the end of the program. The technical work has been underway since 1985 and it is nearing completion. This involved the expenditure of close to $1 billion by all the participants, provided by the vendor design teams, the utility industry and DOE. The design team and the utility industry expenditures have both included substantial

contributions both in cash and in kind from outside of the U.S. This is truly a global effort. NRC has been deeply involved in reviewing the content and results of this work from the start.

The remainder of my talk breaks down into three parts, the utility design requirements, some comments on evolutionary designs, and the first-of-a-kind engineering effort.

The foundation of the technical effort is detailed in quantitative documentation of what the owner operator wants in a future design. The document that captures that information is the Utility Requirements Document, or URD. It has been developed under the direction of EPRI's ALWR Utility Steering Committee which is composed of executives from nuclear utilities in the U.S. and 11 other nations. And George, I think, has a list of the other countries that have been involved a little later.

NEI, INPO and DOE have participated in the Committee's meetings and the development of the requirements involved detailed consultation with plant designers. The resulting URD is comprehensive and detailed, it takes up a bookcase all by itself. It covers both evolutionary designs and passive designs and, as you noted, Chairman, the specifics for Boiling Water Reactors and Pressurized Waters are both addressed, and these -- the URD has been reviewed

in detail by the NRC.

CHAIRMAN JACKSON: Is it still in any way being revised to reflect feedback from the design certification process?

MR. JONES: We have revised the document several times during the -- to reflect the results of both ongoing experience in existing plants and the results of the design efforts, and we expect to continue a low level of further revision in the future, as additional experience is gained.

CHAIRMAN JACKSON: Is there much variation in the degree to which the three advanced designs comply with the specifications?

MR. JONES: No, they all comply in great detail and we ensured that that was the case in the way that we went forward with the process.

So the major program goals of obtaining NRC blessing on the URD were achieved in 1992 for the evolutionary design requirements and 1994 for passive design requirements. The NRC reviews were demanding and detailed and resulted in some instances in higher standards than were originally proposed by the industry.

CHAIRMAN JACKSON: Now, when will the final version of the URD be issued and will the NRC be asked to review that also?

MR. JONES: For the present purposes, the version

that you have reviewed is sufficient. When we accumulate a sufficient number of additional changes, we will be back to you asking for a re-review of those changes.

Before I leave the URD, I will just briefly identify its top-tier requirements in very much a summary form. The intent is to provide greater operational margins through conservative design of various types; to reduce the demand on the operators through the use of state-of-the-art I&C and man-machine interfaces; to provide a cumulative probability of less than 10 to the minus 6 for severe accidents and to mitigate the consequences of any such accidents; to ensure low occupational radiation exposure by the plant works; to design in a core damage frequency of less than 10 to the minus 5 per reactor year; and to assure no fuel damage for substantial breaks in the coolant lines; to assure increased reliability of components, simplification of systems, use of proven technologies all aimed at the goals of achieving 87 percent average plant availability, 24 month refueling interval and a 60 year plant life.

We also attempt to ensure minimal site-specific differences by making sure that they are enveloped by site envelopes requirements in the URD. So that although there will be some variation from plant to plant, they will be minimal.

CHAIRMAN JACKSON: Given that you do have this minimization of site-specific differences, what would you say for the record are the key design features that contribute to the lowering of the core damage frequency?

MR. JONES: The key design features?

CHAIRMAN JACKSON: Well, just, fundamentally, what drives them down?

MR. JONES: The use of lower coolant temperatures, the use of conservative design. Basically, everything we know about how to ensure that --

CHAIRMAN JACKSON: So it's a cumulative thing?

MR. JONES: Yes.

CHAIRMAN JACKSON: Okay. I thought you were going to tell me there is some one --

MR. JONES: No, there is no object here.

CHAIRMAN JACKSON: Okay.

MR. JONES: There are two evolutionary designs that have been developed that comply with the URD, GE's ABWR and ABBC's System 80-plus, and here is perhaps the answer to your question, Chairman. The evolutionary designs have enhanced reactor coolant systems, containment overpressurization protection and emergency core cooling systems. They have reactor cavity flooding capability. Reliability is improved by the use of materials that have proved reliable in existing plant designs. More robust

major component design. Greater operational margins. Modern I&C systems, and consideration of human performance factors throughout the design process. These are more forgiving plants that are easier to operate.

CHAIRMAN JACKSON: Well, I still have two more questions. Were modern I&C systems modeled into PRAs?

MR. JONES: Yes.

CHAIRMAN JACKSON: Okay. Were shutdown PRAs performed?

MR. JONES: I don't know the answer. I assume they have.

Shutdown PRAs?

MR. TAYLOR: Definitely. Definitely.

CHAIRMAN JACKSON: Okay.

MR. TAYLOR: Much more visible than in the past.

MR. JONES: In order to ensure that the URD requirements were reflected in the designs, there was detailed utility industry interaction with the two designers. The certified designs have a very high level of conformance to the URD as a result.

The URD safety goals have been met with margin. The PRAs show core damage frequencies down in the 10 to the minus 6 to 10 to the minus 7 range. This includes seismic events. The PRAs indicate the cumulative probability of an off-site whole body dose of 25 rem beyond a half-mile radius

site boundary is below 10 to the minus per reactor year. NRC has certified both designs.

COMMISSIONER McGAFFIGAN: May I ask?

CHAIRMAN JACKSON: Yes, please.

COMMISSIONER McGAFFIGAN: Is there an intent, if one of these plants is ordered and the combined license comes in, that emergency planning would be different for these? You know, you are saying 10 to the minus 7 probability. Is there, in your discussions with the staff over the years has there been any talk about pulling in some of the emergency boundaries that are in the emergency plans?

MR. JONES: We think the technical work that would permit such a discussion has been done, but the discussion hasn't been held yet and probably won't be until there --

COMMISSIONER McGAFFIGAN: Until there is a real.

MR. JONES: A real opportunity.

CHAIRMAN JACKSON: Steve, you look you have something.

MR. BURNS: No.

CHAIRMAN JACKSON: Just listening?

MR. BURNS: Just listening.

CHAIRMAN JACKSON: Okay.

MR. JONES: Finally, a brief summary of the first-of-a-kind engineering effort. I already mentioned that our top-tier goals included defined designs to a

sufficient level of detail to get robust estimates of cost and construction schedule. That's the process that is encompassed by first-of-a-kind engineering. It takes the plant design from the level required for certification to the level required to make such estimates, which is about a 95 percent complete design.

It entails the preparation of procurement specifications for the major components and form-fit function specifications for the rest. First-of-a-kind engineering unavoidably stops short of detailing specifics that are site-specific, and that's the 5 percent that we think is still to be done.

For this work, the Advanced Reactor Corporation, which I will refer to as ARC, entered into a co-funding agreement with DOE. ARC undertook to manage the project and in that activity was supported by loaned utility personnel and EPRI staff. The utility industry's funding share and in-depth intellectual participation has assured the details defined in first-of-a-kind engineering also have a very high conformance to the requirements of the URD.

The process used to decide which designs would proceed to first-of-a-kind engineering was competitive and it resulted in the selection of two designs co-funded by GE on the ABWR and co-funded by Westinghouse on the AP-600. John Taylor will cover the AP-600 first-of-a-kind

engineering in his presentation in just a moment.

The first-of-a-kind engineering was completed some little time ago on the ABWR for the entire nuclear and balance of plant scope. Detailed cost estimates shows the ABWR meets the 30 mills per kilowatt, our capital cost target set in the URD. The estimated construction time is substantially less than the URD target of 54 months from first concrete to commercial operation, and, indeed, we know that the outcome -- that target can be met in reality as a result of the construction of two units of very similar design in Japan, which I think hit 49 months if I remember rightly.

With the ABWR, GE went on to win a major share of the twin unit project at Lungmen site in Taiwan and that project is ongoing.

Unless there are questions, John Taylor will now address the passive designs, which is by far the most technically interesting part of the program.

MR. TAYLOR: Thank you. The Advanced Light Water Reactors with enhanced passive emergency cooling features arose primarily as a response to the strong utility desire for a simpler, smaller Light Water Reactor. The concept fosters the use of natural driving forces such as gravity flow, natural circulation and compressed gas, substituting for the conventional electrically powered pumping and

control systems.

This substitution not only simplifies the overall system, but counters the loss of economy of scale at lower power outputs. Both the Pressurized Water Reactor, the Westinghouse AP-600, and the Boiling Water Reactor, the GE SBWR, incorporated this concept and design and development were initiated at a reference power level of 600 megawatts electric.

This work has stimulated worldwide interest in the greater utilization of passive safety features in nuclear power reactors. Many countries have initiated their own R&D programs to investigate this approach. These programs range from more radical versions of the concept to incorporation of additional passive safety features in the evolutionary designs.

The difference in reactor and containment cooling systems in the passive plant designs warranted the preparation of a separate volume of the Utility Requirements Document to parallel the evolutionary plant volume. Since there were also many similarities, the Utility Requirements Document safety goals and many other requirements were common for both the evolutionary and passive plants.

For example, safety and reliability is similarly enhanced for both by requirements for better choices of materials, more robust major component design, greater

operational margins, modern instrumentation and control systems and the application of human factors.

But a significant new feature in the passive plants requirements arises from the difference in the emergency cooling systems and it is the regulatory treatment of non-safety systems, shortened to RTNSS. RTNSS is a process for defining regulatory oversight for active non-safety related systems incorporating both deterministic and probabilistic criteria and evaluations. A major goal has been to set reliability standards so that the active non-safety systems can be utilized effectively to minimize challenges to the passive safety systems.

The RTNSS process has helped to identify specifically the role of the non-safety related systems in the PRA and in the regulations. This treatment has been applied to the AP-600 which meets the RTNSS criteria and the Commission's safety goal guidelines, using conservative non-safety reliability bases for the non-safety systems.

Extensive testing has been carried out to verify the design and analyses of the passive emergency cooling features. The testing and analysis plans were reviewed with NRC before implementation and covered test facilities, test designs, data reduction methods, uncertainty evaluation, formal quality assurance requirements and verification and validation of computer codes.

A disciplined test and analysis process called the Code Scaling Analysis and Uncertainty Process was developed by NRC Research in cooperation with the industry and with input from the ACRS to govern the implementation of the testing and analysis plans. NRC observed the work in progress and reviewed all the results. This process and the accompanying NRC reviews were applied to both the AP-600 and the SBWR Test and Analysis Programs.

Now, after over a decade of design, analysis, testing, and NRC review, the 600 megawatt electric Westinghouse AP-600 has received an advanced final safety evaluation report from NRC. The design complies with the Utility Requirements Document and Westinghouse has identified the following noteworthy characteristics.

Two systems are central to the design. First, a passive core cooling system which provides core residual heat removal, safety injection and depressurization. The entire system is located within the containment building requiring no circulation of reactor coolant outside the containment boundary. The system consists of a combination of cooling water resources -- or sources, gravity drain of water from two core makeup tanks and a large refueling water storage tank suspended above the level of the core, as well water injected from two accumulator tanks under nitrogen pressure.

Second, a passive containment cooling system which provides the ultimate heat sink for the plant. In a loss of cooling accident, the natural circulation air cooling of containment is supplemented by evaporation of water flowing by gravity from a tank located on top of the containment building shield. Hydrogen control in design basis accidents is provided by passive auto-catalytic recombiners.

Now, other licensing design basis accident features are also included, which I will review very briefly. All safety-related electrical power requirements are met by Class 1E batteries, eliminating the need for safety-grade on-site AC power sources and greatly reducing dependence on off-site power.

Hermetically-sealed canned primary reactor coolant pumps requiring no seals have been adapted from highly reliable naval nuclear primary coolant pumps, thus obviating a seal failure loss of coolant accident.

Passive cooling and piping configurations prevent core uncovery for loss of cooling accidents up to an eight inch pipe break. As in evolutionary Advanced Light Water Reactors, the AP-600 design has reactor coolant system and containment overpressurization protection and reactor cavity flooding capability. As a result, no operator action is needed to meet the licensing design basis criteria for 72 hours and no off-site support is needed for seven days.

Features that contribute to the mitigation of severe accidents include a main control room habitability system which provides passive fresh air, cooling, and pressurization to the main control room through the use of a compressed air supply. A substantially reduced number of containment penetrations. And igniters are provided for severe accident conditions involving very large releases of hydrogen.

Probabilistic risk assessment evaluation shows that the probabilities of core damage frequency and major radiation releases from containment are in the same extremely low ranges as for the evolutionary plant design.

And commenting on your earlier question, Chairman, the contribution to the core damage frequency from shutdown conditions is 25 percent of the total and very particularly attention paid in the RTNSS process to equipment in the -- the active equipment in the shutdown condition.

CHAIRMAN JACKSON: What is your view of maintaining molten core within the reactor pressure vessel?

MR. TAYLOR: We think from the work that was done by NRC, very much the major sponsor, to do an evaluation of the TMI-1 reactor vessel and the damage that occur to it, combined with the greater assurances we see of availability of water for breaks up to eight inches in the AP-600 case, no uncovery of water, that the probability of getting into a

molten condition is small, and if it does, there's very strong assurance that the vessel will contain it.

Now, we have -- in the design features of both the evolutionary and the passive plant have reactor cavity cooling capability, being able to flood the reactor cavity to further increase the chances of keeping that molten fuel, if it ever did exist, within the vessel. I think we have gone as far as we know how to keep that material in the vessel.

On the passive system testing for the AP-600, separate effects and integral tests of various scales were carried out, both under transient and steady state conditions of the core makeup tank and refueling water storage tank, the automatic depressurization systems and of the passive containment cooling system. Systems interactions tests were also performed.

Now, these tests were carried out in Westinghouse facilities, at Oregon State University facilities in the United States, and in two R&D laboratories in Italy. In addition, NRC sponsored confirmatory tests, an independent integral test of the passive cooling features in a Japanese facility, and additional tests at the Oregon State facility after the industry testing was completed. The NRC test programs put more emphasis on exploring systems interactions and perturbations that were postulated to leave the

challenges imposed by beyond design basis accidents.

The test results confirmed the design and analyses of the passive cooling features, confirmed that systems interactions were self-compensating rather than adverse, and showed the systems to be robust against postulated perturbations beyond the design basis assumptions.

First-of-a-kind engineering was carried out on the AP-600, has been essentially completed for the entire nuclear and balance of plant scope. Full completion awaits receipt of the NRC final design approval so that any licensing related adjustments to the design can be incorporated. The cost and schedule estimates arising from the effort show that a co-located twin unit AP-600 significantly compensates for the economy of scale disadvantage and that it is economically competitive with single unit evolutionary designs.

The simplification and a high degree of modularity in the design gives the potential to reduce the construction time from first concrete pouring to commercial operation to about three years.

Now, the BWR passive design, GE 670 megawatt SBWR, has features comparable to the AP-600, including a gravity drain emergency core pooling system and condensing heat exchangers in elevated pools to provide passive core decay heat removal and containment cooling. In addition, the SBWR

can produce full power with natural circulation, eliminating the water recirculation pumps.

GE pursued a design certification for the SBWR until two years ago, when it decided to discontinue the effort. GE closed out the program with a technical package incorporating the design results, extensive test data and documentation of the progress made in the licensing process.

Now, the SBW Test and Analysis --

CHAIRMAN JACKSON: Excuse me. How soon do you think -- I mean how likely do you think that any efforts with the BWR passive design are to be resurrected?

MR. TAYLOR: Well, my own judgment is that they carried out the Test and Analysis Program to the extent that they did verify the design features and performance characteristics of the passive safety systems. So I think we have that on the shelf and the technical package is available to NRC. We hope that one of these days GE will be back at the table pursuing a design.

In fact, I'll jump ahead, a little ad libbing, they are pursuing with their European partners a larger power output version of the passive BWR, and they have made some significant improvements. Specifically, they have opened up the flow passages to reduce the pressure drops and increased the natural circulation flow also by enlarging the head area to increase the chimney effect and have resulted

in being able to have a design at 1,000 megawatts electric, which fits into -- I am going to read this so I say it correctly -- here we go. It includes a reactor within the same diameter pressure vessel as the ABWR, 1,000 megawatts now, and the same containment size as the 670 megawatt SBWR design.

Additional testing and analyses have been carried out in European facilities on these passive safety performance at the higher power level. The increased natural circulation and other innovations give substantial promise for the BWR passive plant and perhaps even at lower power outputs.

In summary, the passive plant Utility Requirements Document Final Safety Evaluation Report has been obtained. The AP-600 Advance Final Safety Evaluation Report has been issued, right on schedule. The AP-600 first-of-a-kind engineering has been essentially completed and the SBWR design, testing and licensing progress have been documented.

The AP-600 final design approval and design certification are the final steps needed to complete this program.

Without the support of the U.S. and international utilities, the reactor manufacturers and the Department of Energy, and the commitment of resources by the NRC, the Advanced Light Water Program and its excellent results would

not have come to pass.

I would like now to introduce George Hairston, who will summarize the specifics of the utilities' support.

MR. HAIRSTON: Thank you, John. Let me just thank the Commission for giving us an audience to talk about the ALWR Program and where we stand, and on a larger note, we are here to thank you for the support and leadership that you, on your side, have given to this program, it has been essential.

I want to talk just a very few minutes about what the utilities' investments in the ALWR Program have been. The U.S. utilities have both led and supported the technical effort since the early '80s. Their funding has been primarily through EPRI. Substantial utility manpower has been expended in providing overall guidance to EPRI and in establishing the technical specifics.

In the late '80s the utilities commissioned the development of a strategic plan for building new nuclear power plants to open the option for expanded nuclear capacity in the U.S., a plan that Robin referred to earlier.

This plan moves the program along the broader front, encompassing both institutional as well as technical issues. EPRI, INPO and NEI were asked to participate on this broader front. Here, again, utility management devoted substantial resources via participation in the committees

and the working groups formed by EPRI, INPO and NEI. Loan-ins were also provided to these institutions.

Two elements of the plan were identified as prerequisites to the option to build new nuclear power capacity. INPO took the lead on current nuclear plant performance. Major improvements have been achieved in safety, reliability and economics of our operating plants. The improvement in reliability, along with license renewal, will make a vital contribution to sustaining the nation's nuclear capacity over the near term.

NEI took the lead on high level waste. NEI is spearheading the legislation action to support the development of interim management and permanent disposal at Yucca Mountain.

Taking the main technical efforts one at a time, the development of the URD was funded by the U.S. and overseas utilities through EPRI. The utilities also provided executive and management personnel to serve on the Utility Steering Committee that Robin Jones referred to. Technical personnel were also loaned to EPRI.

Through EPRI, the utilities also co-funded the design and analysis work done on the passive designs towards NRC certification. DOE, too, was co-funder to the design teams. The utilities also funded EPRI to assure design conformance for the utility requirements.

A significant portion of the first-of-a-kind engineering was also funded by the utilities, again, along with DOE and the design teams. The utility contribution came from 15 domestic utilities, one of which is my affiliation, the Southern Company. In addition, teams of utility personnel provided project management, located at the designer's office in Pittsburgh and San Jose.

Standardization is a key goal from a utility standpoint. A position paper on standardization for a family of plants having the same design was developed by the utility industry and formally endorsed by all nuclear utilities. But the paper provides policy guidance to standardization at all levels, the URD, design certification, first-of-a-kind engineering and the life cycle of construction, operation, maintenance and decommissioning.

Utility personnel also participated with NEI to help define the detailed implementation of NRC's Standardization Policy and Rule, that is the two-tier approach and the ITAAC.

Let me talk for a minute about the global aspects of this. Utility participation has not been limited to just the U.S. utilities. As Robin mentioned, nuclear utilities from Belgium, France, Germany, Italy, Japan, the Netherlands, South Korea, Spain, Taiwan, Switzerland and the

U.K. have helped fund both the URD and the passive designs. They also contributed substantial personnel resources. They brought extensive knowledge and operating experience. Much of the passive design testing was performed overseas in utility-sponsored facilities.

The URD represents a high degree of international consensus. This is continuing to build as these countries formulate their own specific requirements. Through our program, particularly the URD effort, the U.S. industry has achieved major international leadership in defining the future characteristics of nuclear power. This complements the leadership the NRC has achieved on the international regulatory front.

Our paramount near-term objectives are the final design approval and design certification of the AP-600. The NRC's extensive reviews of the URD and the ALWR designs have been essential to the success of this program. We are most grateful to you for this commitment and allocation of resources. Without your leadership, we would not be where we are today.

COMMISSIONER McGAFFIGAN: There's been several references to the international cooperation, and I know the Europeans themselves are developing a European pressurized reactor. Has there been talk regulatory in the industry circles, whether these reactors would be certified and able

to be built in Europe and whether there is a quid pro quo where we have to look at the European pressurized reactor when it is at a similar stage? How is that -- how have those sorts of discussions worked?

MR. HAIRSTON: Let me ask Joe to take that one.

MR. COLVIN: There have been number of discussions, as you indicated, Mr. McGaffigan, on those issues. There are vast differences, however, in the regulatory systems within those countries that cause design differences. For example, in the European reactor design and the combination, the program Fromatome and Siemens, for example, I mean that is designed to fit the regulatory system within Europe and not necessarily the regulatory system of the United States, because of issues like codes and standards and ISO 4000 and other types of issues which change the approach that we take.

I think that the key thing, though, that George has mentioned, and has been discussed several times, is there is a tremendous amount of technological exchange of information on issues that affect safety, the design, the engineering, the manufacturing techniques in these areas, that allow -- that have been transferred into these concepts that are now being -- have been reviewed by the Nuclear Regulatory Commission are in fact being built overseas today in Asia, and then will be, hopefully, be built in other

areas of the world.

CHAIRMAN JACKSON: In fact, I can actually make a comment to you on that line, Commissioner. The German and the French regulators, in fact, have had to work out some harmonization of regulatory approach for the EPR project and, in fact, within the INRA, the International Nuclear Regulators Association, there is discussion ongoing about harmonization and to what degree that can occur between the disparate regulatory systems generally, but also related to issues such as the licensing of one country's reactor in another.

COMMISSIONER McGAFFIGAN: Could I just -- again, I am learning, so forgive me. But this codes and standards and ISO 4000 issue, we basically designed -- we have European standards and American standards and we have -- they follow ISO 4000, we don't. How does that work?

MR. COLVIN: I will let John Taylor and Pat give you a number of details, but I will say that it sounds simple and something easy to overcome, and in my experience it is extremely difficult. A simple decision between metrification, English units and metric units, issues like that become extremely difficult in the regulatory licensing context and perhaps John or Pat could add their experience because of their involvement.

MR. TAYLOR: There is a great deal of consistency

in the standards we utilize and a great deal of consistency in the regulation but there's a lot of detail difference and the devil I'm afraid is in the details and the end result I think will be that European designs will be developed by European countries to those standards, to the regulation that they would have to deal with in the country that is involved.

Our companies will be designing to NRC regulations, to our standards. Now these NRC regulations and standards have been accepted around the world to date and I believe that a U.S. manufacturer meeting the U.S. standards can sell and build and have in operation a plant in Europe as well as they are doing today in Asia.

CHAIRMAN JACKSON: To what extent do these kinds of issues come up vis-a-vis building the two ABWRs in Kashiwazaki-Kariwa in Japan or to what extent have they come up with the Taiwan, the project in Taiwan, do you know?

MR. TAYLOR: Both Japan and Taiwan are very closely geared into NRC regulations and positions and in fact as I saw the history, it wasn't until NRC indicated some reasonable approval of an FDA level that they really wanted to proceed. They wanted to be sure that NRC was satisfied, and so I think in Asia there is less potential conflict than would be the case in Europe.

COMMISSIONER McGAFFIGAN: Could I also ask, are

there any other reactors -- if you are looking the next 15 years ahead, say -- aside from the three designs that we have worked on and hopefully the last one will get across the finish line soon -- is there -- you know, occasionally in the Congress you hear about the Russians get sold HDGRs and more proliferation-proof reactors, although I don't think any of these have any proliferation problems, properly safeguarded, but is there anything else out there that realistically the utilities are interested that can cross the finish line in the period that is relevant to a utility executive trying to buy a reactor?

MR. HAIRSTON: Speaking of the Southern Company, I think you are looking at what is on the table.

I would like to add one thing in this. As I mentioned earlier in my remarks, we were all together though, the international body was together on the utility requirements document.

CHAIRMAN JACKSON: Right.

MR. HAIRSTON: And that is what is very important, that even though the Europeans may be moving ahead on their reactor, the specific designs flow from that basic utilities requirements document.

MR. JONES: Similarly, the science and technology base -- there is a very good level of agreement on what is proved and what is proved and what is not. It's the way

that that is used in responding to local regulatory requirements that the difference start to emerge.

MR. McDONALD: And along that same line, assuming that continued interest overseas of our designs, we would hope as those designs get built that any variations in our design certifications that are brought about by new information or what have you or improvements, that we get those updated our U.S. design certifications to take advantage of --

MR. TAYLOR: Perhaps I could give a technical answer. There are, as you well know, very promising gas-cooled and liquid metal designs and substantial amounts of development work has been done on them.

The light water system, however, is blessed by a tremendous amount of operational experience and a tremendous development of regulation and in the near, reasonably near-term future that base is essential as a way to expand nuclear capacity.

Having taken that step, I can see these more advanced designs coming into play and substantial enhancing the potential and value of nuclear power energy generation.

COMMISSIONER DIAZ: By the time I make a comment, it will be a lot more difficult to design a European reactor the way it is designed in France and Germany and have it licensed in the United States than having one in here and

have it licensed in Europe.

MR. TAYLOR: Yes. I think you're right.

MR. HAIRSTON: The industry continues to be convinced that the future expansion of nuclear power is essential to meet the country's energy needs. The conviction has just been reaffirmed through the issue of a strategic direction for nuclear energy in the 21st century.

Joe Colvin will now review that document.

MR. COLVIN: Good morning. As George and Robin have indicated and Chairman, as you have indicated, we created that strategic plan for building new nuclear plants in about 1990 and revised that on eight occasions, and that plan contained 24 building blocks that we felt necessary to address to ensure that we were prepared to build new nuclear plants in the United States.

We made tremendous progress in that entire effort and we do thank you, the Commission, for working in a partnership in principle in the areas of the licensing and the reviews as well as the development of the basic rule infrastructures for both license renewal and Part 52.

Through that whole process, and I participated in that process from the beginning along with several of the gentlemen at the table, I believed and I am even more convinced today, as Mr. Hairston indicated, that we will build new nuclear plants in the United States in the future

because they are needed.

We have to look at what is occurring in the world and we see a tremendous confluence of positive change looking at nuclear and that is being driven by an increased amount of support from the policy arena, the policy makers, opinion leaders, as well as the public, and that is what really led the industry to move forward to set out the strategic direction, which in essence is really a shared vision for what we as an industry need to do to move forward into the 21st century.

Shown on this second slide, the strategic direction has eight compass points that will try to lead us into the future and I will be happy to discuss any of those in detail. I would really like to focus on three which are particularly germane to this discussion today, and those are the business conditions and policies that position nuclear plants for a competitive marketplace.

Secondly is the recognition of the environmental benefits of nuclear and how we take advantage of the intrinsic economic values of the emission-free nuclear energy.

Lastly, I would like to end on the real subject of this meeting, which is the next generation of new nuclear plants.

I want really to start a little bit on the

economic picture because there is a tremendous amount of misinformation, assumptions and assertions and allegations by people as to whether nuclear will be or can be competitive in the marketplace as we move forward, and I would like to provide some information on that.

I think it is important when we do that to look at the economic picture from two perspectives -- one, whether we are operating existing generation sources, in this case nuclear, or whether we are constructing new nuclear plants or new generation of any type, and it is important to keep that distinction in mind. They are very much inter-related and yet the decisions and the questions one must address are sometimes vastly different.

The economics will be a deciding factor on whether we build nuclear plants in the country and how well the plants operate today, how competitive they are, and will attract the buyers and decide whether you look at that from a business standpoint whether those are viable sources of generation.

I would like to just talk today -- because I'll tell you that from everything we look at, we see that most plants today are well-positioned for competition and in fact that is largely because the industry undertook tremendous efforts over the past 10 years to make improvements in those various reductions in refueling outage lengths and other

major initiatives, increases the availability and capacity factor, reduction of automatic scrams, and all that information really came about with an integrated focus on safety and how we do that in a more efficient and effective way.

I would like to show this next slide, which you likely have seen before. This slide shows the average cost of production, producing electricity, from the various fuel sources, and this production cost is the operating cost, the maintenance cost, and the fuel cost.

As you can see from this, although the graph is a little bit hard to see from here, the solid line on the bottom is nuclear and the other dotted line, the dashed line that is next to that is coal, and what that shows is that nuclear and coal are fairly competitive right today. They are certainly much more competitive than alternative sources.

There is a lot of discussion about natural gas. Natural gas on average in the United States is about one and a half cents per kilowatt hour of generation -- more expensive than generating through coal, large coal or large nuclear. The myth that gas is cheaper is not correct when done in the context of operating existing plants.

This slide shows the cost performance by quartile and an important distinction on this slide, as you can see,

is no matter which quartile we are talking about all the plants have continued to improve over time. Certainly the lowest plants, the lowest quartile or the first quartile, the plants with the lowest costs, show tremendous ability to compete in the marketplace and I think it is more important to realize that for nuclear units in the United States we internalize all our costs, so the costs for the nuclear waste fee, the cost for decommissioning, the examination of the gaseous diffusion plants, the cost of user fees for NRC and other activities are paid for and they are internalized within these figures.

That is certainly not true in alternative sources of generation, although there are efforts by organizations like the Federal Accounting Standards Board and others to try to balance that out from a business perspective and so forth. We'll see some of that, but as you can see, there is tremendous improvement.

Our challenge is to get the plants in the second, third and fourth quartile moved into the first quartile and have the first quartile continue to move down.

When you look at that and what we are going to compete on, however, we need to look at the competition in the electricity sector on a marginal cost basis, and in essence we have a number of issues such as potentially stranded investment, and other associated fees that -- and

taxes and other things that you have to take into account, but those are being dealt with properly by the states so far and we believe that the Federal Government through whatever actions are taken, any comprehensive legislation will in fact deal with those responsibly.

Then when you get to this at the end of the day, once those are dealt with in whatever manner they are, you need to look at operating costs at the margins. The marginal costs when you look at it from a business perspective has to include not only the operating, maintenance and fuel costs, but also the "to go" cap -- the capital that you need to put in the units to maintain the units efficiently and effectively and reliably and also some types of general administrative costs.

What this slide shows is you can see the bottom line, the bottom set of bar graphs, the gray bars are really the fuel costs fore the units and as you move across the page the second bar is operating and maintenance costs, the light color, and the next bar is an estimate -- it is an estimate of the to go capital costs and the G&A, the general and administrative costs.

The two lines that we have shown on there, the horizontal lines, there is a solid line at 2 cents per kilowatt hour and a dashed line at 3 cents per kilowatt hour. What is going to be determined in each region of the

country is a market clearing price for electricity and the ability to sell electricity into that sector is going to be determined by what the costs of electricity are and what your margin is on that to make a profit and that is going to be very basic business type decisions in this area.

I think you can see if you pick 3 cents per kilowatt hour that we have a majority of plants in the United States that are competitive today under these conditions and given that we internalize those costs we believe that we can be even more competitive in the future as we move forward.

These costs do not take into account any aspects of the economic values that attribute to the emission-free quality of nuclear generation, and that really leads me to the next subject, which is the compass point on recognizing what these -- I'll characterize them hidden values.

I would like to separate in the discussion the issue of environment and think about it in two ways -- Clean Air Act Requirements and separately the Kyoto protocol and climate change issues, although I think that because we had the Kyoto meeting in December, we have the Bonn meeting ongoing, and in preparation for Buenos Aires coming up in November that most of the focus tends to be on CO_2 but the reality is that under the Clean Air Act, first of all, as you know, nuclear does not emit any pollutants to the

environment and under the Clear Air Act it regulates sulfur dioxides, nitrous oxides, particulate matter, and ground level ozone, and the key I think that we see as to how to take advantage of this intrinsic value with nuclear generated electricity that does not pollute.

This next slide shows the emissions from utilities from 1996 in carbon dioxide, nitrous oxides, and sulfur dioxide and as you can see -- well, I'll just make a couple points.

One is that in 1996 alone nuclear generated electricity prevented emissions over 147 million metric tons of carbon, a little over 5 million tons of sulfur dioxide, and 3 million tons of NOX.

If you look at that another way, that is the equivalent of taking 100 million automobiles off the road, avoided emissions or not burning 50,000 railroad cars of coal. It's a significant benefit to our nation and the reality is our Administration is being to realize more and more that we can't meet the targets for emissions even under Clean Air Act without nuclear energy.

Let me give you an example of that. The next slide builds on nuclear energy and if you notice in the benefits, this slide shows the location of nuclear power plants, something that you are very well aware of, but the point that I would like to make is that these plants are

typically in fairly densely populated areas or provide electricity service to those areas where there is a high concentration of activities that generate pollution.

In addition, most of these areas are non-attainment -- they are non-attainment zones under the Clean Air Act for ozone or regulated pollutants and that is shown on the next slide, which builds on the first, which shows that these are the areas of the counties in blue, and I agree is it a little difficult to see on the screen but those are the counties that have taken action to reduce Clean Air Act under EPA's emission controls and those actions, they are in compliance with that, and under the current standards, and they have had to take action such as restricting industrial development and expansion, regulating stationary sources and even emission controls on mobile sources like COM in California with their automobile standards, as you are well aware of.

The next slide really shows in yellow and builds on that the counties that will not meet the EPA's 1997 revised standards for ozone. The real impact on this to the states of not being in attainment, if you want the hammer from that, is loss of Federal highway funds. This is a major issue for the state and these counties that are -- that have this difficulty and it makes a compelling argument, one that is becoming more and more aware -- these

policymakers, state legislators and others are becoming more aware of that from the standpoint of their own particular situation.

This really makes a compelling case for license renewal when you think about it because the license renewal aspects not only tie into economics but they tie into the emission-free generation of electricity and into the helping the states meet their restrictions.

But the third point that I want to talk about was new nuclear plants in the United States, and as you are well aware, the DOE Energy Information Administration, EIA -- I'll get it straight here in a second -- has said we will need over 400,000 megawatts of new generating capacity between now and 2020, and this is shown on this slide, and broken down year to year.

If you look at that, it shows both in the white bar, the new capacity that will be needed but this is based upon increases in demand and the darker colored bar really retirements of plants, and if you look at those between those windows that are shown on the slide, you have to add up the white-colored bars to really get to that but that is 400 gigawatts, 400,000 megawatts, and obviously if we increase it, we take advantage of the license renewal, which we are intending to do, and with the Commission's leadership and support on that, we are going to offset some of that,

but we are not going to offset the whole amount by a long shot. We are not going to make up that amount of electricity by renewables and by solar and by wind and other things. We are going to have to build new capacity, and we believe that nuclear must be in the mix, and in fact it has to be in the mix.

There is really no choice when we move forward and look at this.

Without even taking into considerations of energy diversity security and other factors, if you just look at economics versus demand versus environment and try to balance those, it is pretty clear.

This slide shows that if you --

COMMISSIONER DIAZ: Excuse me --

MR. COLVIN: I'm sorry --

COMMISSIONER DIAZ: Yes, I'm sorry. Did the retirements shown on the graph, did those include the nuclear power plant if they do not renew their license?

MR. COLVIN: Yes, sir. These are the EIA numbers and in fact they predict that no plants will renew their licenses and that by 2020 we will be at half the capacity in the United States, so the retirements of nuclear plants are built into that graph

COMMISSIONER DIAZ: Thank you.

COMMISSIONER McGAFFIGAN: Can I also ask a

question about this graph? In the current five-year period, we have, we are apparently adding over 100 gigawatts of capacity. I know the nuclear component is zero, but where is it all coming from? Is it mostly gas and coal?

Well, first of all, I think you understand that these are the EIA projections and they go into a lot of models and assumptions of what we need and I think what we are seeing is those numbers will be adjusted by what really takes place over this period.

We are seeing an improvement in efficiency. I mean just in the past five years in the nuclear industry we have made improvements in the production, the availability or capability factors of these units such that it is equivalent to putting 11 new 1000 megawatt nuclear plants on the line.

Those were not built into DOE's assumptions that are shown in that graph and that is true not only in the nuclear arena but it is true in the fossil arena. We are operating those facilities better.

We are building some new generation. Most of that is combined cycle gas turbines.

COMMISSIONER McGAFFIGAN: Could I just ask, we are most of the way through this period, how accurate did that first bargraph prove to be?

MR. COLVIN: I don't know but I will be happy to

look at that because we do have some information and I will try to provide that to the Commission but I really can't comment other than to make a total guess at this point, but I will give you some feedback. It is an important question as to whether the validity -- I will say that we do not agree with the assumptions that the EIA uses in their models and predictions.

COMMISSIONER McGAFFIGAN: Okay.

MR. COLVIN: We have our own, but I will try to give you some information on that.

COMMISSIONER McGAFFIGAN: That's fine. I just recall when I was a student almost 25 years ago at Kennedy School getting totally outrageous projections about the future of energy at the time of the oil crisis --

CHAIRMAN JACKSON: Did you compare these to what you got then?

[Laughter.]

COMMISSIONER McGAFFIGAN: I'm sure the numbers were much larger. We probably needed to have 1000 gigawatts a year if you believe what we were believing then.

MR. COLVIN: And I agree totally, but I think if you say that the EIA projects 400 gigawatts, if we are off by a factor of four we are still talking 100 gigawatts and no matter what we try to build, it's a significant amount of generation, and when you try to balance that with the

environmental issues I think that is where it really comes into play.

I will say -- I was going to make a point later, but I will make in now, and that is that even the environmental groups are believing that meeting the nation's environmental needs and the generation of electricity will add between three-quarters of a cent and one cent per kilowatt hour to the cost of electricity that emits pollutants, so you go back to that market clearing price that I was showing, 2 cents and 3 cents. If you add a penalty to generation that emits or you add a benefit or give a credit to generation that does not emit, whichever convention you would like to choose, then -- I mean we have a tremendous value that has not been recognized, and I think when we look at that together, that is why we see that we need these plants.

COMMISSIONER McGAFFIGAN: Could I ask another question outside of our regulatory framework? I read in "Nucleonics Week", which is not a good source of information most of the time, that even Electricite de France, when it thinks about capacity, you know, when they need capacity, which isn't anytime soon, they have people from EDF quoted that they will look hard at combined cycle gas, and there probably is not a more pro-nuclear nation and utility.

So how does that square, you know, with what you

are saying? That they haven't caught up to EPA in terms of NOX and sulfates and all that and when they do, they will make -- or will that --

MR. COLVIN: Well, I guess, first of all, let me make sure that I am clear on one point. I am not saying that we ought to build nuclear and not build anything else. In fact, as a nation, we are going to need everything we can build upon in new generation for the future if we are going to compete in the global marketplace and other. I mean just look at it from a national perspective. In fact, we try to recognize this in the strategic direction.

I think they are doing the same thing. I mean when a utility in the United States, and I'll let Mr. Hairston speaks, they run all the scenarios for all their generation mix and how you meet all these various requirements and how it fits into your economic planning features and so on. And I think the EDF and others are doing the same thing.

You can build a combined cycle gas turbine plant with a fairly low capital cost, about $400-$450 per kilowatt installed. And yet you are subject to significant swings in fuel costs.

COMMISSIONER McGAFFIGAN: Right.

MR. COLVIN: I mean those are all trade-offs. Low capital cost, low construction time to get on line. Low

staffing levels. But yet you have got some other factors. So I think it is more of that.

I will say that the other countries do not have the restrictions on the Clean Air Act in the same way that we do. And they have environmental laws, and if you start looking, I mean it is intriguing in the context of the Kyoto protocol to talk to other countries, and when we talk clean air, they really are not on the same sheet of music. They are thinking CO2. And I think that is going to change around the world.

COMMISSIONER McGAFFIGAN: Is NEI thinking of subsidizing Carol Brenner trips to Europe?

[Laughter.]

MR. COLVIN: I would prefer not to comment on that one or answer that question.

But I just wanted to make -- if I can, go back to that slide and comparison just to make a point here. And that's -- these are -- no, not that one, the one on generating, costs of new generation. You have to look at, as I indicated, not only the cost to operate it, and how you are going to compete, but you have to look at the cost of what it costs to install it, new capacity, and those are DOE's numbers, those are EIA's projections that they have had.

One that is not on there is the cost to renew the

license. If you think about it as compared to generating new capacity and that range is in our estimates between $10 and $50 per kilowatt. And if you just think that Baltimore Gas and Electric has, in round numbers, 2,000 kilowatts -- 2,000 megawatts of capacity at Calvert Cliffs, the estimate for NRC licensing, and this is round numbers, $10 million if you assume that they have to make other changes to the plant and so on, call it, say it's $50 million total, that $50 per kilowatt. I mean that -- you can't compare that.

So I think, you know, if you start to think about it in those ways, you can see quickly why people are moving in that direction, and especially as we move into a competitive marketplace.

As was indicated about the GE APWR at Kashiwazaki, an important point on that was that that was a -- those were 1350 megawatt plants. They were put on line, in operation in under four and a half years, you know, ahead of schedule, under budget. I mean it is obviously do-able if we set in place the proper framework to accomplish that. And I think besides that we are going to make a tremendous improvement as the learning curve, as was indicated by Mr. Taylor.

I would like to just close on the slide that -- the last slide, which really makes the points, in summary, that I think, as I have indicated, most of our units are highly competitive today. We certainly are going to see a

change in the business structure of our industry as we go through competition. Some companies are going to be in the generating business and other companies are not. And that's going to change how we move forward. There's going to be consolidation, there's going to be new business entities come about and it's going to be pretty exciting to work through a lot of that.

We are going to see more increased emphasis on emission-free electricity. I mean just to give you one quick example, if you add new control technology to a fossil plant, for example, a scrubber, you get a tax credit today. Yet if you don't generate it in the first place, there is no credit. There is something basically flawed with that concept, and there are a lot of initiatives in the policy arena to look at that from a national perspective.

As I also indicated, we have, as you know, certainly, that our fuel price, our low fuel price and the relative sensitivity of that is -- and sensitivity to the fuel price changes is very important. So I think that as we move forward we are going to see, certainly, the licenses renewed and we are going to see new nuclear power plants built in the United States, and the question is when and what pace, and we'll look forward to working with the Commission to ensure that we do that safely and effectively.

Thank you.

CHAIRMAN JACKSON: Any further comments, questions? Commissioner Diaz? Commissioner McGaffigan?

[No response.]

CHAIRMAN JACKSON: Well, I would like to thank EPRI and NEI for this status briefing today. The Commission appreciates the joint cooperative effort of industry, DOE, others and the NRC in the two design certifications that have been completed. We anticipate a continued cooperative effort on the AP-600 final design approval and design certification process.

As you know, an Advanced Final Safety Evaluation Report was issued to the Commission this past month, and it is currently review by the Advisory Committee on Reactor Safeguards, the ACRS. The staff still expects to issue the final design approval in September of this year. However, maintaining this schedule will depend on timely, high quality responses, and I have made this point to them, by Westinghouse to issues or items identified by the Commission, the staff or the ACRS. It also depends on timeliness in terms of the staff continued activity. And the NRC will continue to examine its regulatory structure, bearing in mind our responsibility for protecting public health and safety, but in a manner to ensure that our requirements are not an impediment to bringing about new nuclear plant orders in the United States.

And unless there is any further comments, we are adjourned.

[Whereupon, at 11:24 a.m., the briefing was concluded.]

CERTIFICATE

This is to certify that the attached description of a meeting of the U.S. Nuclear Regulatory Commission entitled:

TITLE OF MEETING: BRIEFING ON EPRI ON THE STATUS OF THEIR ADVANCED LIGHT WATER REACTOR (ALWR) PROGRAM PUBLIC MEETING

PLACE OF MEETING: Rockville, Maryland

DATE OF MEETING: Friday, June 5, 1998

was held as herein appears, is a true and accurate record of the meeting, and that this is the original transcript thereof taken stenographically by me, thereafter reduced to typewriting by me or under the direction of the court reporting company

Transcriber: Martha Brogal

Reporter: Jon Hundley

Advanced Light Water Reactor Program (ALWR) Accomplishments and Status

A Utility Industry Executives' Briefing
to the NRC Commissioners

NRC Headquarters
Rockville MD

June 5, 1998

1

Sequence of Industry Presenters

Robin Jones	Completed Technical Elements
John Taylor	Passive Designs
George Hairston	Utility Investments
Joe Colvin	Strategic Direction

2

Top-Tier Technical Goals

- Define future standardized ALWR designs
  - Through to regulatory approval
  - Plus through to detailed plant cost and construction schedule estimates
  - Standardize from certification through operation

- Incorporate worldwide plant experience
  - Designers
  - Regulators
  - Constructors
  - Operators

3

Top-Tier Technical Goals
(continued)

- Establish evolutionary and passive design alternatives

Underway since 1985 and nearing completion

Expenditure of ~$1B, including in-kind efforts

Industry-DOE cost-sharing program

NRC deeply involved from the start

4

Utility Design Requirements

- Under the direction of EPRI's ALWR Utility Steering Committee
  - Operating executives from nuclear utilities: US and eleven other nations
  - NEI, INPO and DOE participation
  - Detailed consultation with the plant designers
- Comprehensive and detailed requirements
  - For evolutionary designs (~1350 Mw) and passive designs (~600 Mw)
  - For boiling water reactors and pressurized water reactors

Utility Design Requirements
(continued)

- FSERs issued
  - For the evolutionary-design requirements - 1992
  - For the passive-design requirements - 1994

Top-Tier Utility Design Requirements

- Greater operational margins through reductions in coolant temperature and core power density and through increased coolant inventory
- State-of-the-art I&C and man-machine interfaces directed to transparent monitoring and reduced demand on the operators
- A large, rugged containment building such that the whole body dose is less than 25 rem at the site boundary for severe accidents with cumulative frequency greater than 10-6 per reactor year

7

Top-Tier Utility Design Requirements

- Occupational radiation exposure less than 100 person-rem per year
- A core damage frequency of less than 10-5 per reactor-year and no fuel damage for up to a 6-inch coolant line break
- Increased reliability of components, simplification of systems and the use of proven technology to assure 87% average plant availability, a 24-month refueling interval and a sixty-year life
- Minimal site-specific differences, controlled by "site envelope" requirements

8

Evolutionary Designs

ABWR (GE) System 80+ (ABB-CE)

- Enhanced:
  - Reactor coolant systems
  - Containment overpressurization protection
  - Emergency core cooling
- Reactor cavity flooding capability
- Improved reliability:
  - Better choices of materials
  - More robust major component design
  - Greater operational margins
  - Modern I&C systems
  - Application of human factors

Evolutionary Designs

(continued)

ABWR (GE) System 80+ (ABB-CE)

- Very high level of conformance to the Utility Requirements Document (URD) - Safety goals met
  - Core damage frequencies below 10^{-6}/reactor-year
  - Cumulative probability of 25 rem beyond half-mile below 10^{-7}/reactor-year
- Design Certification obtained

First-of-a-Kind Engineering

- To support detailed estimates of plant cost and construction schedule
  - Takes the level of plant design completion from that required for design certification to that required to support these estimates.
  - Includes these estimates
- ARC/DOE co-funding agreement
  - ARC project management
    - Supported by on-loan utility personnel and EPRI staff
    - Assured very high level of conformance to the URD

11

First-of-a-Kind Engineering
(continued)

- Competitive selection
  - ABWR, co-funded by GE
  - AP-600, co-funded by Westinghouse
- ABWR completed
  - Meets the URD's capital cost and construction schedule targets
  - Won major share of Taiwan plant

12

The Passive Design Concept

- Arose from utility desire for a simpler, smaller LWR
- Substitutes natural driving forces (gravity flow, natural circulation, and compressed gas) for conventional electrically powered pumping and control systems
- Substitution not only simplifies overall system but counters loss of economy of scale at lower power outputs
- PWR and BWR application with reference power level ~ 600 MWe

13

Passive Plant URD

- Difference in reactor and containment cooling systems warranted a separate URD volume
- Safety goals and many other requirements same as in evolutionary plant URD volume
- As for evolutionary ALWRs, safety enhanced and reliability improved by better choices of materials, more robust major component design, greater operational margins, modern I&C systems, and the application of human factors
- A significant step: Regulatory Treatment of Non-Safety Systems

14

Regulatory Treatment of Non-Safety Systems

- A process for defining regulatory oversight for active non-safety related systems incorporating both deterministic and probabilistic criteria and evaluations
- Active non-safety systems reliability standards set to minimize challenges to the passive safety systems

Regulatory Treatment of Non-Safety Systems
(continued)

- The RTNSS process has helped to identify specifically the role of the non-safety related systems in the PRA and in the regulations
- The AP-600 meets the RTNSS criteria, including the Commission's safety goal guidelines based on conservative non-safety-related reliability bases for the non-safety-related systems

Passive Safety System Testing

- Extensive testing to verify design and analyses
- Testing and analyses plans reviewed with NRC before implementation
- Disciplined process developed by NRC Research to govern implementation
- NRC observation of work and review of results

PWR Passive Core Cooling System

- Provides core residual heat removal, safety injection, and depressurization.
- Located within containment building; no circulation of reactor coolant outside the containment boundary.
- Combination of cooling water sources:
  - gravity drain from two core makeup tanks
  - gravity drain from large refueling water storage tank suspended above the level of the core
  - injection from two accumulator tanks under nitrogen pressure

PWR Passive Containment Cooling

- Containment system provides the ultimate heat sink for the plant.
- In a LOCA, natural circulation air cooling of containment is supplemented by evaporation of water flowing by gravity over containment from a tank located on top of containment building shield
- Hydrogen control for design basis accidents is provided by passive auto-catalytic recombiners

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Other PWR Licensing Design Basis Accident Features

- All safety-related electrical power requirements are met by Class 1E batteries, eliminating the need for safety-grade on-site AC power sources and greatly reducing dependence on off-site power
- Hermetically-sealed canned primary reactor coolant pumps requiring no seals have been adapted from highly reliable naval nuclear primary coolant pumps, thus obviating a seal failure LOCA

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Other PWR Licensing Design Basis Accident Features (continued)

- Passive cooling and piping configurations prevent core uncovery for LOCAs up to an eight inch pipe break.
- As in evolutionary ALWRs, the AP-600 design has reactor coolant system and containment overpressurization protection, and reactor cavity flooding capability
- For LDBAs, no operator action is needed to assure safety for 72 hours and no off-site support is needed for 7 days

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PWR Severe Accident Mitigation

- A passive main control room habitability system provides fresh air, cooling, and pressurization to main control room through compressed air supply
- Containment penetrations have been substantially reduced
- Igniters are provided for severe accident conditions involving very large releases of hydrogen
- Core damage frequency and major radiation releases from containment in the same extremely low ranges as for the evolutionary plant PRAs

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PWR Passive System Testing

- Separate effects and integral tests carried out
  - In Westinghouse and university facilities in the U.S.
  - In industrial laboratories in Europe
- NRC sponsored tests of the passive cooling features carried out in Japan and Oregon State U
- Test data has confirmed the design of the passive cooling features

First-of-a-Kind Engineering

- AP-600 first-of-a-kind engineering essentially completed
- Covers entire nuclear and balance of plant scope
- Full completion awaits receipt of the FDA, to incorporate new licensing related adjustments to the design

AP-600 Cost and Schedule Estimates

- Compensation for the economy-of-scale disadvantage
- Twin-unit AP-600 plant economically competitive with large single unit evolutionary plant
- Simplification and modularity lead to potential for less than three years from pouring first concrete to commercial operation

BWR Passive Design

- GE 670 MWe SBWR has features comparable to the AP-600
- Condensing heat exchangers in elevated pools provide passive core decay heat removal and containment cooling
- Operates at full power with natural circulation, eliminating water recirculation pumps
- Technical package was produced incorporating the design results, extensive test data and analytical code comparisons, and documentation of the progress made in the licensing process

BWR Passive System Testing

- Component, separate effects and integral system tests were conducted
  - at GE in the U.S.
  - at industrial laboratories in Italy, Japan, and Switzerland
  - included full, 1:25, 1:400, and 1:500 scales with non-dimensional analysis for comparison of results
  - both transient and steady-state conditions
- Test data confirmed the performance of the passive emergency core cooling and containment cooling systems

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Large Passive BWR

- GE-European cooperative effort to design and develop a 1350 MWe version of the SBWR
- Natural circulation flow rate increased with potential for the same diameter pressure vessel as the ABWR and the same containment size as the 670 MWe SBWR design
- This and other innovations give substantial promise to the BWR passive plant

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Passive Plant Status Summary

- Passive Plant URD FSER obtained
- AP-600 Advance FSER obtained
- AP-600 First-of-a-Kind Engineering essentially completed
- SBWR design, testing, and licensing progress documented
- AP-600 FDA and Design Certification the final steps to be completed in the ALWR program
- Without the support of the utilities, DOE, and NRC, these excellent results would not have come to pass

Utility Investments in the Program

- US utilities led and supported:
  - Technical effort since early '80s
    - Utility funding primarily through EPRI
    - Utility manpower for guidance and technical specifics
  - Institutional effort since late '80s
    - Through EPRI, INPO and NEI
    - Utility manpower for guidance, working groups, loan-ins

Prerequisites to New Nuclear Capacity

- Current nuclear plant performance
  - INPO lead
  - Major improvements in safety, reliability, economics
- Spent Fuel Management
  - NEI lead
  - Spearheading legislative action re: Yucca Mountain

Utility Investments Specifics

- URD funded by US and overseas utilities
  - Plus personnel to serve on the Utility Steering Committee
  - Plus technical personnel loaned to EPRI
- Utilities co-funded the passive design work towards certification
  - Including funding EPRI to assure conformance to the URD

Utility Investments Specifics (continued)

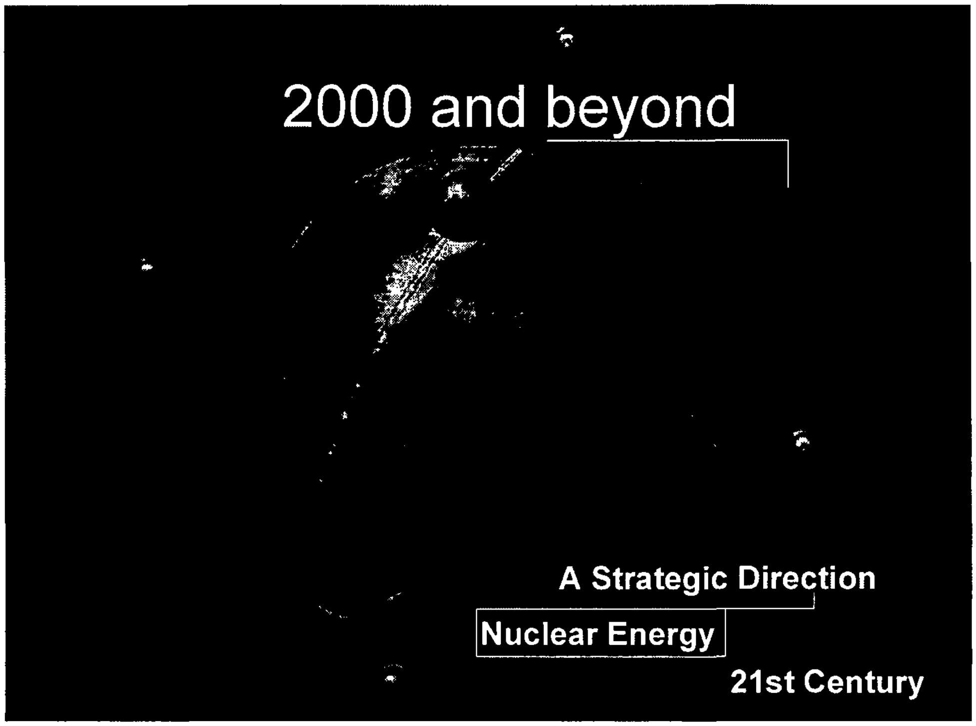
- Utilities also co-funded the first-of-a-kind-engineering
  - From fifteen domestic utilities
  - Plus teams of utility personnel for project management
- Utilities sponsored the Position Paper on Standardization
  - Formally endorsed by all the nuclear utilities
  - Provides policy guidance to standardization at all levels
  - Also participated with NEI to help define the detailed implementation of NRC's Standardization Policy and Rule

Global Aspects

- Participation by overseas utilities
  - Belgium, France. Germany. Italy, Japan. the Netherlands. South Korea. Spain. Taiwan, Switzerland, the UK
  - Funding for the URD and the passive designs
  - Plus personnel resources
  - Extensive knowledge and operating experience
  - Passive design testing at overseas facilities.
- The URD - a high degree of international consensus

Global Aspects
(continued)

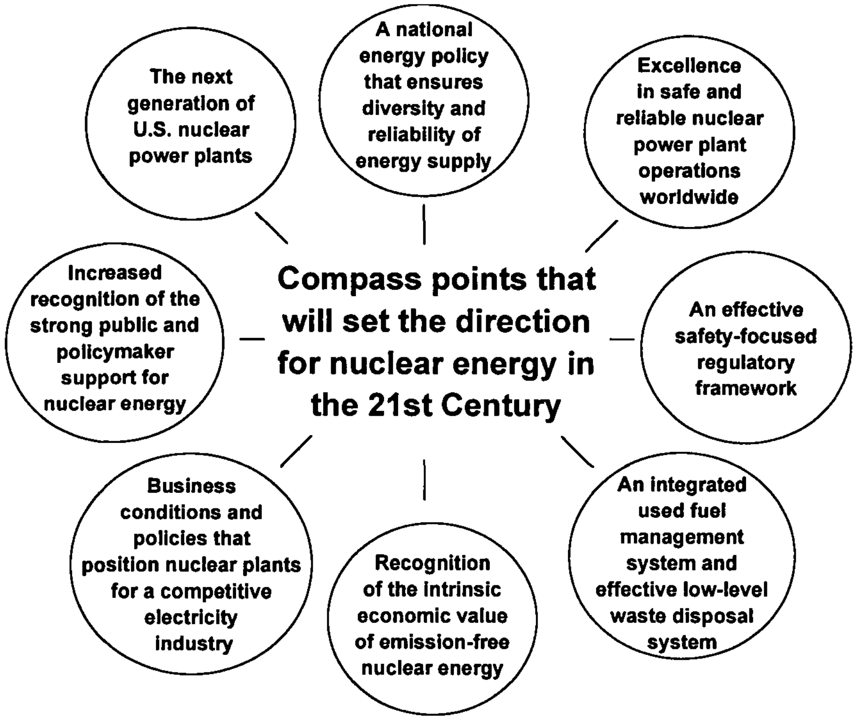
- US industry - major international leadership in defining the future characteristics of nuclear power
  - Complements NRC global leadership
- Paramount near-term objectives - FDA and DC of AP-600
- Gratitude for allocation of NRC resources



EPRI Briefing for the NRC

Joe Colvin
President and CEO
NEI

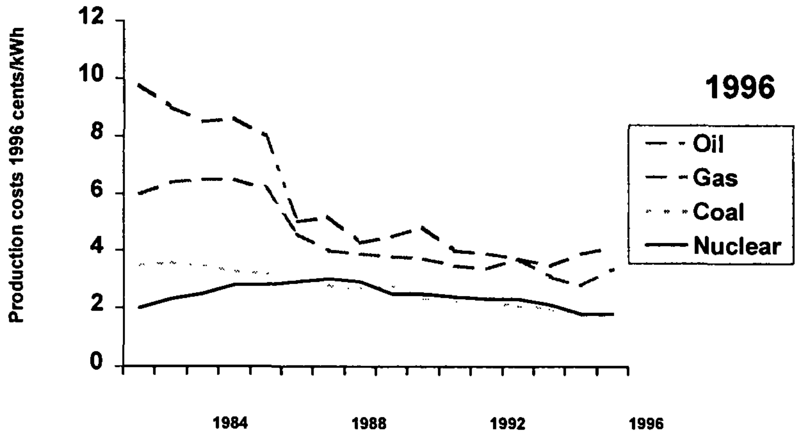
June 5, 1998



Toward business conditions and policies that position nuclear plants for a competitive electricity industry

U.S. Electricity Production Costs
(1996 cents/kWh)

■ ■ ■ ■ ■ ■ ■ ■ ■ ■



U.S. Nuclear Industry Production Costs
(3-year rolling averages by quartile)

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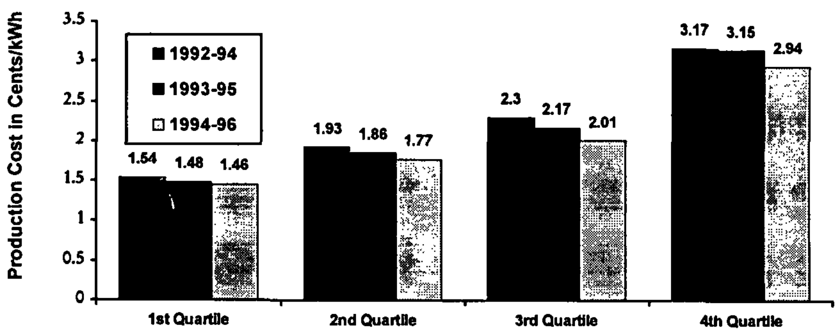
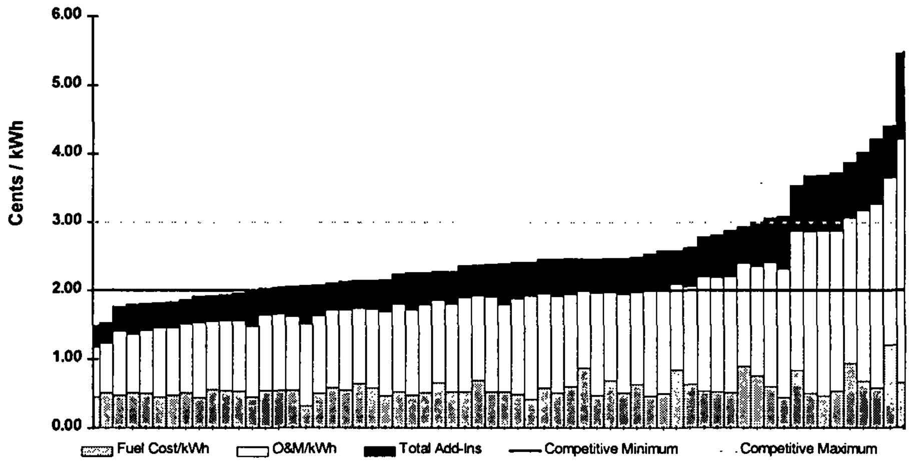
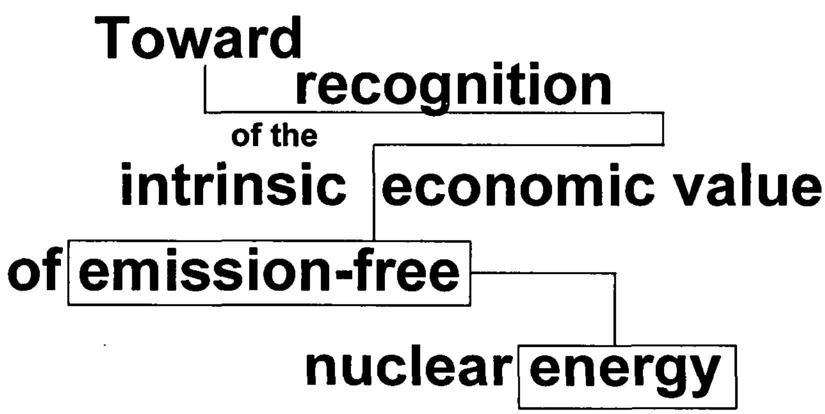


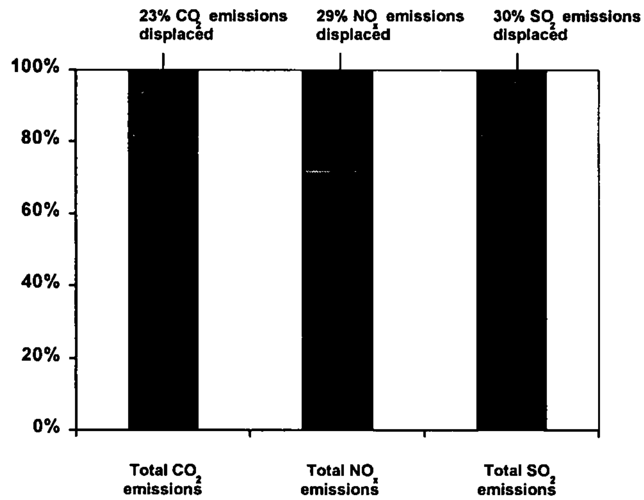
'To Go' Costs Per Plant

(1994-96 Production Costs + Estimated Capital + G&A)

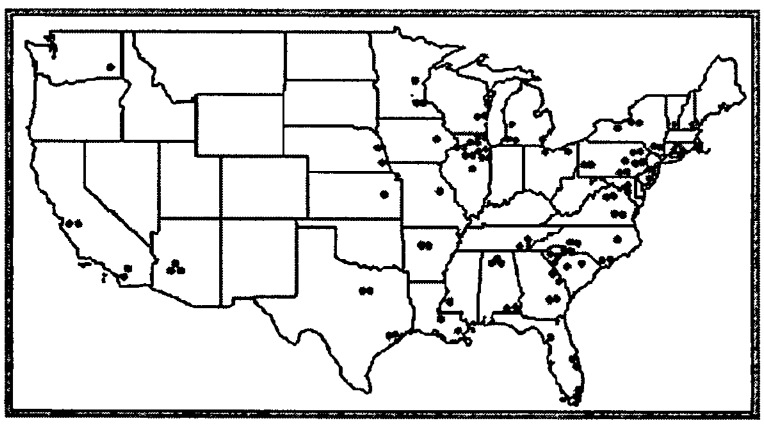




Nuclear. The Clean Air Energy
(1996 electric utility emissions)

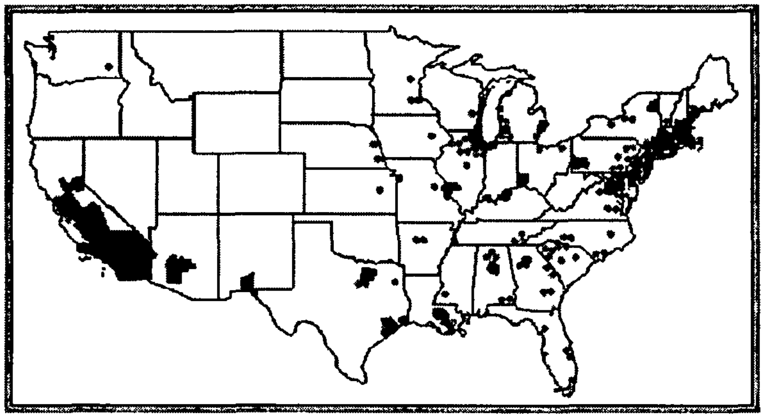


Nuclear Energy and Attainment



● = Nuclear power plants

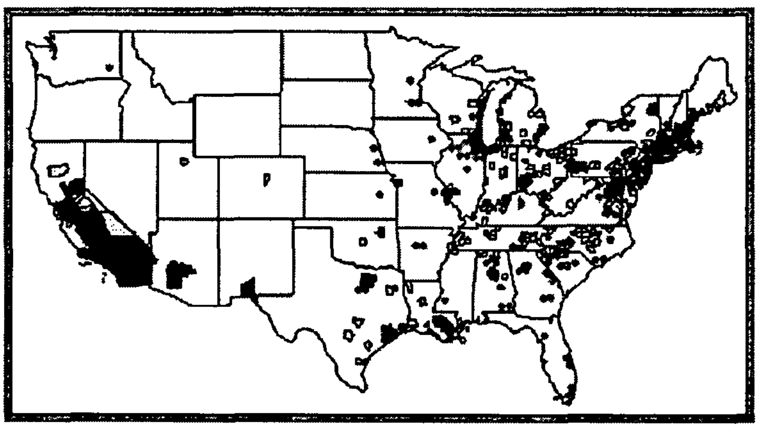
Nuclear Energy and Attainment



■ = Counties with control programs in place under current ozone standard

(Source: EPA 1993-95 data)

Nuclear Energy and Attainment



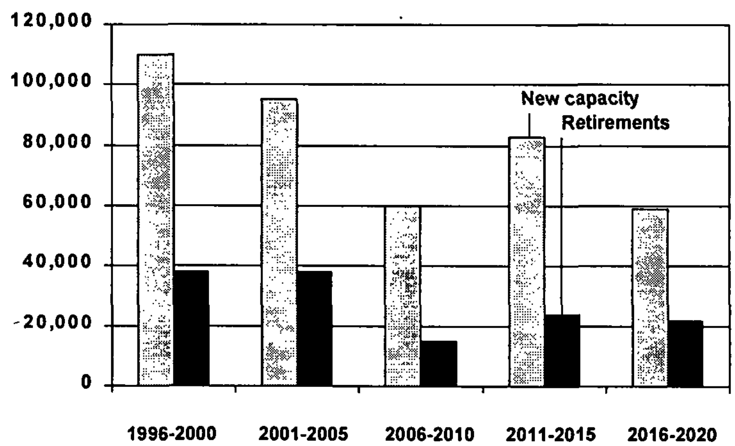
= Counties that will not meet EPA's 1997 revised ozone standard

(Source: EPA 1993-95 data)

Toward the next generation of U.S. nuclear power plants

New Capacity Will Be Needed to Replace Retirements, Meet Demand

New generating capacity and requirements, 1996-2020 (megawatts)



Capital Costs: New Generating Options

- Combined-cycle natural gas plant: $440 per kilowatt
- Pulverized coal: $1,079 per kilowatt
- Integrated gasification combined-cycle coal plant: $1,206 per kilowatt
- New nuclear: $1,550 per kilowatt
- Solar plant: $3,185 per kilowatt

Nuclear Energy Today. . .

- Most nuclear units highly competitive
- New business structures
- Emission-free energy source
- Relatively insensitive to fuel price increases

. . . and in the 21st century

» License renewal

» New nuclear power plants