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PUBLIC MEETING

Nuclear Regulatory Commission
One White Flint North
Rockville, Maryland

Wednesday, November 1, 1989

The Commission met in open session, pursuant to notice, at 10:00 a.m., Kenneth M. Carr, Chairman, presiding.

COMMISSIONERS PRESENT:

KENNETH M. CARR, Chairman of the Commission
THOMAS M. ROBERTS, Commissioner
KENNETH C. ROGERS, Commissioner
JAMES R. CURTISS, Commissioner

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STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

SAMUEL J. CHILK, Secretary

WILLIAM C. PARLER, General Counsel

DOCTOR BERTRAM WOLFE, Vice President and General Manager of GE Nuclear Energy

DOCTOR DANIEL R. WILKINS, ABWR Program General Manager

P.W. MARRIOTT, Manager, Licensing and Consulting Services

JOE QUIRK, Program Manager

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

10:04 a.m.

CHAIRMAN CARR: Good morning, ladies and gentlemen.

The purpose of today's meeting is for the General Electric Company to brief the Commission on the progress of the certification program for their advanced boiling water reactor design, the ABWR.

The Commission was last briefed on this subject by GE in January of this year. In addition, more recently, the NRC staff, NUMARC and EPRI have briefed the Commission on advanced reactor designs in the EPRI Requirements Document.

The Commission is considering the priority to be applied to these reviews in light of resource constraints and the apparent lack of express domestic interest in purchasing an evolutionary light water reactor. Factors of concern include concurrent development of specific advanced evolutionary designs and the EPRI Design Requirements Document for evolutionary designs and the indication that current industry activity in progress and planned will not lead to the Commission's goal of standardization.

Today we look forward to hearing another perspective as the Commission considers what priorities should be given to these reviews.

I understand that copies of the slides presentations to be used today are available at the entrance to the meeting room.

Do any of my fellow Commissioners have any opening comments?

If not, Doctor Wolf, please proceed.

I might add, I may have to leave a little early to go participate in an exercise, and if I do, why, Commissioner Roberts will take over.

DOCTOR WOLF: Thank you, Commissioner Carr.

Let me just introduce my colleagues here. We've got, to my far left, Joe Quirk, who is managing our certification program. To my left here, Dan Wilkins, who's in charge of the ABWR program and, to my right, Pat Marriott, who manages the licensing activities for General Electric Nuclear.

I have a prepared statement and in the interest of time, Commissioners, I thought I'd read it rather than extemporaneously take some time to elaborate on it.

We appreciate this chance to meet with the NRC on the GE ABWR Certification Program. This is our fifth meeting with the NRC since the program began in late 1986. We believe the program is progressing well and is still basically on target. Doctor Wilkins, to my left, will give you a status report shortly.

But first, I would like to address several questions that have been the subject of recent discussions among the NRC, the NRC staff, staff and groups representing the industry.

First, I'd like to address the question of whether there's a U.S. market for the evolutionary light water reactor. My answer is I think there is. I can tell you that the U.S. utilities, the government and industry are making major investments in the evolutionary LWR as the best way to provide our country with a nuclear option when new base load commitments are needed. Utilities will need to commit new base load plants in the 1990s.

(Slide) The first chart, I think, is a very important chart, if you would put that on, please.

What the chart shows is that since the Arab oil embargo of 1973, when load growth in the United States was cut roughly in half, electrical load growth was cut roughly in half, we've had a surplus of capacity here in the United States. We've gone from the roughly minimum requirements of some 16 to 17 percent prior to the '73 Arab oil boycott to excess capacities approaching 30 percent.

In this period one could, without significant consequences, be against new coal plants, nuclear plants, dams, oil exploration and even geothermal power when it was near active fumaroles or mud pots. Indeed, some organizations took exactly this position. This excess capacity led to the succession of new nuclear plant commitments and, in fact, cancellation of many nuclear as well as fossil units.

However, the situation is ending. Electrical brownouts occurred in the Eastern U.S. during the past two summers and new base load commitments will be needed in the early '90s to avoid electrical shortages on a national scale. Estimates for the new generating capacity needed by the end of the century range from 100 to 200 gigawatts electric.

There are no perfect energy sources. Environmental issues including air pollution, the greenhouse effect, acid rain and oil spills are receiving front page attention and the public is becoming increasingly aware of the risks of burning fossil fuels. In addition, there is increasing concern over our rising dependence on imported oil which now constitutes 40 percent of our oil supply and subjects us to the vagaries of Mid East governments.

The coming need for power and the rising importance of environmental and energy security issues are creating a renewed interest in the revival of nuclear power. This is why U.S utilities, government and industry are investing in the ALWR, in the near-term the evolutionary ALWR, to ensure that the option is available when difficult choices must be made.

In GE's case, our ABWR has several hundred million dollars invested in its design and development by GE and its worldwide associates. It's been adopted as the next generation standard BWR in Japan and a two unit lead project has been committed by the Tokyo Electric Power Company.

We are seeking NRC certification of the ABWR design because we believe it could be an excellent plant for U.S. application, not just to support our overseas business. With the serious energy problems facing the U.S., we believe it important that the American public not have excluded from them meaningful options which could ameliorate the problems.

Perhaps the most important factor governing whether utilities will be able to turn to nuclear to fill their future needs will be the existence of NRC certified standard designs. Lead time for design, developments and certification is on the order of five years or longer and it is unlikely that any utility will order a nuclear unit unless it's certified in advance. This necessitates that we conduct the design and certification work now as a precondition to any market need.

Further, and importantly, the ABWR certification proceeding provides both the occasion and the opportunity for a working demonstration of the effectiveness, predictability and timeliness of a major element of the Commission's Part 52 standardization and licensing regulations. This also is a vital factor governing whether utilities will turn to nuclear, will be able to turn to nuclear as a viable option to fill their future energy needs.

Let me turn to some generic questions on safety issues.

The second question I would address is whether the ALWR issues should be resolved generically. We believe the answer is yes to the extent practical. We should be careful, however, not to impose generic solutions of ALWR issues where plant-specific resolutions would achieve better results. Our experience has been that generic resolution of advanced light water reactor issues frequently results in least common denominator approaches that fail to exploit plant-specific opportunities which only become apparent in the context of a specific design. Certification itself represents a generic resolution of issues for a class of standard plants and has the advantage that issues can be considered within the context of an actual design rather than in a more abstract context.

We believe the EPRI advanced light water reactor requirements and the DOE ALWR Certification Programs provide an unusually effective vehicle for considering both the generic and the plant-specific aspect of issues. We encourage the NRC to continue to support these programs. We recommend against generic rulemaking as an approach to the resolution of the ALWR issues at this time. Generic rulemaking would be an enormously disruptive event of both the ALWR Requirements Program and the ALWR Certification Programs which have had major private sector investment and are nearing completion.

GE has been a participant in the EPRI ALWR Requirements Program since its inception. The ABWR currently under review by the NRC staff is in substantial conformance with the utility ALWR requirements.

In a few areas, most notably hydrogen

control and containment overpressure protection, we have elected to exceed the EPRI requirements. In the case of hydrogen control, this was done to avoid a lengthy discussion of an issue which has no real consequences for the ABWR. In the case of containment overpressure protection, it was done to take advantage of unique ABWR features to provide a substantial added measure of off-site public and property protection which could be exceeded at a very modest cost.

In these two areas, we fully support the generic positions reflected in the ALWR Requirements Documents while, at the same time, believe there are sound reasons for the ABWR to exceed these requirements on a certified standard plant basis. Doctor Wilkins will discuss both of these areas in more detail in his presentation.

We appreciate the very strong support the NRC and the NRC staff have provided to the ABWR Certification Program which was initiated in 1986. We believe the program has been remarkably successful to date and is on track to provide a convincing demonstration of the benefits of Part 52 standard plant licensing process. It is being closely followed in the United States and around the world as a pioneering effort which will set the direction for plant standardization in the second nuclear age. We request your continued support and I assure you that GE is fully committed to the successful completion of the program.

Thank you very much.

I'd be pleased to answer questions on that statement.

CHAIRMAN CARR: Any questions?

Well, wait. You can go ahead and proceed with the rest of the brief.

MR. WOLFE: I'd like to turn it over to Dan Wilkins then who will give you a more detailed update on the progress of the certification program.

DOCTOR WILKINS: (Slide) Could I have the next slide, please?

I will begin with just a brief reminder of what the ABWR is and where we are in the program. The ABWR is a 1350 megawatt reactor designed by an international team of BWR manufacturers by pulling together into a single design the best proven features from BWRs around the world. So, it is both an advanced and a proven design.

The development effort is complete, amounted to some $250 million in development work plus on the order of another $100 million at this point in design effort.

(Slide) Next slide, please.

In the U.S., the certification program is well underway, aimed at making -- having the ABWR certified as the first U.S. standard plant. This is a cooperative effort between the U.S. Department of Energy, the Electric Power Research Institute and General Electric, and it has a two-fold purpose. First, to provide an evolutionary LWR option for the U.S. in the early '90s and, second, to demonstrate the standard plant licensing process.

The effort, as I mentioned, began in 1986 and is scheduled to be complete in 1991. So we're about 70 or 75 percent into the mission at this point.

(Slide) Next chart, please.

In Japan, the ABWR has been adopted as the next generation standard boiling water reactor for Japan. The lead plants are committed by the Tokyo Electric Power Company, two units at their Kashiwazaki site. They are currently in licensing on essentially the same schedule as here in the U.S. and the construction will begin in '91 with the first unit achieving commercial operation in '96 and the second one in 1998. I might say that the activity in Japan is also very much on schedule at this point.

(Slide) The two units in Japan -- next chart, please -- will be provided by a joint venture of General Electric, Hitachi and Toshiba. Within the joint venture, General Electric is responsible to supply the nuclear steam supply systems, the fuel, the turbines and the generators for both units. Because of the parallel licensing schedule in Japan and the U.S., there is a great deal of regulatory interaction between the two countries. You might say that this is really on the track at the present time to becoming an international standard plant.

(Slide) May I have the next chart?

The schedule for our U.S. certification is shown here. This is the same schedule that we have used in prior meetings. In fact, it is the schedule contained in the licensing review basis which was issued by the staff in 1987 and we are both, GE and the staff, are continuing to measure ourselves against that original schedule. It provided for modular submittals of the safety analysis report. That was done to enable the program to be in proper schedule relationship with the EPRI Requirements Document submittals. If you look at the fourth quarter of '89 there, you can see that at this point the safety analysis report submittals are supposed to all be in to the NRC and they essentially are. The NRC staff review is in ful swing at this point and I'll talk a little more about that with safety evaluation reports, either drafted or being drafted.

Looking forward, the schedule calls for the final design approval in September of '90, followed by the certification a year later in '91.

(Slide) The scope -- next chart, please-- on the ABWR was expanded early in the program at some urging from the NRC. We had originally envisioned only the nuclear island portion of the plant as the scope of certification, but have since expanded it to include the essentially complete plant. All of the buildings in the crosshatched area in the figure are within the scope that is being reviewed under the certification program.

(Slide) Next chart.

The program has three tasks which are described on the chart. I'd like to highlight just the first one. The licensing review basis was completed in 1987. This developed, in effect, the blueprint for the certification process, for the review and certification process, by establishing review procedures and interfaces. The review schedule and acceptance criteria on some of the technical issues.

And I might say that from our perspective this has been very successful. We are still proceeding right down the course that the licensing review basis laid out more than two years ago and we found that it's been an extremely helpful document in terms of guiding the process.

(Slide) Next chart, please.

We have had a very active review and dialogue with all of the parties involved in the review and certification effort on the ABWR and I just listed there the various meetings we have had with the Commission, with the ACRS Subcommittee and full ACRS, and with NRC staff management. So you can see that there's a great active dialogue going on.

(Slide) Next chart, please.

The standard safety analysis report status is shown on this chart. We now have all chapters of the standard safety analysis report into the NRC staff for review. I say 98 percent complete instead of 100 becuuse there are a few loose ends that we have yet to submit to get up to 100 percent. But the full description of the design, with few exceptions, is now before the NRC staff.

(Slide) Next chart, please.

The requests for additional information, numerous requests, have been received from the NRC staff. To date we've received some 598 questions on the ABWR submittals and have provided responses to some 524 of them. So you can see that there's a very active review effort going on and active effort on our part in terms of responding to that review.

CHAIRMAN CARR: How many of those are satisfactorily resolved?

DOCTOR WILKINS: From our perspective, we do not see any major unresolved issues at this point. I think you would have to put that same question to the NRC staff, but we think the review is going very well.

Now, I'd like to devote most of the remainder of my discussion to what I think is perhaps the most important technical areas in the review and that's the severe accident capability of the ABWR.

We submitted in January a probablistic risk assessment for the ABWR which covered internal events and this past summer we submitted the second portion of it which covered external events. So, we now have the probablistic risk assessment work completed. It covers both prevention and mitigation of accidents and it addresses both the probability of core damage and the off-site consequences of accidents.

I'd like to give you an overview of the results and some of the thinking that went into the decisions we made in the course of that. This design, I might say, is one that has benefited from the PRA in that after we did the PRA we changed the design and added some features which weren't there earlier. I want to particularly talk about those.

(Slide) On this chart and the next two, I have summarized some of the key features of the ABWR which contribute to its very good accident prevention capability, which we've designated with a P, and its mitigation features, which we've designated with an M. I won't go through all of them, but I would like to highlight a few.

The stability issue is handled in the ABWR by having an automatic run-in of rods. If you approach the region of operation, you would have marginal stability. So, you're precluded, in effect, from operating in that region.

The pressure vessel provides no large nozzles below the core. Because of the internal recirculation pumps, we have a large water gap around the core which provides very low fluence to the vessel.

We have integrated the containment and

reactor building to provide a very high seismic capability. In fact, the design is being analyzed for 0.3 G on any site within the envelope. So, for any specific site, in fact, it would be somewhat higher than 0.3.

We've applied everything we know about BWR materials and water chemistry problems. All of the materials being used have been qualified either through testing or in field service and in most cases both. We've adopted a belt and suspenders approach in the sense that we are, in addition, planning to apply hydrogen water chemistry to the ABWR.

(Slide) Next chart, please.

In the system design area, the plant is designed for no fuel uncovery during any loss-of-coolant accident, including any break of any line without uncovering the core. We have three full safety divisions for both core and containment cooling with, in the case of core cooling, diversity in that some of those divisions are powered electrically and others by steam-driven pumps.

The control rods, unlike past BWRs, are diverse. They can be inserted both electrically and hydraulically and we've eliminated the scram discharge volume, which was a source of -- is a potential source of common mode failures.

The containment is inert for hydrogen control. We've gone to advanced solid state fault tolerant safety systems in the control and instrumentation area with full two out of four safety system logic.

(Slide) Next chart, please.

Finally, and I'll talk about these each in a little more detail, we have added some severe accident features which really go beyond what we have done on previous BWRs. We're conscious of the NRC policy that future plants should be a step forward in safety. Three out of these four features are, in fact, required by the EPRI ALWR requirements and our decision to put them on was made in close cooperation with EPRI. I'll talk a little more about them.

(Slide) But before I do that, in the next chart I've summarized the results of our probablistic risk assessment against the goals we've set.

In terms of core damage frequency, the EPRI ALWR requirements and our licensing review basis in 1987 set a goal of 10^{-5} per year or less. Our ABWR results indicate 4×10^{-7}. So we have exceeded the goal we set by a factor of about 25 in terms of probability to have core damage.

The licensing review basis also established a containment performance goal. The goal we selected was a conditional containment failure probability and we set the goal at 0.1. The ABWR PRA work indicates that we have a conditional containment failure probability of 0.004. So, again, it's about a factor of 25 times beyond the goal that we set.

Finally, both the ALWR requirements and the licensing review basis set an off-site risk goal of less than 25 rem off-site. Off-site was defined as half a mile at the 10^{-6} probability level. In the case of the ABWR, the core damage frequency is, in fact, below 10^{-6}. So, we, in effect, have zero off-site risk at that probability level. And I'll show you shortly what it looks like at other levels.

COMMISSIONER CURTISS: Before you leave that chart, I wonder if you could say a few brief words about what the logic is in your mind of having a conditional containment failure criteria? Why is that something that you think makes sense to do?

DOCTOR WILKINS: Well, we think there are-- we think it makes sense to have a measure of containment performance. We think that the conditional containment failure probability is one logical way to approach that problem. I don't think we would say it's the only one. There may be others, but it's one that the more we've looked at, the more logical it looks. And I might say that if you didn't set that as a containment performance criteria, then you have to consider the question of how would you feel if you set some other one and the conditional containment failure probability is high. We think this is a logical way to do it, certainly not the only one.

COMMISSIONER CURTISS: Has it had any impact on the approach that you're taking on the prevention side?

DOCTOR WILKINS: No.

COMMISSIONER CURTISS: By knowing that you have to meet a conditional containment failure criterion, does it affect the logic on prevention rather than mitigation or the balance between the two?

DOCTOR WILKINS: Not really because to have a properly optimized system, your containment should handle what your PRA tells you are dominant sequences. In that context, if you do something to make those sequences better, both the core damage probability and the off-site risk go down and the containment failure probability tends to stay the same. So, it has not had any adverse effect in terms of our approach to it.

Let me talk about these four features that we have added to deal with the severe accident issue. Again, I'll try to do it very briefly.

(Slide) Can I have the next chart, please?

The first one is the addition of a gas turbine to provide an alternate source of on-site AC power. This was required by the EPRI ALWR requirements. It provides diversity in terms of on-site AC power. We now have both diesel capability and gas turbine capability and it therefore reduces the frequency of station blackout.

The diagram shows how we have hooked this in. In effect, the gas turbine can backup any of the three safety divisions or the operational buses that handle the plant investment protection loads. So, it's a whole other layer of reliability that goes beyond what we have had on existing plants.

(Slide) The second one, and this again is one that are our PRA shows us is quite attractive, is we have taken advantage of a unique BWR capability, namely the ability to depressurize the reactor to provide AC independent water addition. This is done by providing the piping and valves which would enable you in a very unusual situation to add fire water to either cool the reactor or to flood the containment.

This can be done either from the standpipe or, if necessary, could actually be done from a fire truck. This is made possible in the BWR because we have the provisions there to depressurize the reactor and to handle safety at ambient conditions.

So, these features which are relatively modest in cost and easy to add, provide another layer of protection for the reactor and the containment. They would be operated manually. In fact, the valves you have to operate to perform this water addition are all in one room and would be relatively easy to carry out. This does not provide the passive safety that we are looking at in the longer term for plants beyond the ABWR, but this is very close to providing a passive capability even in the evolutionary generation of plants.

I will, in the interest of time, skip over the next two charts which talk a little more in detail about the water addition. Let's go to the one that says lower drywell flooder.

(Slide) This is again a feature that was called for in the EPRI ALWR Requirements Document. The ABWR has a large cavity below the vessel which is there to provide maintenance space and equipment for the control rod drives and the pumps. But that cavity also provides an opportunity to ensure that if there were a core damage accident in which the core came through the bottom of the vessel, that it would be handled in an effective way.

What we have done is provided a fusible plug that would allow, if the under vessel region became very hot due to the presence of corium, would flood it and allow the suppression pool water to enter that region. This provides for an early and very reliable passive water addition to the under vessel region, would quench an' corium that arrived there and stop the core concrete reaction and also greatly reduce the temperatures within the containment. Again, it's a feature. The only thing really we're adding is that fusible plug and it provides another layer of protection beyond existing plants.

DOCTOR WOLFE: It, in effect, allows you to make an assumption that you've just got a core on the floor and the design takes care of it without arguing, as we would normally argue, that that probability is very, very small.

DOCTOR WILKINS: (Slide) Let me speak to the hydrogen generation issue, which I know has been a topic of discussion between the NRC and the staff and the industry on future plants. I'll try to give you our perspective on it.

The current NRC regulations require that we design for 100 percent metal water reaction. EPRI, in its requirements document, has submitted a technical case to the staff that supports 75 percent as being conservative. GE was involved in the EPRI work. We believe that 75 percent is, in fact, conservative and support EPRI in that view. On the other hand, it's inconsequential for the ABWR.

(Slide) Look at the next chart.

It turns out in the ABWR that the size and pressure capability of the containment is set by other considerations and nothing would be different if we adopted 75 percent instead of 100 percent. So, we opted to do our analyses at the 100 percent level and we can obviously meet 75 percent if that's the outcome, but it won't make any difference on the design whichever way it is. So, we chose not to engage in lengthy discussion of an issue that really had no consequence for us. That's why we have taken the course we have.

(Slide) Let me talk about containment overpressure protection on the next chart. This is the final severe accident measure I want to talk about. This one is not required by the EPRI ALWR requirements. What we are doing with the ABWR goes beyond those requirements and I'd like to give you our perspective on this. And this one, I might say, is a continuing area of discussion between ourselves and the staff.

In any PRA for a light water reactor, there are some sequences that if you carry them to a sufficiently degraded state they lead to containment failure. In the BWR, when we do those analyses, the location of the failure is very important. If the failure occurs in the drywell, you have an unfiltered release. If it occurs in the wetwell below the water level, you lose the water. And if it occurs in the wetwell above the water level, you have a filtered release that has -- any fission products that would be released would be scrubbed.

Because of that, we felt that in the ABWR it would be appropriate to make sure that we controlled the location of the failure for these extremely unlikely events. The way we do that is by putting a rupture disk in the wetwell air space with two downstream valves which are normally open. That is then piped to the stack. The rupture disk would be set slightly below the ultimate capability of the containment. So, because of that, we characterize this as overpressure protection as opposed to a vent. It is there to ensure that if containment failure is inevitable, that you get a benign failure.

(Slide) On the next chart we discuss some of the benefits. It's a passive system. Our PRA indicates that it would be very unlikely to ever be used down in the 10^{-7} per year range. By the way we've designed it, we think there is very little risk of it being misused. The operator can't open it. It's a rupture disk and only mother nature can open it.

It has the advantage of making -- if the failure is going to occur anyway, it makes it benign. What I mean by that is the release is scrubbed by the suppression pool. It's an elevated release. The operator can later reclose it and because of this it, in effect, makes the containment a fail safe containment. It virtually eliminates off-site doses greater than 25 rem for any of the accident sequences we've studied. It has the advantage of making sure we don't lose the core cooling water in the process. It has very high seismic capability and it's a passive feature.

(Slide) If you look on the next chart, we show the impact it has on our probablistic risk assessment. The upper curve shows the probability of exceeding certain off-site doses without the containment overpressure protection feature. The lower curve shows the probability with it and you can see that it's worth about a decade in terms of reducing off-site risk. Plus, it virtually eliminates the possibility of large off-site releases greater than 25 rem.

So, our thinking has been that this is a worthwhile insurance policy. It's something that can be done at very modest cost in the ABWR because it takes advantage of features and capability which are already there. Because of that, we've elected to exceed the ALWR requirements in this area.

COMMISSIONER CURTISS: Let me ask a question on this chart. If I read it correctly, it looks to me like you -- just roughly you would meet the EPRI Requirements Document goal as well as the safety goal of the Commission, according to your PRA, at about 10^{-7}. Do I read that correctly? 10^{-6}?

DOCTOR WILKINS: The box up in the corner is the goal represented by the ALWR requirements.

CHAIRMAN CARR: Both of these meet those requirements.

COMMISSIONER CURTISS: Yes.

DOCTOR WILKINS: Yes, both of them.

COMMISSIONER CURTISS: In view of that, I take it what that means is that without the vent, without the overpressure feature, according to your PRA, you would fully satisfy the EPRI goal as well as the NRC safety goal.

DOCTOR WOLFE: That's correct.

COMMISSIONER CURTISS: Is that correct?

DOCTOR WILKINS: Correct.

COMMISSIONER CURTISS: Why isn't this an issue that really is in the background noise then in terms of overall risk? Why is it that you think this feature is necessary if, according to your PRA, you meet both the safety goal of the Commission as well as the requirements document?

DOCTOR WILKINS: Well, I don't think we would say it's a feature that's necessary. We think it's a feature that for a very modest cost provides a substantial degree of protection.

DOCTOR WOLFE: But let me put it a different way, Jim. It provides a satisfaction, I think, that goes beyond detailed calculations. In other words, as designed this way, you can ask a question, what if the core goes on the floor and all your safety devices fail? The answer is, in this case you can let the core go on the floor and through this vent you essentially get no significant off-site dose.

Now, if you go through the analysis to your point, the answer is you don't need it. It's an added suspender, belt and suspenders. In our case, this is something like $200,000.00, $250,000.00 extra to a billion and a half dollar machine, billion dollar machine. And in our view, just the inherent satisfaction or inherent ability to make the statement I just made to you, we think from a public standpoint and from just the standpoint of saying maybe the probablistic assessment missed something, is worthwhile. If it were a billion dollar adder, we would be here arguing with you that it wasn't necessary.

COMMISSIONER CURTISS: Okay.

DOCTOR WILKINS: Let me finish with one final perspective on the ABWR severe accident mitigation. The industry is looking longer range at passive light water reactors, passive safety features. The ABWR, in fact from the point of view of the public, has passive protection. The threats to containment that you worry about in a light water reactor are failure due to hydrogen, combustion due to core debris or due to overpressure protection. Those are the basic three ways to fail containment. In fact, for each of those, the ABWR provides a passive capability to protect the public against those threats.

So, we have, in a sense, achieved with the ABRW that is now being reviewed by the staff, many of the objectives that we are looking at in the longer range for passive water reactors, including in GE's case our SBWR, our smaller, simplified BWR.

(Slide) In summary -- the final chart -- we are nearing the three-quarter point on the certification effort. The program is still essentially on track. We think the program is on course to achieve a final design approval next year and beyond that a certification in '91. We've completed our severe accident work and meet all of the goals that we, the EPRI and the NRC have set. We have a number of remaining actions which we are carrying out, but we think the program is going along very well and we're still on the course we set back at the beginning in 1986.

With that, we'll -- questions?

CHAIRMAN CARR: Commissioner Roberts?

COMMISSIONER ROBERTS: Well, it's encouraging to hear that a multi-year project that involves the government and the private sector is on schedule.

I've got just a couple of nits. I'm interested in the Japanese endeavor. If you're doing the nuclear steam supply of fuel and turbine generators, what are Hitachi and Toshiba doing?

DOCTOR WILKINS: In the first unit, Toshiba has the balance of the nuclear side of the plant and Hitachi is handling the balance of the turbine side. In the second unit, they will reverse roles whereas our role remains the same. So that by the time the two units are complete, both of the Japanese suppliers will have had experience in the entire plant.

COMMISSIONER ROBERTS: Where will the reactor pressure vessel be fabricated and by whom?

DOCTOR WILKINS: We will purchase the pressure vessel in Japan.

COMMISSIONER ROBERTS: In Japan? Who will make it?

DOCTOR WILKINS: It will be made by Toshiba on the first unit and Hitachi on the second.

COMMISSIONER ROBERTS: This has nothing to do with any of the NRC role, but I'm just curious. Have you publicly announced a projected installed cost per kilowatt for the Japanese plants? Don't give me an answer if you haven't.

DOCTOR WOLFE: We have a number with the Japanese. I don't know that it's been published and we'd prefer to not mention it.

COMMISSIONER ROBERTS: I understand.

CHAIRMAN CARR: You don't want to publish it here?

DOCTOR WOLFE: Pardon me?

CHAIRMAN CARR: You don't want to publish it here.

DOCTOR WOLFE: We don't want to publish it here.

COMMISSIONER ROBERTS: Sure.

DOCTOR WOLFE: Let me make this comment though. When we do our analysis of the ABWR for U.S. application, we think it's going to be a very cost effective competitive source of power.

DOCTOR WILKINS: We have published numbers in the U.S. overnight cost excluding financing and so forth, in the vicinity of $1,100.00 a kilowatt. That's assuming that it's done on a rapid construction schedule that you can do with pre-certification and a pre-approved site.

COMMISSIONER ROBERTS: Last question. Slide 17, on you gas turbine alternative AC source. Is this shown for one reactor? Have you got three diesel generators for each reactor plus the gas turbine?

DOCTOR WILKINS: Yes.

COMMISSIONER ROBERTS: That's all I have.

CHAIRMAN CARR: Commissioner Rogers?

COMMISSIONER ROGERS: Yes. I wonder if you could say a little bit about the assumptions in the modeling that you did in working out your PRA for the conditional containment probability? What's the status of that? What --

DOCTOR WILKINS: Well, let me --

COMMISSIONER ROGERS: Were there any outside organizations involved in that as well as your own internal assessment?

DOCTOR WILKINS: Well, we did our own PRA, but we have been involved with outside organizations in the PRA area for many years. I think the key assumptions in that area are we looked at two different definitions of containment failure. Our initial definition and one which we see a lot of merit to was a functional definition where we defined containment failure as 25 rem off-site. And anything that produced that obviously must have had a containment failure.

In discussions with the NRC staff, they

asked us to look at a different definition of containment failure, namely any uncontrolled loss of the pressure retaining capability of the containment barrier. So, we did the analysis both ways. For internal events, we are able to meet the 0.1 conditional containment failure probability goal either way. For external events, we would require the overpressure protection feature to meet it.

COMMISSIONER ROGERS: Well, there have been a number of questions about the details of a core melt and its effect on the containment and rupture of pressure vessel and so on and so forth. I'm just trying to understand to what extent your PRA analysis built in certain assumptions about what those models are and to what extent there's a disagreement in the community as to the model that you used.

MR. QUIRK: Let me say that the PRA analysis that GE did did look at the phenomenological effects of what occurs should the molten core penetrate the vessel and drop in the cavity underneath the vessel without cooling water. In our original PRA submittal, we evaluated the structural effect of that. Then we looked at if there were water down there, what the phenomenological effect in the generation of non-condensibles would be arrested and the overall temperature would be suppressed.

So, if you're looking for modeling and to what extent we go in and look at those interactions, I can assure you we do that. I'm not sure though -- it seems like you're saying, is this modeling a point of departure with our associates.

COMMISSIONER ROGERS: Yes. There's a common agreement in the community as to the model that you used to arrive at those numbers.

MR. QUIRK: No, I wouldn't characterize it that way. But it's not a point of argument either. I mean each organization has their approach and they must defend that and calibrate it against other models, and that's the approach we took.

COMMISSIONER ROGERS: Yes, but are the consequences of these different models significantly different?

MR. QUIRK: We haven't seen another analysis at the same level of depth as ours has to compare it.

MR. MARRIOTT: I think the answer to that is when the results of the analyses are applied in a bounding way as they are in the core melt sequences, in our PRA it doesn't make a great deal of difference what detailed phenomenological assumptions are used in the model. As you correctly point out, there's a good deal of, for want of a better word, controversy over the details of core melt among the national labs and with NRC Research. But those are phenomenological niceties which are necessary to model in the severe core melt sequences in a PRA.

COMMISSIONER ROGERS: To what extent have you had independent organizations look at your PRA analysis? Is this strictly an internal analysis or have you had any independent groups look at that and do it themselves?

DOCTOR WILKINS: Well, we did our own PRA work on our BWR 6 GSAR submittal and that, of course, was subjected to a review by the NRC staff and also the NRC staff consultants. And so, many of the methods that we have used come from our earlier work on the BWR 6. This PRA, of course, will also be reviewed by the NRC staff and consultants.

MR. QUIRK: We have just recently made this PRA available to EPRI and their technical associates. They have that now for their use and study.

COMMISSIONER ROGERS: But no comments back from them on it?

MR. QUIRK: They just received it.

COMMISSIONER ROGERS: In the area of the tests, inspections analyses and the acceptance criteria requirement to Part 52, what have you done so far on that?

MR. QUIRK: Well, we have worked with the NUMARC organization in follow-on to the Part 52 work. They have set up a NUMARC task force to say the proof of the pudding in Part 52, in one-step licensing, is demonstrating that the as-built plant conforms to its licensed basis. The proof of that pudding is test, inspections and analysis. Very, very important. So, NUMARC has taken this upon themselves to draft the approach and we've been working quite closely with them in that regard, as other vendors have as well.

COMMISSIONER ROGERS: Okay. Thank you.

CHAIRMAN CARR: Jim, is it okay if I ask a couple?

COMMISSIONER CURTISS: Fire away.

CHAIRMAN CARR: Are you going to request certification for the exact design you're building in Japan?

DOCTOR WILKINS: Almost.

CHAIRMAN CARR: Now you know what my next question is.

DOCTOR WILKINS: We have committed to keep a list of the differences and to make both the NRC staff and the Japanese aware of them. That list is continuously maintained.

CHAIRMAN CARR: Is it this kind of a list or is it this kind of a list?

DOCTOR WILKINS: I would -- how long a list is it?

MR. QUIRK: It's less than 20, I'd say, some of them quite minor. You know, we keep track of all of them. I think we've pointed out some of these to you. For example, the orientation of the turbine. Land space being as vital as in Japan, they do not have an in-line plant arrangement. They turn the turbine building so that it's perpendicular to the containment to save space and that's a difference. So, it's --

CHAIRMAN CARR: Well, isn't it good for us to save space too?

MR. QUIRK: It's not quite the same land problem.

COMMISSIONER ROBERTS: That is where it's mindful of that problem there.

DOCTOR WILKINS: Yes. I think it's less of a space issue than Japan.

COMMISSIONER ROGERS: Is that a missile protection --

MR. QUIRK: Well, you do need that.

DOCTOR WILKINS: For missile protection regions. They turn it transverse primarily -- not just space, but the rocky coast. They have a lot of excavation --

CHAIRMAN CARR: Needless to say, that will be an interesting list for us to look at.

COMMISSIONER CURTISS: Just a quick question. Will the Japanese design include the containment overpressure feature?

DOCTOR WILKINS: That is still being looked at.

COMMISSIONER CURT'SS: No decision has been made yet on that?

DOCTOR WILKINS: No.

COMMISSIONER CURTISS: Okay.

Sorry, Ken. Go ahead.

CHAIRMAN CARR: I guess I have some problem with how this is going to achieve standardization for me if I continue on with what I call business as usual. Everybody that submits me a design to certify, I certify, and I end up building all these plants out in the country. How do you see that?

DOCTOR WOLFE: I would think the ABWR is different than other plants that you're being presented with now.

CHAIRMAN CARR: I realize you'd like to certify on your plant, just have that the standard design.

DOCTOR WOLFE: The point I was going to make though, Commissioner, is that the plant is a detailed design. It's had several hundred million dollars invested in it in terms of tests as well as detailed design. It's a plant that's going to be built in Japan as a power plant. It's one that's clearly suitable and meets all the requirements --

CHAIRMAN CARR: I realize all that but let's look -- if we get a U.S. buyer for your AL --

DOCTOR WOLFE: ABWR?

CHAIRMAN CARR: -- ABWR. We also are coming along with passive designs. We're coming along with three other proposed designs. I can see us having as many, say, as eight different designs out there. While that's probably better than 52 or 112 or something, is that what you see as standardization?

DOCTOR WOLFE: Well, again, let me say. We're working on the passive design also. Our --

CHAIRMAN CARR: I know. That's two.

DOCTOR WOLFE: But that's several years down the pike. The results, although we're very optimistic and enthusiastic about the design, nevertheless we've got a few years of detailed design before we come up to the final design and let me say to the final cost estimate, to show that it really would be cost effective.

CHAIRMAN CARR: Well, is this a 40 year design or a 60 year design, the ABWR?

DOCTOR WILKINS: Sixty.

DOCTOR WOLFE: It's a 60 year design.

CHAIRMAN CARR: Sixty year design. So, a few years down the pike for a passive doesn't mean much. In 60 years, we're liable to have another three year designs. Standardization being the goal, I'm a little worried about if I'm really getting there.

DOCTOR WOLFE: Well, again, if we go back to our present situation where we have 111 plants out there, no two plants being identical, I think our thought is that the ABWR is going to be the next generation of large BWRs and they're all going to be identical. That's going to be quite different than the present situation.

We're looking at the 600 megawatt plant because we think there may be a requirement for smaller sizes. It's not clear whether the small or the large size, and I could give you a ten minute discussion of the differences -- we think there's an application for both. So, we're looking at a small size which, of necessity, has to be different because the economics of small plants are going to be different than the large plants.

So, in five years, if we're successful, you're right, you're going to have three standard designs, maybe four with the combustion plant standard designs. Now, I think that's going to be what you'll have in the next decade because those are plants that meet utility requirements and they meet your requirements in terms of using technology which the NRC is well acquainted with.

How many of each type will be built is a question I can't answer here, but it seems to me that there are four plants which have been reviewed by you in detail which will be built as standard plants, if all of them are built. I think I share your kind of question. I'm not sure that all four plants will ultimately be built, but if they are they at least are standard plants which can be replicated and which can be operated effectively, much more effectively than the present hundred different plants that we have out there.

CHAIRMAN CARR: Of course they're not going to go away, so we'll have 116 different designs.

DOCTOR WOLFE: You'll have those too.

CHAIRMAN CARR: The next question is, what do you --

DOCTOR WOLFE: I think -- let me make a point though. I think those will go away quicker if we can get decent standardized designs here so the utilities can build them with assurance

CHAIRMAN CARR: Well, I'm not saying standardization won't be a few kinds of plants. I just wanted to get your opinion of that.

This next question is, what do you perceive as the value in completing the NRC review of the EPRI Requirements Document for evolutionary plants?

DOCTOR WOLFE: Well, we'd like to see it completed it because we think it provides a good base for those who are designing a new plant. We think that the EPRI Requirements Document by itself does not provide a means of licensing new plants. As Dan Wilkins has just mentioned, as you go through the actual details of an honest to God plant, you find things that you can do that really make, we think, significant safety and perhaps other improvements that you don't see when you do it generically.

CHAIRMAN CARR: Well, but at that point do you change the EPRI Requirements Document or do you change the plan?

DOCTOR WOLFE: Well, I think what you do is you use the EPRI Requirements Document as a major guideline and where you see that there are reasons to depart from the EPRI guidelines, you depart and explain why you depart.

CHAIRMAN CARR: But then if that's such a valuable idea, why wouldn't you change the guidelines?

DOCTOR WOLFE: Well, I think you might change the guidelines ultimately. I think it's an iterative procedure. Let me say, when you take the EPRI document, it tries to span the light water reactor field. So if I take the venting that we find is very, very inexpensive in the ABWR, it may, in a different design, be much more expensive and it may well be in that kind of a situation there'd be a cost benefit analysis which would say that you'd do something else. You'd find other advantages in one design over another.

So that the EPRI document itself might not require a venting of the containment because it's a general document, but in our case, as Dan has said, we think the venting would be required. On the other hand, it might look at what we've done and then change it's requirements if it finds that in the details there are things that could be done more expeditiously.

CHAIRMAN CARR: And one comment. I would like to encourage you to take a look at the failure of the rupture disk for those two open valves. Having participated in the failure of a rupture disk that wasn't supposed to rupture and flooding the lower level of a reactor compartment, you've got it in a water environment right next to the -- according to your diagram.

DOCTOR WILKINS: No, it's in the air space.

DOCTOR WOLFE: It's in the air space.

CHAIRMAN CARR: But you don't think that's going to be steamy?

DOCTOR WILKINS: It will be -- in normal operation, it --

CHAIRMAN CARR: And on the other side of that is going to be outside cold air, the way you've got it perhaps. All I'm saying is if that rupture disk fails, personally I want to be sure there's a manual valve shut somewhere in that so that we don't have inadvertent --

DOCTOR WOLFE: Well, we've considered both. Let me say, Commissioner, you can end up now in one of these philosophical debates.

CHAIRMAN CARR: I can join the argument.

DOCTOR WOLFE: The point that Dan made is that the operator doesn't have to do anything. Now, we've also considered keeping one of those valves closed and so the operator just has to push a button.

CHAIRMAN CARR: Well, you can put it outside the wall if you want to, but I feel like initiation of venting a containment is going to be a very tough decision for anybody to make, especially with the margin that's usually in a containment that we really can't figure.

Commissioner Curtiss, I'm through.

COMMISSIONER CURTISS: Three quick questions.

DOCTOR WOLFE: Just let me make the point--

COMMISSIONER CURTISS: Go ahead.

DOCTOR WOLFE: I think the analysis that we've done so far has shown that even under the most severe accident condition where you want to rupture the disk, even then the off-site dose is less than 25 R. So that if you imagine the --

CHAIRMAN CARR: Well, you may want to put two rupture disks.

DOCTOR WOLFE: Yes. No. I understand what you're saying.

DOCTOR WILKINS: We're looking at that issue.

CHAIRMAN CARR: All I worry about is that steamy environment up against that --

COMMISSIONER CURTISS: The complications of an issue like this that you've described, whether the operator ought to be involved or not, might be important if we were talking about 10^{-4}, but we're up to 10^{-6}. I guess I wonder do we even need to get to those questions, even if it is inexpensive.

Quick questions. The EPRI Requirements Document, as a practical matter, the evolutionary requirements document is really irrelevant for you at this point because you proceed ahead of that. We haven't completed our review of that document.

The question that I have is, the passive requirements document which is coming up on our screen and which could provide some benefit for those vendors that want to build passive plants, if you had your druthers, do you think from your own parochial perspective it would make sense for us to complete action on the evolutionary document or to devote our resources to getting a leg up on the passive document?

DOCTOR WILKINS: I think, first of all, the evolutionary document has had a big impact on our work already and it has come from our working directly with EPRI as opposed to coming from your review of the requirements document. But we have --

COMMISSIONER CURTISS: Yes, but if it's already been accomplished or achieved today --

DOCTOR WILKINS: Yes, but I think it's --

COMMISSIONER CURTISS: Is there any future benefit for you?

DOCTOR WILKINS: I think that to the extent there are still issues open, that there is an opportunity by proceeding with both the requirements document and the certification in parallel to close those issues and to have the right balance between generic and plant-unique content in the solutions that are reached. So, we think both should go forward.

I would also say that we think there is merit in the requirements and the design proceeding in parallel. I've been involved in reactor designs for many years and you always try to write down the requirements first. You ought to do that. But you always find that when you try to implement them into the design, you have to go back and take another look at the requirements. We think one of the advantages of the current program is the fact that you do have both the requirements and the design on the table together and can look at both of them.

COMMISSIONER CURTISS: Just one final question. You'll be the first design that goes through our Part 52 process. You've had a chance now to take a look at the rule. It's been on the books for some time. Based upon what you've seen and where you're headed, are there particular soft spots or potential glitches that you think exist from your perspective in terms of the design certification part of that rule, what has to be included in the design, procedural glitches that you think we ought to be especially sensitive to?

DOCTOR WOLFE: We're reviewing those with our consultants on this matter, Mark Rowden for example, and we think we have a path to meet your Part 52 regulations. It will be the first one, and so there will be give and take between you and your staff and us. But we think we have a path that --

COMMISSIONER CURTISS: You haven't identified any problems yet, to date?

DOCTOR WOLFE: No insurmountable problems.

Joe?

DOCTOR WILKINS: I would say we're not very far into it yet either.

COMMISSIONER CURTISS: That's all I have.

Thank you.

COMMISSIONER ROGERS: I'd just throw in one. That is, in your view, what do you think the role of the EPRI Design Requirements Document would be after this -- assuming your design is all approved and so on and so forth? What do you think the role of that would be, as far as you're concerned, in the future?

DOCTOR WILKINS: Well, the EPRI Requirements Document could very well become the bid spec for utilities to use in ordering future plants. Our view is that the utilities, through that document, are putting down their requirements. Over on the other side you have the NRC structure and the regulatory requirements and our job as certification applicant is to meet both. Certainly there is merit to having a standard utility bid specification for future plants. In fact, one of the reasons we have 112 plants, all different, is that there wasn't a standard utility bid specification.

DOCTOR WOLFE: But I think after we finish our procedures and clearly we begin producing ABWRs, I would say if we make changes in the ABWR for future uses, we would be looking at the requirements document and either suggesting they change the requirements document or making sure we conformed with it. But I think there will be -- and this is a judgment -- there will be people following us who will then start with a base of requirements which I think provides a uniformed way to develop a plant.

As Dan said, we did use the -- we were part of the EPRI Requirements Document. We helped formulate it and we did follow it and we found it very useful in getting the initial design through.

CHAIRMAN CARR: When I look at your chart here and hear your words, are you really telling me I don't need an EPZ anymore?

DOCTOR WOLFE: That's what we're trying to tell you.

CHAIRMAN CARR: Okay. I just wanted to make sure I was reading the message.

DOCTOR WOLFE: That's correct.

CHAIRMAN CARR: Any other comments, questions?

Well, I'd like to thank the representatives of General Electric Company for coming in today to brief the Commission on the status of the advanced boiling water reactor design certification program. The perspective you've provided will help the Commission making an informed decision as to the priorities to be applied in performing NRC's review of specific plant designs, as well as the EPRI Design Requirements Documents.

If there are no other comments, we stand adjourned.

(Whereupon, at 11:16 a.m., the above-entitled matter was concluded.)

CERTIFICATE OF TRANSCRIBER

This is to certify that the attached events of a meeting of the United States Nuclear Regulatory Commission entitled:

TITLE OF MEETING: BRIEFING BY GENERAL ELECTRIC ON THE ADVANCED BWR STANDARD PLANT REVIEW

PLACE OF MEETING: ROCKVILLE, MARYLAND

DATE OF MEETING: NOVEMBER 1, 1989

were transcribed by me. I further certify that said transcription is accurate and complete, to the best of my ability, and that the transcript is a true and accurate record of the foregoing events.

Carol Lynch

Reporter's name: Peter Lynch

SCHEDULING NOTES

Title: Briefing by General Electric on the Advanced BWR Standard Plant Review

Scheduled: 10:00 a.m., Wednesday, November 1, 1989 (OPEN)

Duration: Approx 1 hr

Participants: General Electric — 60 mins

- Dr. Bertram Wolf, Vice President and General Manager of GE Nuclear Energy — Introduction
- Dr. Daniel R. Wilkins, ABWR Program General Manager
  - Status of GE ABWR standard plant review
  - Severe accident design and other changes
- P.W. Marriott, Manager, Licensing and Consulting Services
- Joe Quirk, Program Manager

ABWR Certification Program
Progress Report

Presented to

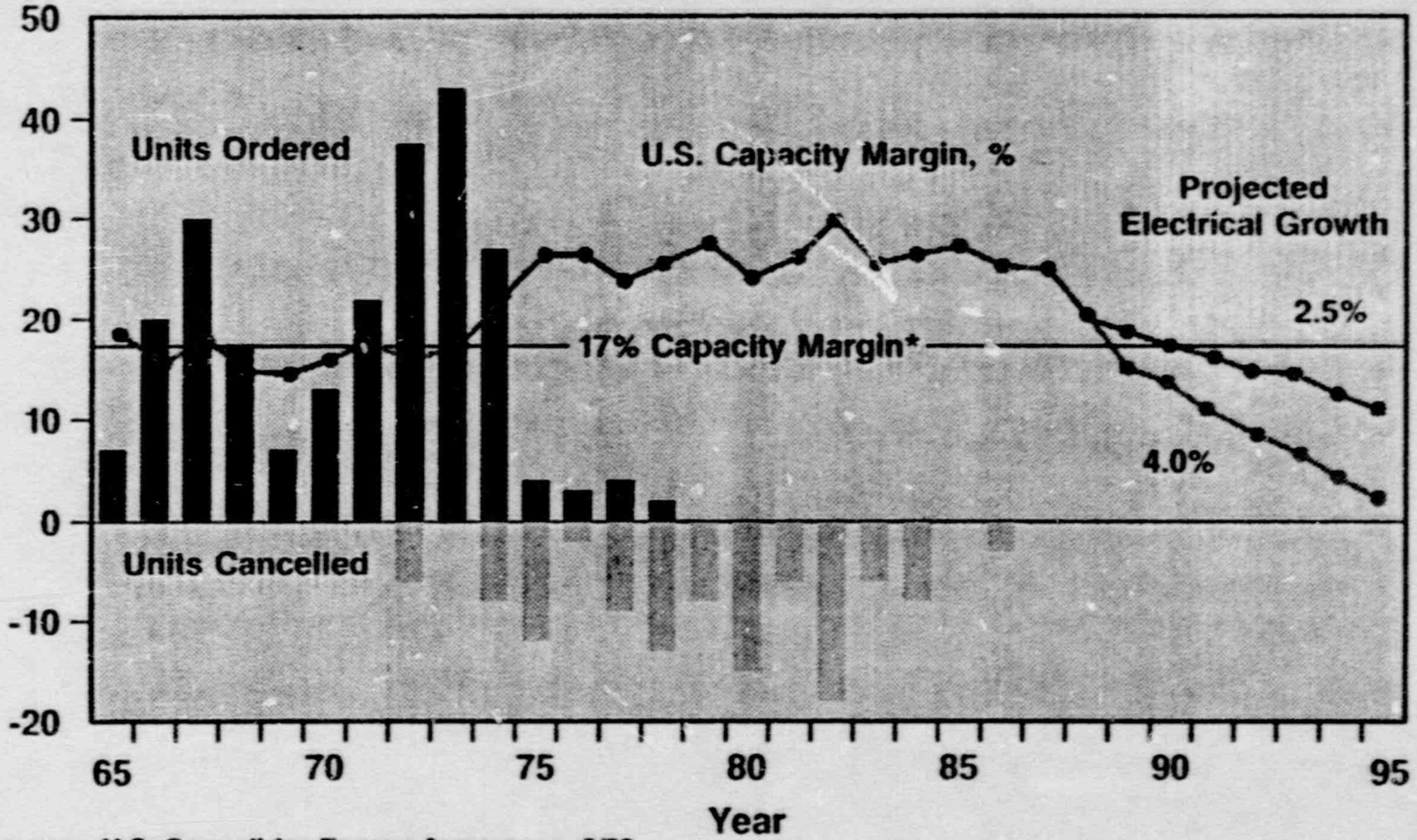
Nuclear Regulatory Commission

November 1, 1989
Rockville, Maryland

GE Nuclear Energy

D:\MEETINGS:COMM11-1

U.S. CAPACITY MARGIN AND NUCLEAR ORDERS



Source: U.S. Council for Energy Awareness, 6/89

*Minimum Required for Reliability

117 A2064.61

Advanced BWR (ABWR)

- 1350 MWe
- World-class design by International Team
  - Best proven features
- Development complete - $ 250 M

Advanced BWR (ABWR) (cont.)

- **U.S. certification underway**
  - **First U.S. standard plant**
  - **Cooperative DOE/EPRI/GE effort**
  - **Demonstrate standard plant licensing process**
  - **Complete 1991**

ABWR In Japan

- ABWR is next generation standard BWR for Japan
- Lead plants committed by Tokyo Electric Power Co.
  - Kashiwazaki 6 & 7
  - Licensing application 1988
  - K-6 commercial operation 1996
  - K-7 commercial operation 1998

ABWR In Japan (cont.)

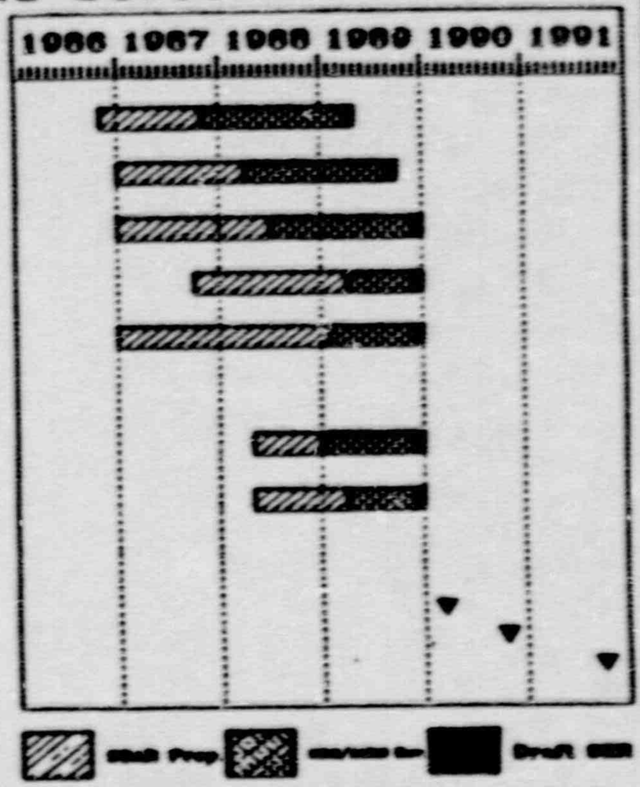
- GE/Hitachi/Toshiba joint venture
  - GE to supply nuclear steam supply, fuel, and turbine generators
- U.S./Japanese regulatory interaction

ABWR Certification Program
Scope and Schedule

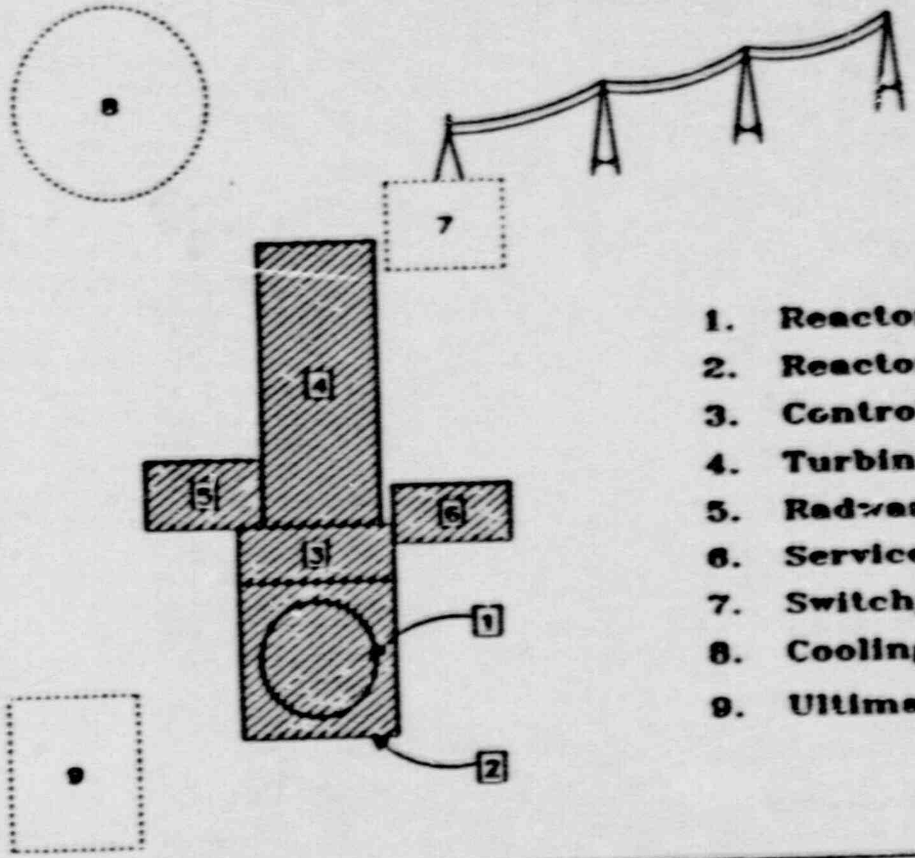
Nuclear Island
- Reactor & Safety Systems
  - Chapters 4, 5, 6 & 15
- Plant Arrangement
  - Chapters 1, 2 & 3
- I&C, Auxiliary Systems & QA
  - Ch's 7-9, 11-14, 17
- Tech Specs & Emerg. Proc.
  - Chapters 16 & 18
- Severe Accidents
  - Chapter 19

Remainder of Plant
- Turbine Island
  - Ch. 10, Parts of other Chs
- Radwaste Facility
  - Ch. 11, Parts of other Chs

Key Milestones
- Final SER Issued
- FDA Issued
- Certification Issued



SCOPE OF ABWR SSAR



1. Reactor containment
2. Reactor building
3. Control building
4. Turbine building
5. Radwaste building
6. Service building
7. Switchyard
8. Cooling tower
9. Ultimate heat sink

ABWR Certification Program
Tasks

- **Licensing basis - completed in 1987**
  - Developed acceptance basis for review
  - Defined review procedures and interfaces
  - Established review schedule
- **Preparation and submittal of SSAR - in process**
  - Prepare and submit SSAR
  - Respond to NRC Questions
  - Participate in ACRS meetings
  - Obtain FDA
- **Design certification - to be initiated in 1990**
  - Rulemaking proceeding
  - Obtain certification

Status of Regulatory Briefings and Meetings

Commission Briefings

Sept. 19, 1986
Apr. 30, 1987
Jan. 26, 1988
Jan. 24, 1989
Nov. 1, 1989

ACRS Subcommittee Meetings

Jan. 7, 1987
Jun. 1, 1988
Nov. 15-16, 1988
May 10-11, 1989
Oct. 31, 1989

ACRS Full Committee Meetings

Jan. 7, 1987
Mar. 6, 1987
Jan. 7, 1988
Aug. 11, 1989

NRC Management Meetings

Oct. 16, 1986
Nov. 21-22, 1987
Mar. 13-14, 1989

Status of SSAR Submittals

Description	Submittal Date
Reactor and Safety Systems	9/29/87
Plant Arrangement & Criteria	3/29/88
I&C, Auxiliary System & Quality Assurance	6/29/88
Turbine Island	12/30/88
Radwaste, Human Factors & Reliability	3/31/89
Technical Specifications	6/23/89
Severe Accident Evaluation	7/28/89

ALL SSAR CHAPTERS NOW 98% COMPLETE

Status of Response to NRC Request for Additional Information (RAI)

- 598 NRC Questions Received
- 524 Questions Answered

ACTIVE DIALOGUE CONTINUING

ABWR ACCIDENT PREVENTION (P) AND MITIGATION (M) FEATURES

- SYSTEM DYNAMICS
  - INCREASED THERMAL MARGINS — P
  - STABILITY ASSURED BY DESIGN — P
- REACTOR PRESSURE VESSEL ASSEMBLY
  - NO LARGE NOZZLES BELOW CORE — P
  - REDUCED VESSEL FLUENCE — P
- CONTAINMENT STRUCTURES
  - INTEGRATED CONTAINMENT/REACTOR BUILDING — P/M
  - LOWER LOCA LOADS — M
- MATERIALS/WATER CHEMISTRY
  - PROVEN MATERIALS — P
  - HYDROGEN WATER CHEMISTRY — P

ABWR ACCIDENT PREVENTION (P) AND MITIGATION (M) FEATURES

- **SYSTEM DESIGN**

- NO FUEL UNCOVERY DURING LOCA	P
- THREE SAFETY DIVISIONS	P/M
- DIVERSE ECCS SYSTEMS	P
- DIVERSE CONTROL ROD	P
- NO SCRAM DISCHARGE VOLUME	P
- INERT CONTAINMENT	M
- FAULT TOLERANT CONTROL	P
- FULL 2 OUT OF 4 SAFETY LOGIC	P

ABWR ACCIDENT PREVENTION (P) AND MITIGATION (M) FEATURES

• SEVERE ACCIDENT DESIGN ENHANCEMENTS

- COMBUSTION TURBINE	P
- DRYWELL FLOODER	M
- AC INDEPENDENT COOLING WATER	M
- CONTAINMENT OVERPRESSURE PROTECTION	M

BALANCED APPROACH TO PREVENTION AND MITIGATION

SEVERE ACCIDENT ANALYSIS RESULTS

Summary

Subject	Goal	Result
Core Damage Frequency	$<10^{-5}$ Per Yr.	$4X10^{-7}$ Per Yr.
Conditional Containment Failure (25 rem) Probability	<0.1	0.004
Offsite Dose at 1/2 Mile/10^{-6} Probability	<25 rem	0

-16-

All Goals Met

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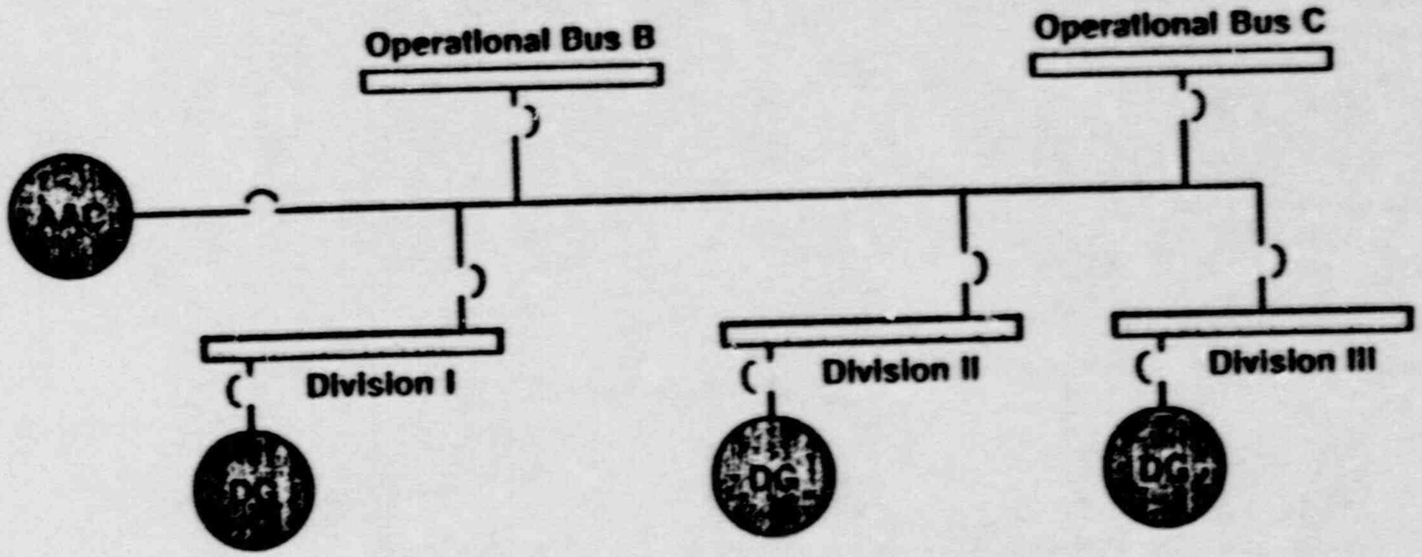
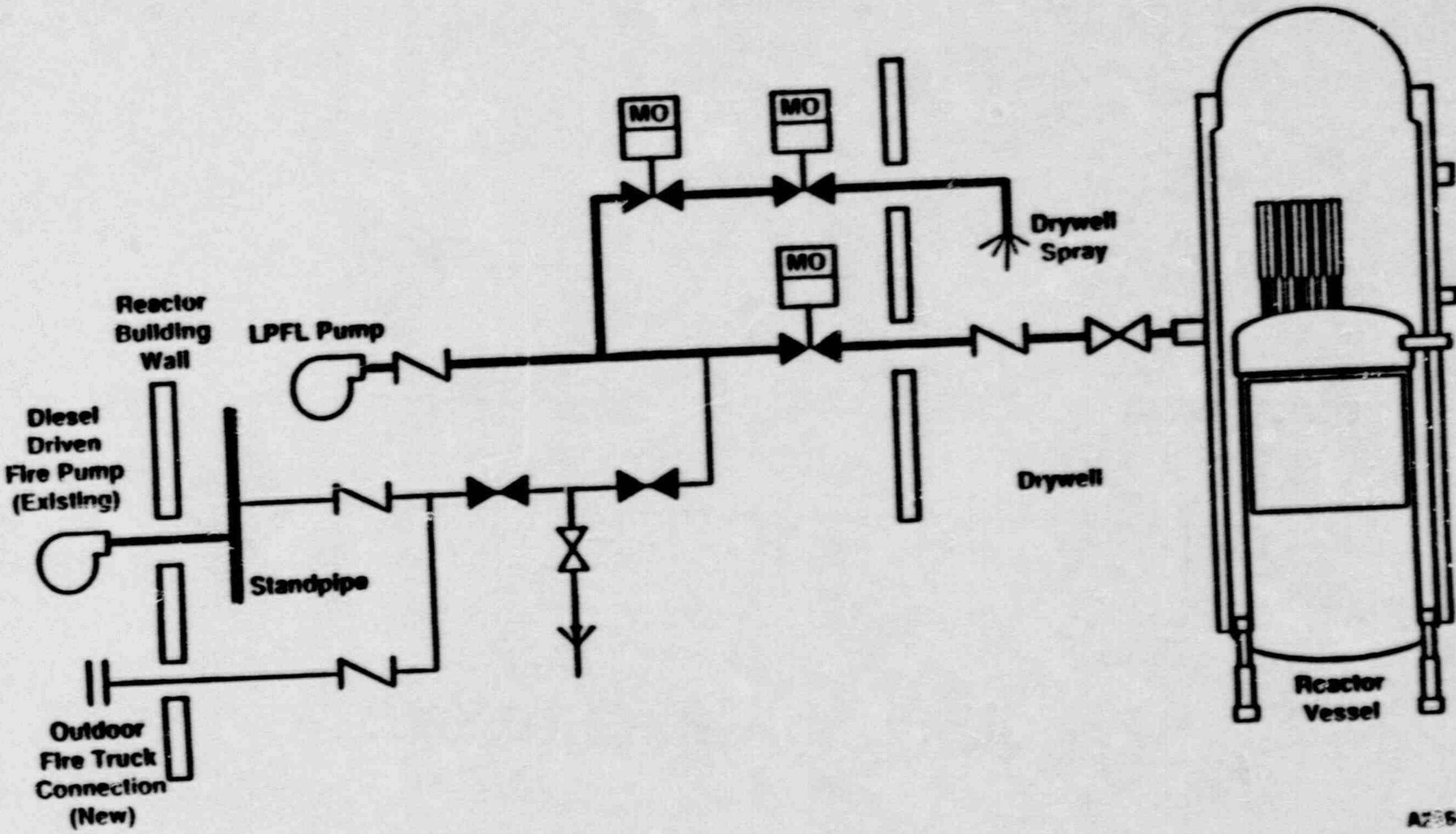
GAS TURBINE - ALTERNATE AC



- **Operation:**
  - AAC Backs up Emergency Diesel Generators
- **Benefits:**
  - Reduces Frequency of Station Blackout in Internal Events Analysis

A2064.82

AC INDEPENDENT WATER ADDITION



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097

AC INDEPENDENT WATER ADDITION

- EPRI-ALWR Requirements:
  - Connection to Decay Heat Removal Lines for Introduction of Water to Drywell Independent of Normal Systems
- Operation
  - For Addition to Reactor Vessel: If No High Pressure Core Cooling and No Low Pressure Injection Pumps Available, Manually Depressurize Reactor Vessel. Manually Close One, Open Three Valves to Admit Fire Water
  - Accident Mitigation: If Not Available in Time to Prevent Core Damage/Vessel Failure, Adds Water to Containment, Slows Pressure Rise

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098

AC INDEPENDENT WATER ADDITION

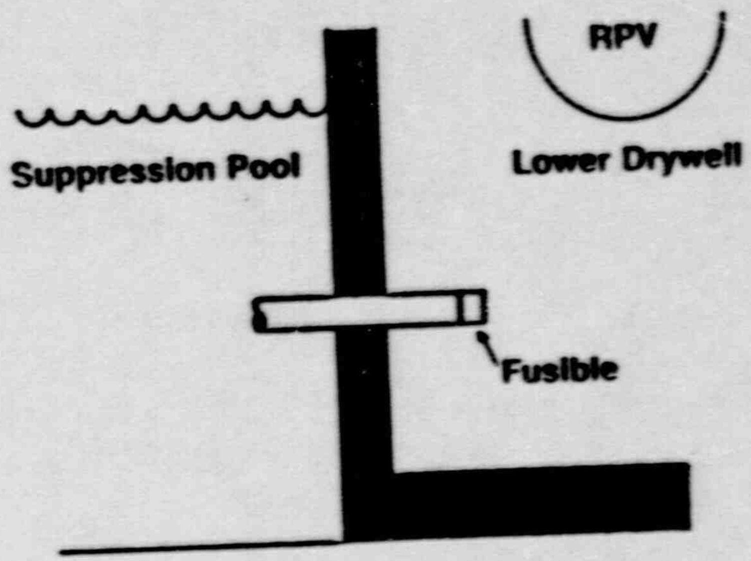
- For Drywell Spray: If Reactor Vessel Melt Occurs at High Pressure and Normal Drywell Spray Is Not Available, Manually Close One, Open Four Valves to Admit Fire Water to Drywell Spray. Mitigates Potential for High Upper Drywell Temperature

Benefits

- No Dependence on AC Power. Adds Reliability to Low Pressure Injection and Drywell Spray Function
- Seismically Qualified System with High Capability

LOWER DRYWELL FLOODER

- Required by EPRI-ALWR Requirements
- Operation
  - High Drywell Temperature After Vessel Failure
  - Melts Fusible Plug
  - Suppression Pool Water Flows to Drywell
- Benefits
  - Early Water Addition. Very Reliable
  - High Seismic Capability
  - Quenches Corium
    - -- Stops Core-Concrete Reaction
    - -- Reduces Drywell Temperature, Leakage Potential



-21-

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HYDROGEN GENERATION

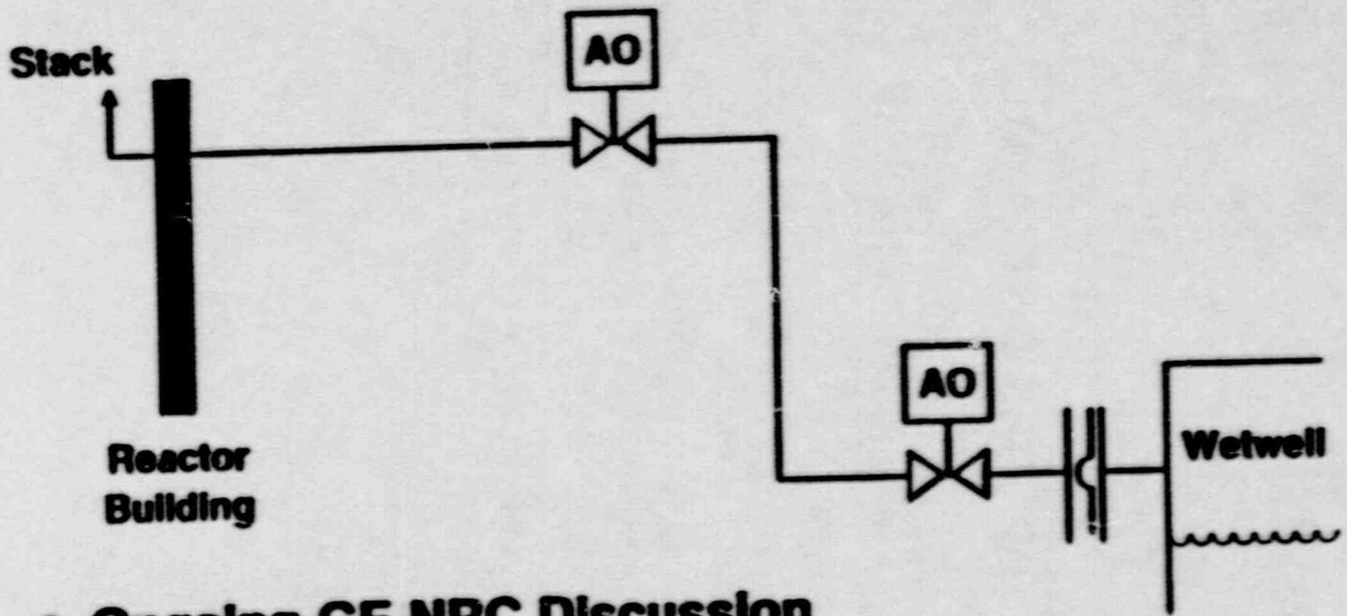
- NRC REGULATIONS REQUIRE MEASURES TO ACCOMMODATE HYDROGEN GENERATED FROM REACTION OF EQUIVALENT OF 100% METAL (ZIRCONIUM IN ACTIVE FUEL CLAD) AND WATER
- EPRI ALWR REQUIREMENTS PROGRAM TECHNICAL SUBMITTALS TO NRC DEMONSTRATE A DESIGN BASIS OF 75% METAL-WATER
- GE BELIEVES 75% METAL-WATER DESIGN BASIS IS CONSERVATIVE

HYDROGEN GENERATION

- DIFFERENCE BETWEEN 75 AND 100% METAL-WATER IS INCONSEQUENTIAL FOR ABWR (BECAUSE OF ITS INERTED CONTAINMENT)
- GE MEETING EXISTING NRC REGULATIONS (i.e. 100%) ON ABWR
- GE CAN EASILY ADOPT EITHER BASIS SINCE IT DOES NOT IMPACT THE DESIGN

INCONSEQUENTIAL ISSUE FOR ABWR

CONTAINMENT OVERPRESSURE PROTECTION



- Ongoing GE-NRC Discussion
- Operation
  - At Pressure Above Design Pressure and Below Capability Rupture Disks Open
  - Later, Operator Closes Isolation Valves to Regain Control of Containment Integrity

-24-

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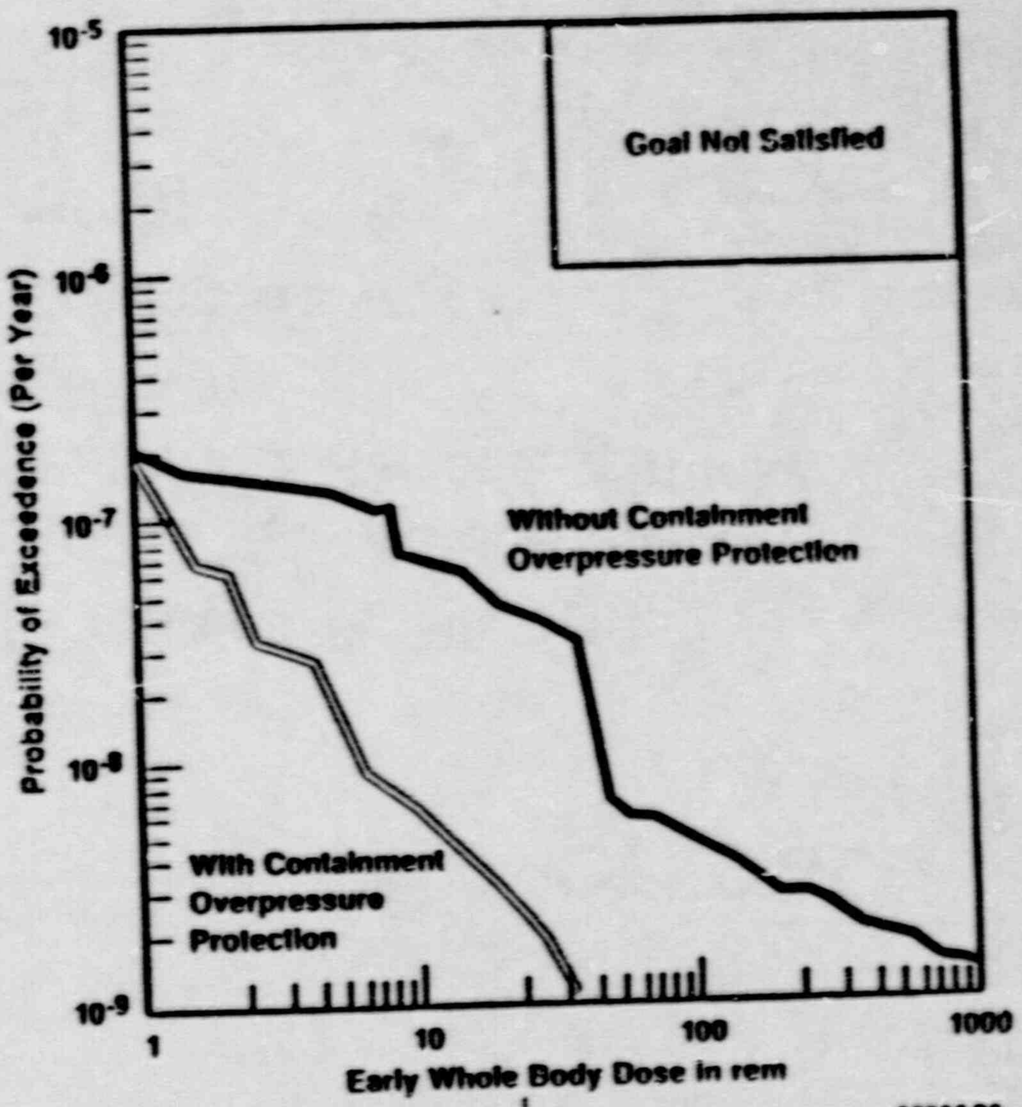
CONTAINMENT OVERPRESSURE PROTECTION

- Benefits
  - Passive/"Never" Used/Can't Be Misused
  - Insures Benign Failure: Release Scrubbed by Suppression Pool, Elevated Release. Virtually Eliminates Dose >25 rem
  - No Loss of Core Cooling Water
  - High Seismic Capability
  - Low Failure Probability

WHOLE BODY DOSE AT 1/2 MILE vs. PROBABILITY OF EXCEEDENCE



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ABWR PASSIVE SEVERE ACCIDENT MITIGATION

ABWR Passive Features Which Mitigate Severe Accidents

- Inerted Containment
  - Hydrogen Control
- Lower Drywell Flood Capability
- Suppression Pool - Fission Products Scrubbing and Retention
- Containment Overpressure Protection

Public Safety Ensured by Simple, Passive Features

SUMMARY

- GE ABWR Certification on Track
  - NRC review nearing 3/4 point
  - NRC current schedule consistent with DOE FDA milestone of September 30, 1990
- ABWR meets all severe accident goals
- Remaining actions prior to certification
  - Outstanding SSAR portions
  - Tests, Inspections, Analyses and Acceptance Criteria
  - Response to NRC Questions

Statement of
Dr. Bertram Wolfe
Vice President and General Manager
GE Nuclear Energy
before the
U.S. Nuclear Regulatory Commission
November 1, 1989

INTRODUCTION

We appreciate this chance to meet with the NRC on the GE ABWR Certification Program. This is our fifth meeting with the NRC since the program began in late 1986. The program is progressing well and is still basically on target. Dr. Wilkins will give you a status report shortly. First, however, I want to address several questions that have been the subject of recent discussions among the NRC, NRC Staff and groups representing the industry.

U.S. MARKET FOR EVOLUTIONARY LWR

The first is the question of whether there is a U.S. market for the evolutionary LWR. My answer is: I think there will be. I can tell you that U.S. utilities, government and industry are making major investments in the evolutionary LWR as the best way to provide our country with a nuclear option when new base load commitments are needed.

Utilities will need to commit new base load plants in the 1990's. The chart shows that for the past 15 years or so, since the Arab oil embargo pushed energy costs and load growth was cut in half, there has been an excess of electrical generating capacity in the U.S. This led to no new nuclear commitments and in fact cancellation of many nuclear as well as fossil units. This situation is ending, however. Electrical brownouts occurred in the Eastern U.S. during the past two summers, and new base load commitments will be needed in the early 1990's to avoid electrical shortages on a national scale. Estimates for new generating capacity needed by the end of the century range from 100 to 200 GWe.

There are no perfect energy sources. Environmental issues including air pollution, the greenhouse effect, acid rain and oil spills are receiving front page attention, and the public is becoming increasingly aware of the risks of burning fossil fuels. In addition there is increasing concern over our rising dependence on imported oil, which now constitutes 40% of our oil supply, and subjects us to the vagaries of Mid East governments.

The coming need for power, and the rising importance of environmental and energy security issues are creating a renewed interest in the revival of nuclear power. This is why U.S. utilities, government and industry are investing in the ALWR -- in the near term, the evolutionary ALWR -- to ensure the option is available when the difficult choices must be made.

In GE's case, our ABWR has several hundred million dollars invested in its design and development by GE and our worldwide associates. It has been adopted as the next generation standard BWR in Japan, and a two unit lead project has been committed by the Tokyo Electric Power Company. We are seeking NRC certification of the ABWR design because we believe it could be an excellent plant for U.S. application -- not just to support our overseas business. With the serious energy problems facing the U.S., we believe it important that the American public not have excluded from them meaningful options which could ameliorate the problems.

Perhaps the most important factor governing whether utilities will be able to turn to nuclear to fill their future needs will be the existence of NRC certified standard designs. Lead time for design, development and certification is on the order of five years or longer, and it is unlikely that any utility will order a nuclear unit unless it is certified in advance. This necessitates that we conduct the design and certification work now as a precondition to any market need.

Further -- and importantly -- the ABWR certification proceeding provides both the occasion and the opportunity for a working demonstration of the effectiveness, predictability and timeliness of a major element of the Commission's Part 52 standardization and licensing regulations. This also is a vital factor governing whether utilities will turn to nuclear as a viable option to fill their future energy needs.

GENERIC RESOLUTION OF SAFETY ISSUES

The second question is whether ALWR issues should be resolved generically. We believe the the answer is yes to the extent practical. We should be careful, however, not to impose generic resolution of ALWR issues where plant specific resolutions would yield better results. Our experience has been that generic resolution of ALWR issues frequently results in "least common denominator" approaches that fail to exploit plant specific opportunities which only become apparent in the context of a specific design. Certification itself represents a generic resolution of issues for a class of standard plants, and has the advantage that issues can be considered in the context of an actual design rather than in a more abstract context.

We believe the EPRI ALWR Requirements and DOE ALWR Certification Programs provide an unusually effective vehicle for considering both the generic and plant specific aspects of issues, and encourage the NRC to continue to support these programs. We recommend against generic rulemaking as an approach to the resolution of ALWR issues. Generic rulemaking would be enormously disruptive of both the ALWR Requirements Program and the ALWR Certification Programs which have major private sector investment and are nearing completion.

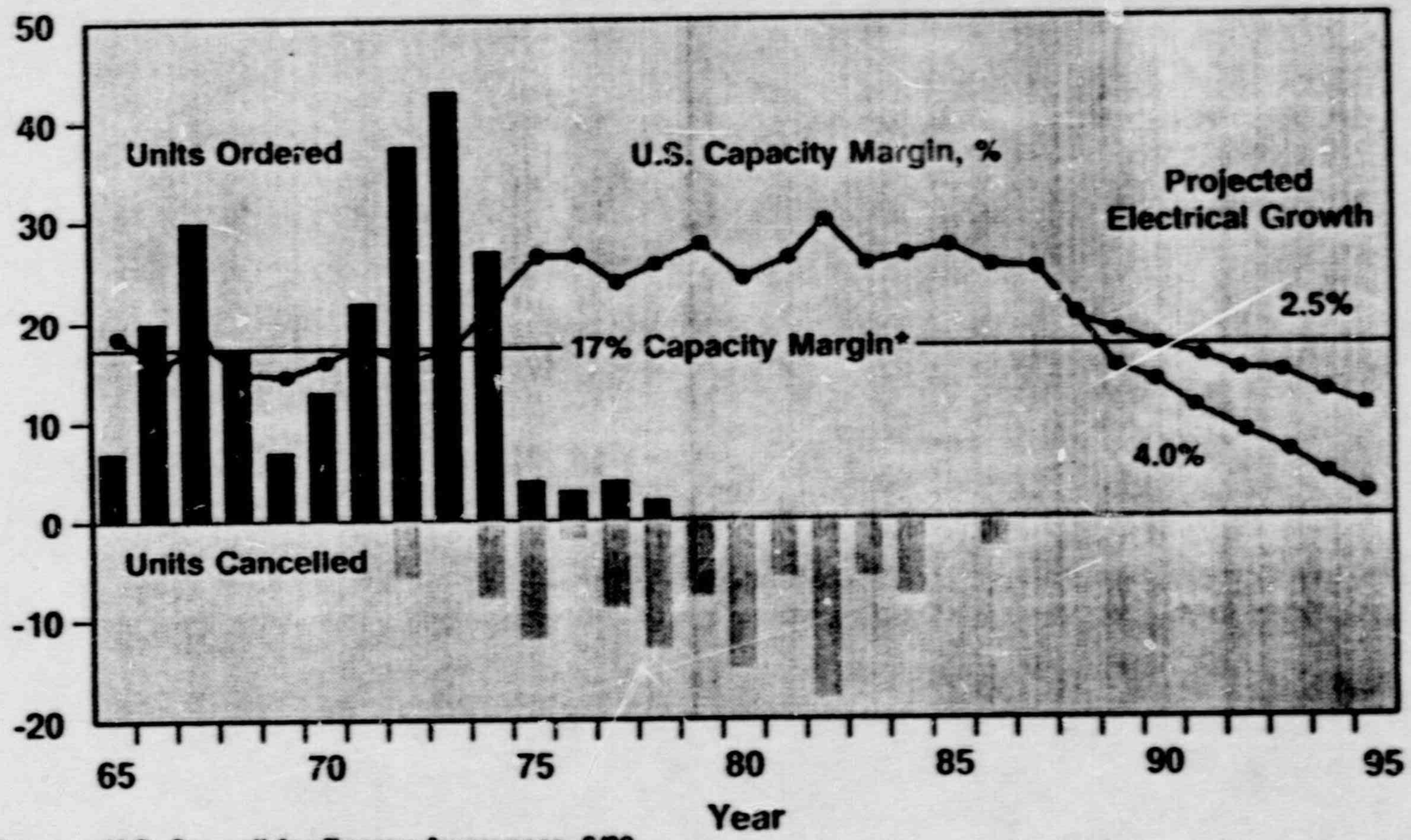
GE has been a participant in the EPRI ALWR Requirements Program since it's inception. The ABWR currently under review by the NRC staff is in substantial conformance with the utility ALWR Requirements. In a few areas -- most notably hydrogen control and containment overpressure protection -- we have elected to exceed the ALWR requirements. In the case of hydrogen control this was done to avoid lengthy discussion of an issue which was inconsequential for the ABWR. In the case of containment overpressure protection it was done to take advantage of unique ABWR features to provide a substantial added measure of offsite public and property protection which could be achieved at modest cost. In these two areas, we fully support the generic positions reflected in the ALWR Requirements Document while, at the same time, believing there are sound reasons for the ABWR to exceed the ALWR Requirements on a certified standard plant basis. Dr. Wilkins will discuss both of these areas in more detail in his presentation.

REQUEST FOR CONTINUED SUPPORT

We appreciate the very strong support the NRC and the NRC Staff have provided to the ABWR Certification Program. We believe the program has been remarkably successful to date, and is on track to provide a convincing demonstration of the benefits of the Part 52 standard plant licensing process. It is being closely followed in the U.S. and around the world as a pioneering effort which will set the direction for plant standardization in the second nuclear age. We request your continued support and I assure you that GE is fully committed to the successful completion of this program.

Thank you.

U.S. CAPACITY MARGIN AND NUCLEAR ORDERS



Source: U.S. Council for Energy Awareness, 6/89

*Minimum Required for Reliability

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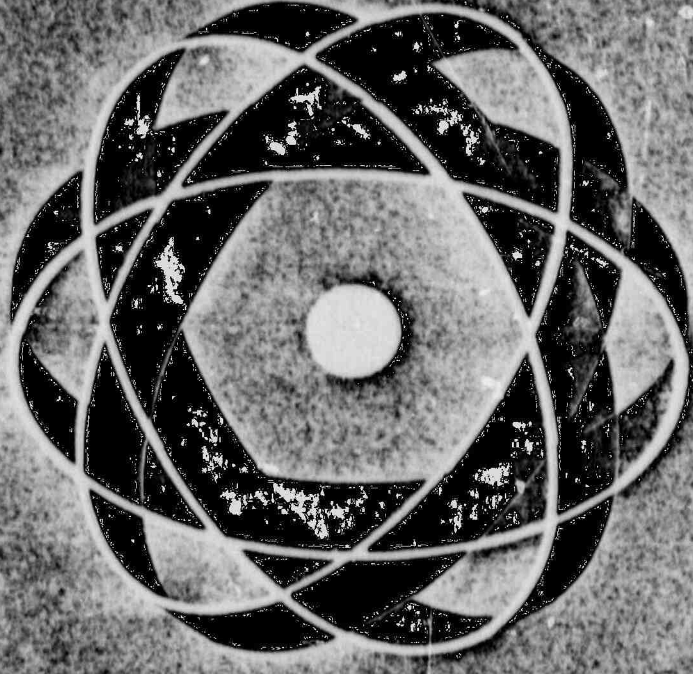
Light water reactors: The next generation



GE Nuclear Energy

Advanced Light Water Reactor... the next step in meeting U.S. energy needs

"For almost 30 years, nuclear power has proven its ability to generate large amounts of electricity without contributing to acid rain or the greenhouse effect, or increasing dependence on foreign oil."

David Rossin
Former Assistant Secretary
for Nuclear Energy
U.S. Department of Energy

"…actual (electricity) demand has been rising more than four percent a year for the past two years. That's why some parts of the country… are getting close to the limits of their generating capacity."

The Washington Post
March 3, 1989

"The light water reactor is miles ahead of any other competing (nuclear energy) technology in terms of design and operating experience… And, there is an extensive infrastructure in place for designing, building, operating, maintaining and licensing new light water reactors."

James J. O'Connor
Chief Executive Officer
Commonwealth Edison

Since 1984, demand for electricity in the U.S. has increased at an average of 3.5 percent per year. Peak load rose 6.7 percent in 1988. At these growth rates, our electricity demand will outgrow our present supply in the early 1990s. And yet no significant new generating capacity has been added.

Nuclear power is the second largest source of electricity in the United States, currently providing 18 percent of the country's electrical generation. It overtook oil in 1980, natural gas in 1983 and hydropower in 1984. Only coal provides more of the nation's electricity. Coal and uranium will continue to be our major sources of electricity for the foreseeable future.

Increasing public sensitivity to atmospheric pollution and the greenhouse effect, and the risks associated with dependence on foreign oil give further impetus to the use of clean and safe nuclear energy.

Surveys show that 79 percent of American adults believe nuclear energy will be important in meeting the nation's future electricity needs. They also anticipate that future nuclear reactors will perform even better than current reactors. The advanced light water nuclear power plants presented in the following pages meet these expectations with their progressive performance, economics, environmental and safety features.

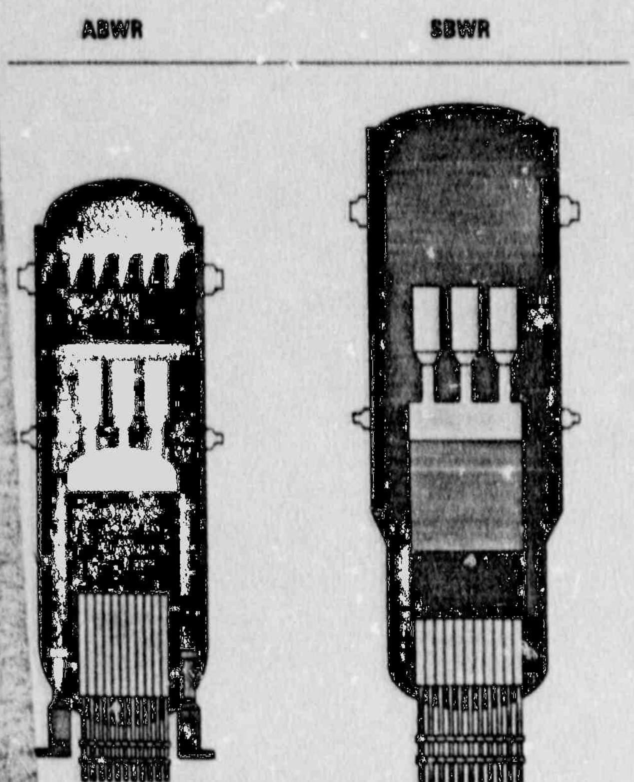
The birth of peaceful nuclear power in the U.S. dates to President Eisenhower's "Atoms for Peace" program, enacted into law in 1954. Today nuclear power in the U.S. provides more electricity than was generated by all sources in 1954, and saves this country the equivalent of a billion barrels of imported oil a year. In fact, our nation's nuclear generating base consists of more than 100 light water reactors (LWRs).

The successful history of LWR development has included the application of technological advances and plant modifications to achieve prompt, satisfactory resolution of the unforeseen problems inevitable in the development and application of any new technology. Today we can build optimized light water reactors based on the three decades of experience. The Advanced Boiling Water Reactor (ABWR) and the Simplified Boiling Water Reactor (SBWR) are designs which take advantage of this experience.

Together, the ABWR and SBWR are innovative, near-term candidates for expanding electrical generating capacity in the U.S. And, they possess the features necessary to do so safely, reliably and economically.

GE was a pioneer of commercial nuclear power and a key participant in the development of the U.S. Navy nuclear submarine and surface ship propulsion programs. GE chose to develop the BWR for land-based electrical power generation because of its inherent simplicity and the advantages of its direct steam cycle design.

In response to initiatives to encourage improvements in nuclear plant design and licensing by the U.S.



...gether the ABWR and SBWR are innovative, near-term candidates for expanding ...S. electrical generating change capacity.

GE Nuclear Energy

ABWR and SBWR: Meeting the need for future power systems

	ABWR	SBWR
[illegible]	[illegible] completed.	Conceptual design completed.
Testing status:	All new systems tested [illegible]	Testing of new systems completed or under way.
Licensing status:	Scheduled for 1991 as first U.S. standard NRC-certified plant.	Scheduled for certification in 1995.
Deployment/project status:	Selected for two units at Tokyo Electric Power Company's Kashiwazaki site with '96 and '98 startups.	Investor ready by 1995.

In contrast to non-LWR advanced reactors, the ABWR and SBWR are ready for near-term commercial deployment.

Department of Energy (DOE), the Electric Power Research Institute (EPRI) and the Nuclear Regulatory Commission (NRC), GE is jointly developing two new light water reactor designs, the Advanced Boiling Water Reactor and the Simplified Boiling Water Reactor.

The ABWR is a 1356 MWe reactor developed by an international team of Boiling Water Reactor (BWR) manufacturers—from the United States, Japan and Europe—to respond to worldwide utility needs in the 1990s.

The SBWR is a 600 MWe reactor which uses natural circulation and passive safety features to minimize dependence on mechanical components and operator action.

The ABWR is the only advanced light water reactor currently being commercially deployed. It embodies the best safety and performance experience of BWRs worldwide. Its acceptance is evidenced both by its selection as the next-generation BWR in Japan, and by its progress toward becoming the first certified U.S. standard nuclear plant design.

The SBWR, four to five years later than the ABWR in its development, continues the ABWR's trend in design simplicity. In doing so, it extends the favorable economics of nuclear power generation to smaller output ratings.

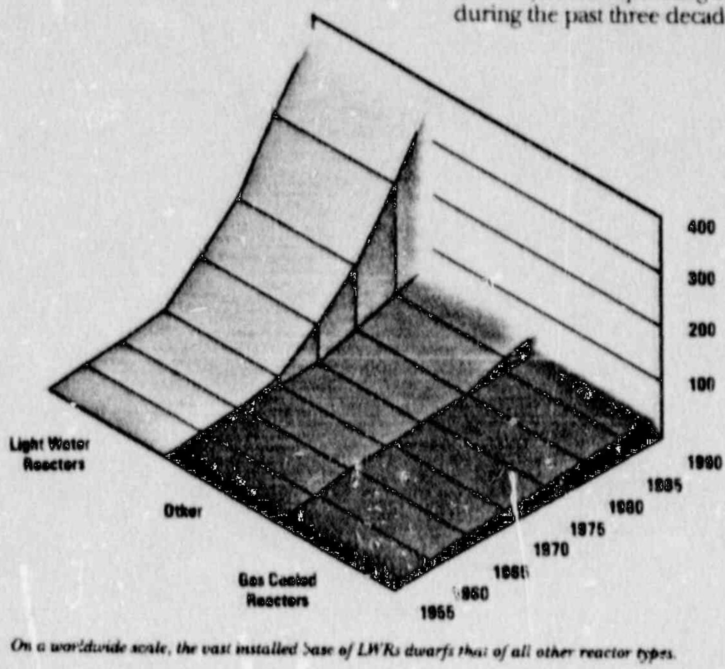
"A majority in the nuclear power industry expect an improved version of the light water reactor to be the preferred choice for the next increment of nuclear capacity in the U.S."

—James J. O'Connor
Chief Executive Officer
Commonwealth Edison

Research and development on the future LWRs are supported by the U.S. Department of Energy, the Electric Power Research Institute, major corporations, educational institutions and international teams of utilities and suppliers.

In the global nuclear power industry, LWRs are the unquestioned experience leaders in terms of design, construction, licensing and maintenance. An extensive worldwide infrastructure is already in place to support them. LWRs are the nuclear electrical generating technology choice of almost all industrialized nations. In fact, four out of five operating reactors today are LWRs.

Advanced LWRs are endorsed by U.S. utilities as the reactor technology for the next 10 to 20 years. Worldwide, LWRs have accumulated over 4600 reactor-years of operating experience during the past three decades.



On a worldwide scale, the vast installed base of LWRs dwarfs that of all other reactor types.

ABWR and SBWR: Based on experience from leading LWR technology

"Gas cooled reactors will have their place early in the next century, but only advanced water reactors will be ready within ten years, when the country will need more kilowatts."

—Karl Stahlkopf
Director of
Materials and System
Development
Electric Power Research
Institute

Although LWRs make up less than one-fifth of U.S. generating capacity, their performance has been noteworthy. In a recent five-year period, 14 of the top 20 performing steam power plants in the U.S. were LWRs.

Historically, unforeseen technical issues have been the nemesis of many emerging advancements. But in the LWR, such maturation issues have been encountered and solved. With a life cycle for most reactors of 40 years or more, it takes decades of experience to identify and correct unanticipated technical problems. Favorable positioning on the "learning curve" is a distinct advantage which LWRs, like the ABWR and SBWR, have over more developmental nuclear power technologies, such as gas-cooled reactors and liquid-metal fast breeder reactors.

Light water reactors are the preferred nuclear technology in most industrialized nations.

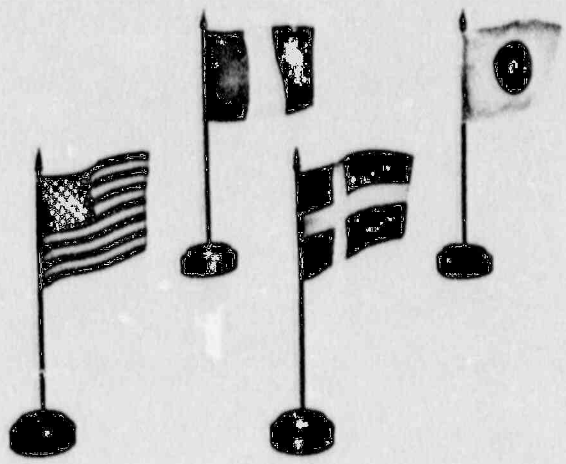
"International cooperative programs are in place to bring into being a new generation of BWR plants. These plants will incorporate the best features and technology from the current generation of worldwide BWRs and will represent world-class standard plants to serve utility needs in the 1990s and beyond."

—D.R. Wilkins
General Manager
GE Advanced BWR Programs

An international cooperative effort is now under way to establish the ABWR as a world-class standard plant. Design simplification, enhanced safety and reliability margins plus lower construction, fuel and operating costs are among the attributes cited by the ABWR's worldwide support team. ABWR program objectives also include improved maneuverability and reduced occupational exposure and radwaste volume.

In 1978, when GE launched its Advanced BWR program, it assembled representatives of BWR suppliers and leading architect-engineer firms from around the world in an Advanced Engineering Team. These individuals established the basic ABWR design parameters: A reactor which takes advantage of the strongest, operationally proven features from BWR designs in Europe, Japan and the United States.

The ABWR, the first reactor to be entirely designed since the accident



The international team of BWR manufacturers who have contributed to the ABWR includes major firms in the United States, Sweden, Italy and Japan.

Energy

ABWR: A world-class reactor from an international team

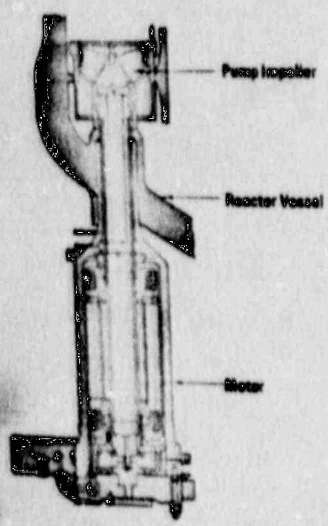
at Three Mile Island, incorporates all relevant design improvements resulting from the lessons learned from that event.

The ABWR program reached an important milestone in 1987 when the Tokyo Electric Power Company selected two ABWR units for its Kashiwazaki-Kariwa Nuclear Power Station. Commercial operation of the first plant will take place in 1996 and the second in 1998. A joint venture involving GE, Hitachi and Toshiba is supplying the units. GE's scope of supply encompasses the reactor systems, fuel and turbine-generators.

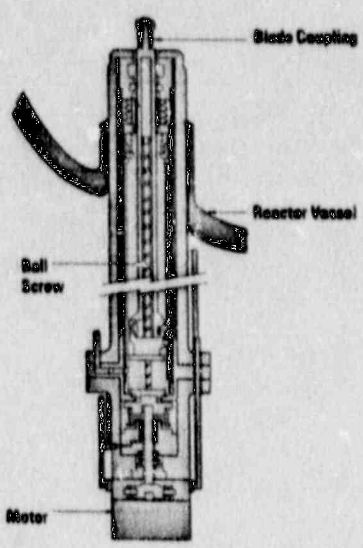
Another milestone, certification of the ABWR design as a pre-approved U.S. standard BWR plant, is on target for 1991 completion.

Simplification—and the ability to take advantage of 30 years of international BWR experience—play a key role in the ABWR development program. For example, the ABWR makes reactor operation and maintenance easier by using internal circulation pumps, in place of the external pumps of most operating plants. This eliminates piping, decreases construction time and reduces in-service inspections.

Internal circulation pumps also enhance safety by eliminating large reactor vessel nozzles and piping below the top of the core. As a result, the fuel remains covered with water even in the case of a postulated, loss-of-coolant accident.



Elimination of external recirculation piping reduces weld requirements by more than 50 percent over current BWRs.



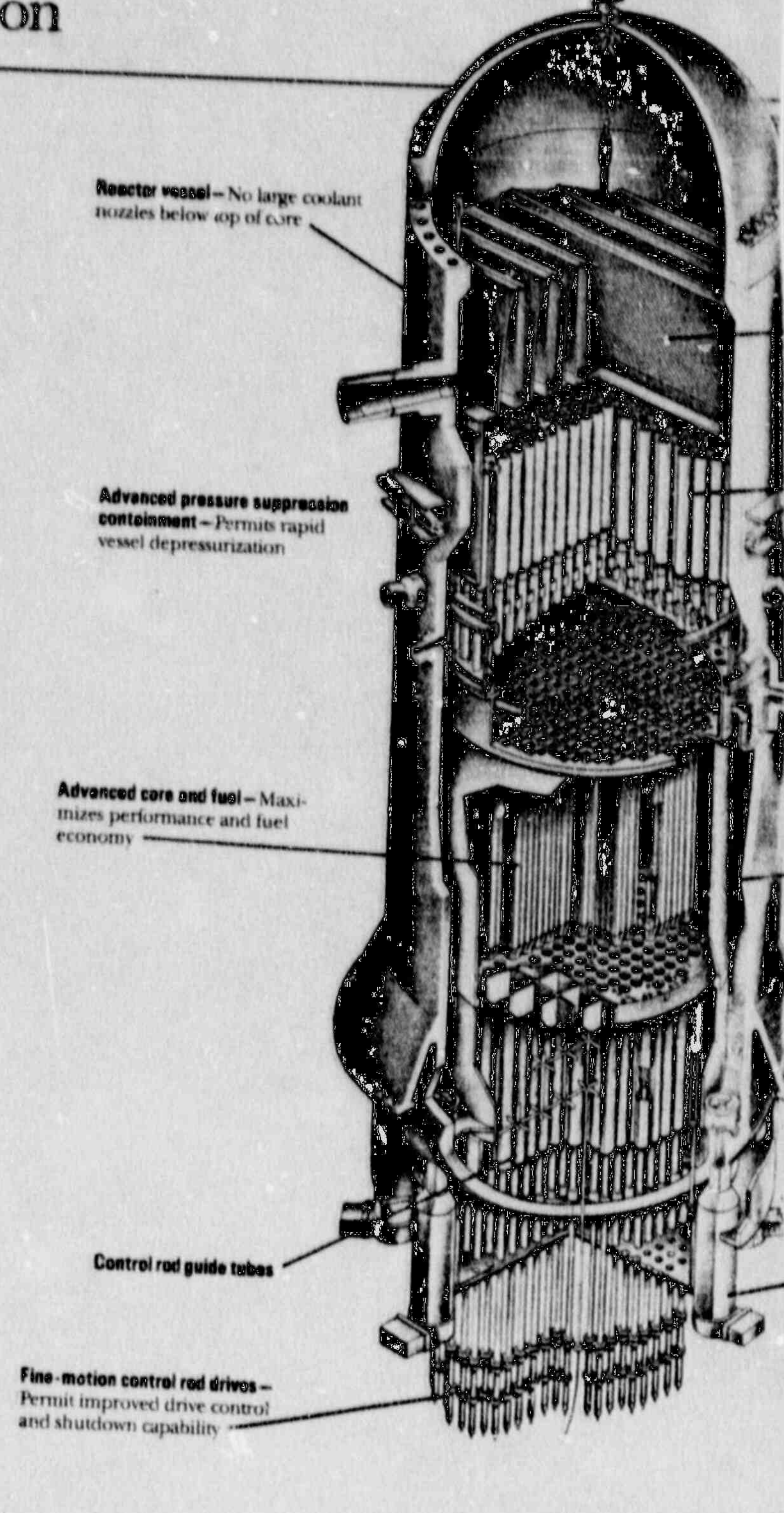
Electrical-hydraulic drives permit fine-motion control rod movements and provide diverse shutdown capability.

ABWR: The benefits of standardization

GE welcomes the initiative taken by the NRC in adopting regulations (10 CFR 52) to streamline the licensing of new, standardized nuclear power plants. The new NRC regulations create a licensing framework that will enable the benefits of design standardization to be realized in the U.S. The ABWR, based on such standardization, is only two years away from certification.

The entire ABWR plant—including the nuclear island, turbine island and radwaste facility—is now being reviewed as a preapproved U.S. standard BWR under the U.S. Department of Energy's ALWR Program. When completed in 1991, the ABWR will be the first such standard U.S. nuclear design to achieve certification.

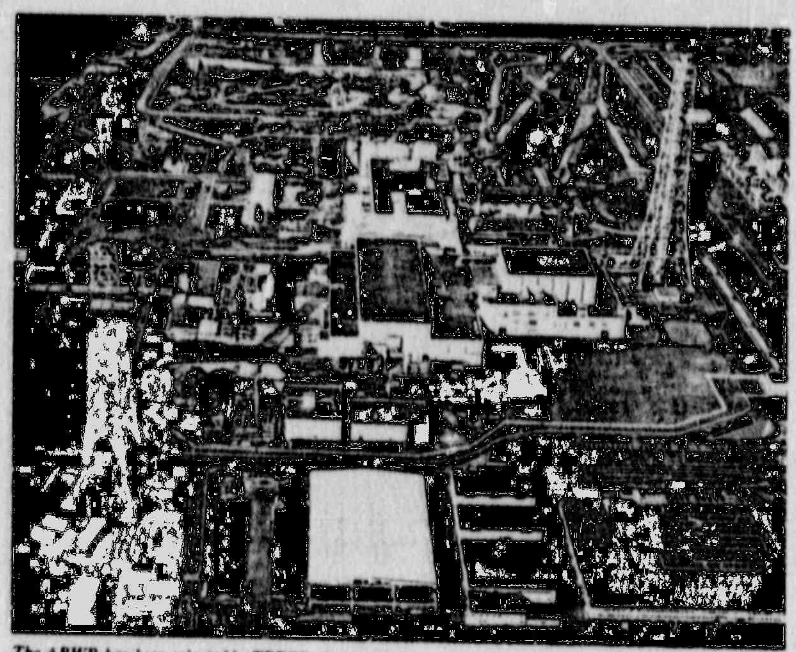
With certification, the ABWR can be constructed on a family of sites—as defined by its site envelope—without further review of the design. As a result, expensive 10- to 15-year construction cycles can be replaced by five-year construction programs, as planned for Japan's first ABWRs.



and favorable

"We think that the standardization and certification process is the future of nuclear energy in our country."

—Lando Zech
Chairman
U.S. Nuclear Regulatory Commission



The ABWR has been selected by TEPCO, the world's largest private utility, for construction at a seven-unit site as the next generation, standard BWR in Japan.

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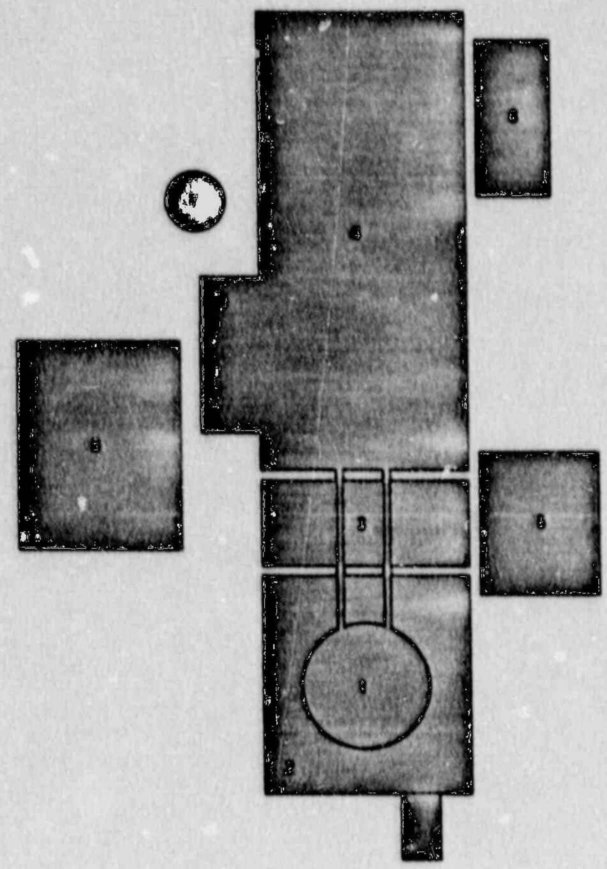
and



1 Reactor Containment
2 Reactor Building
3 Control Building
4 Turbine Building
5 Service Building
6 Radwaste Building
7 Condensate Storage Tank
8 Main Transformer
9 Normal Switchgear

The ABWR certification application encompasses all significant plant structures and systems.

"The payoff from the NRC's April 1989 rulemaking on one-step licensing is more immediate than many people realize. The ABWR design is on schedule to receive the NRC's first standard plant certification in 1991. Using that design on a preapproved site will mean a dramatic, near-term construction cycle improvement for a utility applicant."

—Bertram Wolfe
Vice President and General Manager
GE Nuclear Energy

[illegible]

Plant output		**Core and fuel**	
Net electrical output	1356 MWe	Active fuel length	3.81 m
Gross thermal power	3926 MWt	Equivalent core diameter	5.14 m
Plant cycle	Direct	Power density	50.5 kw/l
Vessel dome pressure	73.1 kg/cm²	Number of assemblies	872
Main steam flow	7640 tons/hour	Fuel material	UO_2
Turbine	TC6F-52 inches	Cladding material	Zircaloy 2
Reheat stages	Two	Fuel lattice type	8 x 8 barrier
Nuclear boiler		**Reactivity control**	
Reactor vessel		Number of control rods	205
Inner diameter	7.1 m	Neutron absorber	B_4C
Height	21.0 m	Control rod form	Cruciform
Primary coolant circulation		Control rod drive	Electro-hydraulic, fine-motion
Recirculation system	Internal pumps		
Recirculation flow	52,200 tons/hour	Other control	Burnable poison (Gd_2O_3)
		Containment	
		Type	Pressure suppression
		Configuration	Cylindrical reinforced concrete

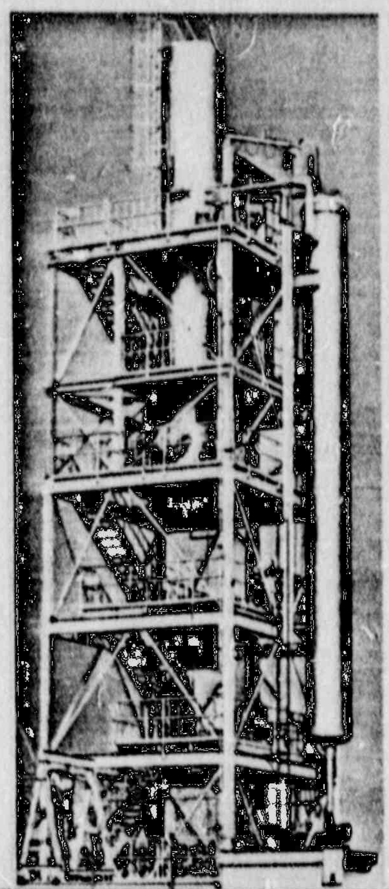
"Many utilities in the United States have grid sizes compatible with baseload units of 600 MWe or less. Combined with uncertain load growth, this scenario points the way to small, passive advanced light water reactors."

—John Taylor
Vice President
Electric Power Research Institute

Featuring less than half the electrical output of the ABWR, an SBWR plant will extend the favorable economics of nuclear power to smaller electrical ratings.

The SBWR takes full advantage of its smaller size by using gravity and natural circulation of the coolant to mitigate potential accidents. In the event of an emergency, the reactor shuts itself down and cools itself without the need for operator intervention. SBWR safety features also avoid reliance on external pumps or power supplies.

Full-scale (vertical) testing of the gravity-driven cooling system has been successfully completed.



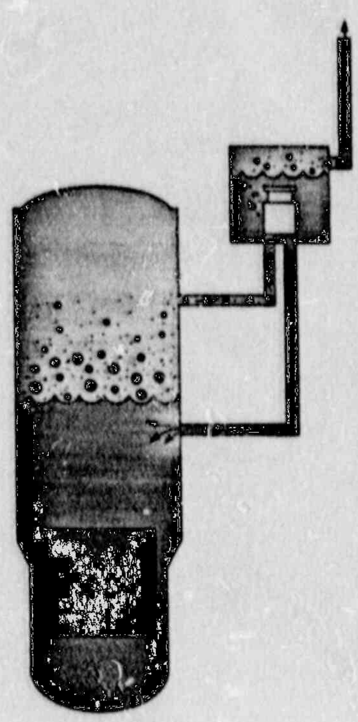
SBWR: Passive safety and favorable economics in smaller output ratings

Like most GE boiling water reactors, the SBWR utilizes a pressure suppression containment to absorb vessel energy releases. In an emergency, the SBWR vessel is depressurized, and cooling water flows by gravity from an elevated pool into the reactor vessel. No operator action is needed to activate this automatic safeguard.

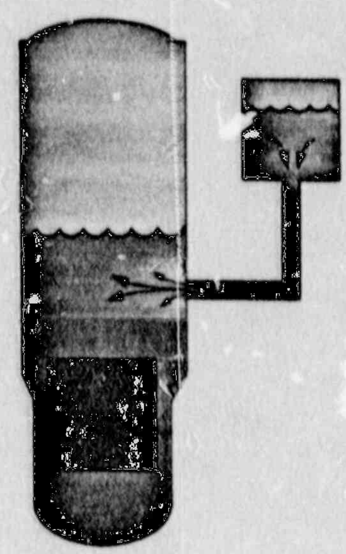
Significant design features incorporated in the ABWR, such as fine-motion control rod drives and digital controls, have been carried over to the SBWR.

A passive containment cooling system uses natural convection to provide long-term cooling capability.

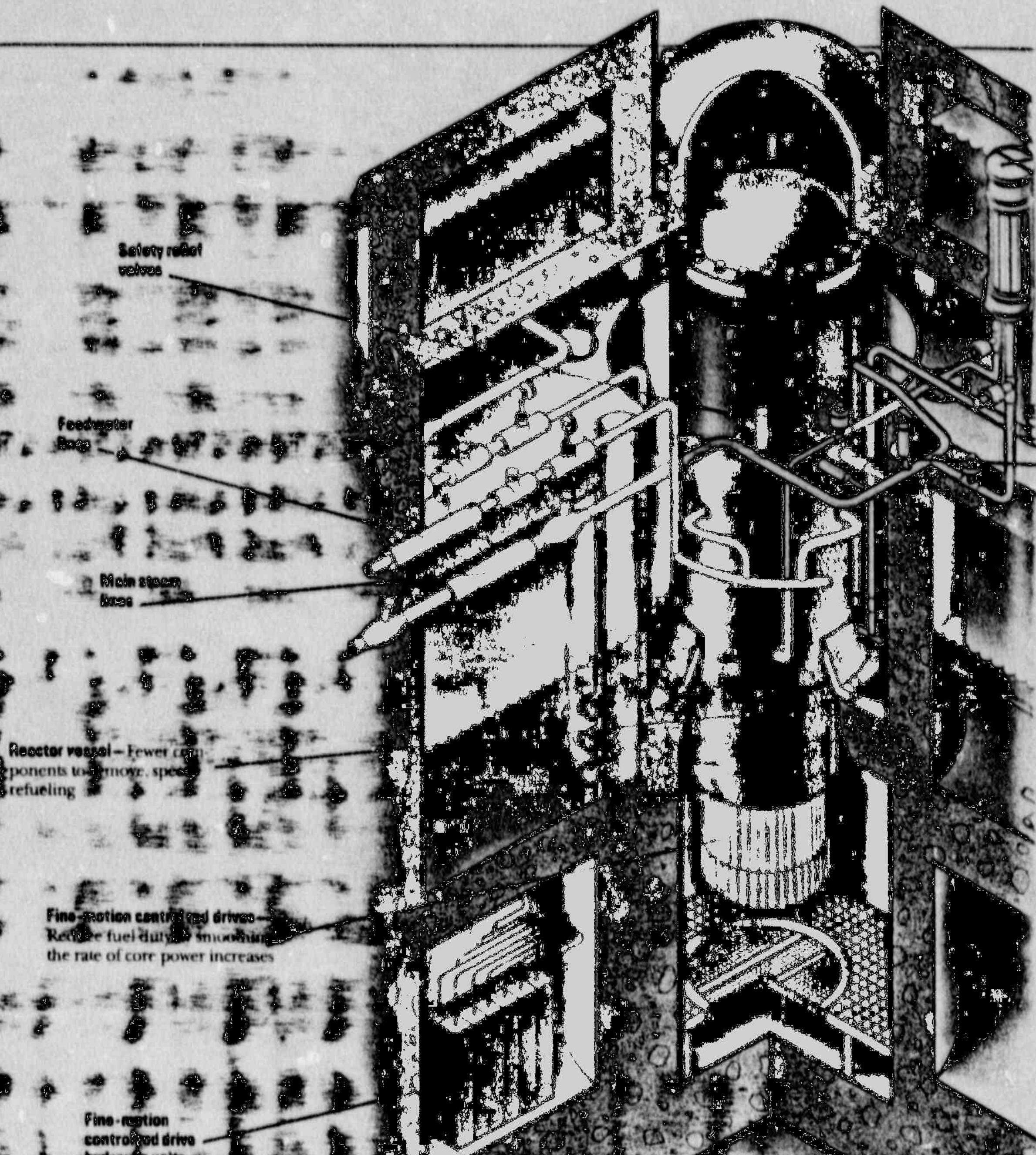
SBWR natural circulation maintains core heat transfer.



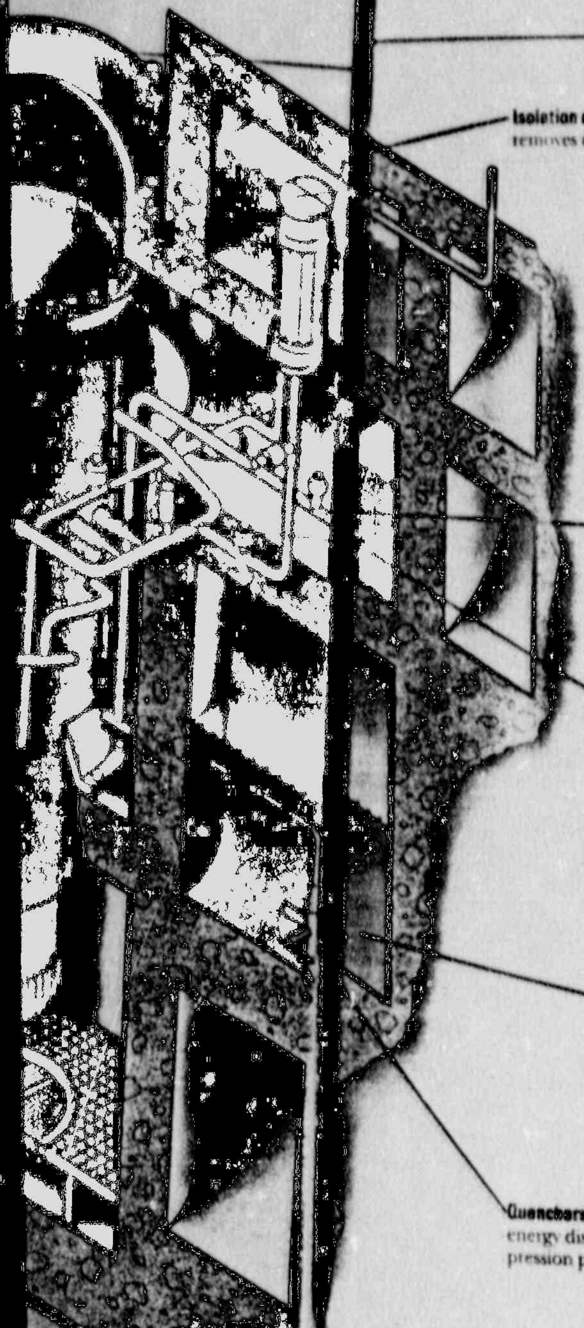
SBWR isolation condenser for passive, long-term heat removal.



SBWR gravity-driven emergency core cooling system.


Safety relief valves
Feedwater line
Main steam lines
Reactor vessel — Fewer com- ponents to remove, speed refueling
the rate of core power increases
Fine-motion

H



"Both the SBWR and ABWR are based on 30 years of progressive technology and operating experience. The SBWR capitalizes on ABWR technology to provide passive safety and favorable economics in smaller ratings."

—D. R. Wilkins
General Manager
GE Advanced BWR Programs

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SBWR's simplified design enhances operation and maintenance

...are based on ...ology and ... capitalizes on ...passive safety ...aller ratings."

...ion – Simplifies ...nd operation

...eration sys- ...ruction costs

SBWR Technical Data Summary

Plant output	
Net electrical output	600 MWe
Gross thermal power	1800 MWt
Plant cycle	Direct
Vessel dome pressure	71.1 kg/cm^2
Main steam flow	3490 tons/hour
Turbine	TC2F-52 inches
Reheat stages	One
Nuclear boiler	
Reactor vessel	
Inner diameter	6.0/7.0 m
Height	23.6 m
Primary coolant circulation	
Recirculation system	Natural circulation
Recirculation flow	23,700 tons/hour
Core and fuel	
Active fuel length	2.44 m
Equivalent core diameter	4.73 m
Power density	42.0 kw/l
Number of assemblies	732
Fuel material	UO_2
Cladding material	Zircaloy 2
Fuel lattice type	8x8 barrier
Reactivity control	
Number of control rods	177
Neutron absorber	B_4C
Control rod form	Cruciform
Control rod drive	Electro-hydraulic, fine-motion
Other control	Burnable poison (Gd_2O_3)
Containment	
Type	Pressure suppression
Configuration	Cylindrical reinforced concrete
Schedule	
First concrete to fuel load	30 months

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SBWR improves cost-effectiveness through reduced capital outlays

"(An advanced reactor) must provide very high protection of the utility investment in terms of predictable construction costs and schedules, assured licensability, predictable operating and maintenance costs...."

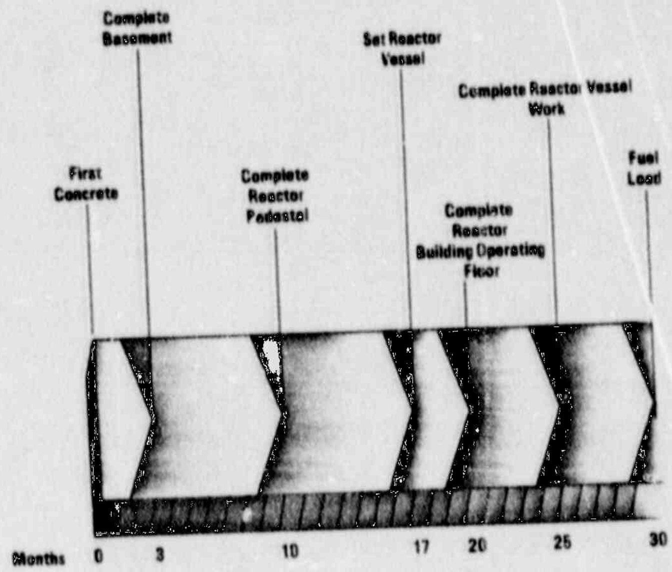
—Sherwood Smith
Chairman/President
Carolina Power & Light

Most reactor systems offered today have a capacity of 900 to 1200 MWe. In contrast, the SBWR has an output of 600 MWe. This smaller capacity, coupled with its simplified design, shortens construction time.

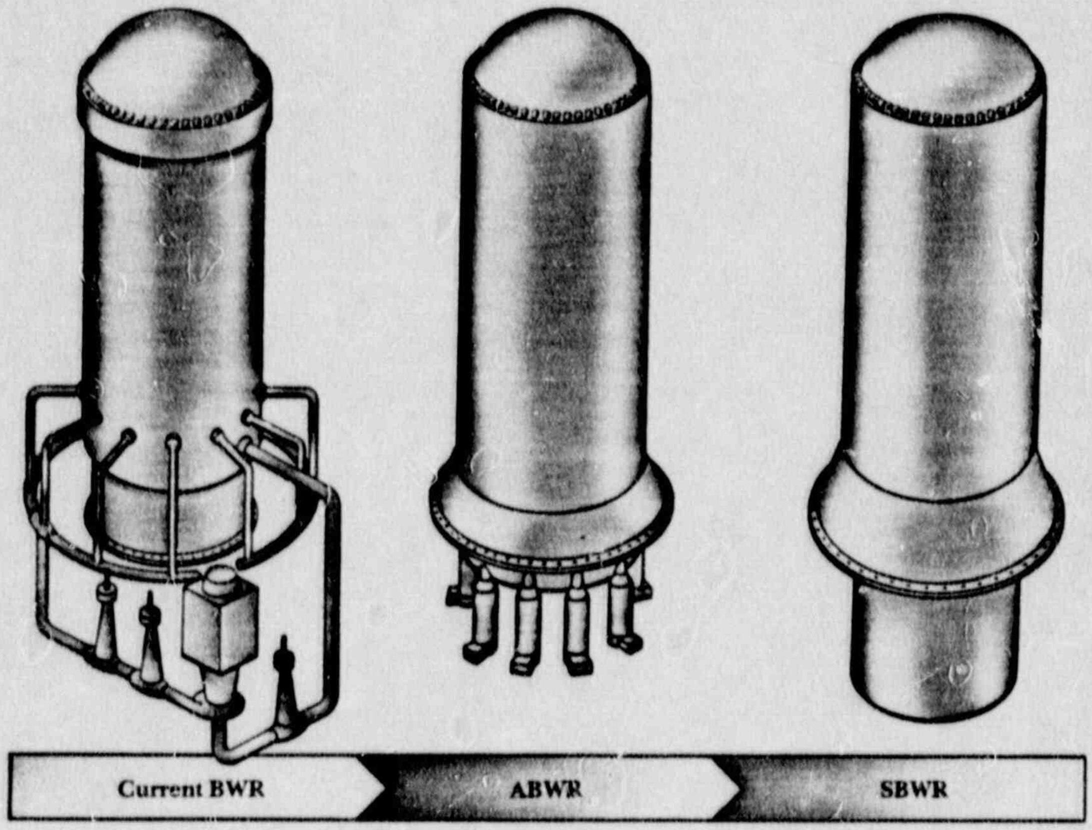
The simpler design incorporates more factory fabricated components for reduced costs, improved maintenance and enhanced quality control. Modular components also contribute to shorter construction schedules.

Much of the cost associated with current reactors is the result of long construction periods which tie up a utility's capital and impose excessive carrying charges. Given a certified SBWR design, GE anticipates a 30-month construction period from first concrete to fuel loading.

To achieve a predictable licensing process, GE plans to submit the SBWR for standard plant certification by the NRC. Participation in a DOE program for detailed design and NRC certification is expected to yield a pre-licensed, standardized investor-ready SBWR design by 1995.



SBWR Construction Schedule Milestones



Current BWR

- 900–1200 MWe
- External, forced circulation
- Nearly 100 plants operating worldwide

ABWR

- 1356 MWe
- Internal, forced circulation
- World-class design by international team
- Selected as Japan's next generation of standard BWRs
- U.S. NRC certification program in progress
  - First certified U.S. standard plant
  - Cooperative DOE/EPRI/GE effort

SBWR

- 600 MWe
- Natural circulation
- Focus on simplification and automatic safety
- Builds on BWR and ABWR technology bases
- Design and development in progress
  - Cooperative DOE/EPRI/GE effort
  - International support
  - Testing under way
- U.S. licensing certification targeted for 1995

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The BWR: A study in disciplined evolution

"Thirty years of BWR evolution have resulted in two new reactor designs—the ABWR and the SBWR—that incorporate the best of current technology with simplified designs and reduced construction, operation and maintenance costs."

—Bertram Wolfe
Vice President and
General Manager
GE Nuclear Energy

The ABWR and SBWR are based on more than 30 years of boiling water reactor experience. GE designed the first licensed U.S. nuclear plant—a BWR—which began operation in 1957. GE pursued the BWR design because the simplicity of its direct steam cycle eliminates the need for intermediate steam generators.

During the succeeding 30 years, the BWR has evolved through several design simplification stages. With each evolutionary change, major components—proven unnecessary to the steam generation cycle—were eliminated to simplify the BWR and enhance reliability.

GE BWRs enjoy worldwide acceptance. Shortly after their introduction in the U.S., GE BWRs became the first commercial light water reactors ever ordered in Japan, Mexico, the Netherlands, India, Taiwan and West Germany. More than half the current and planned nuclear power capacity in Japan, Switzerland, Mexico and Taiwan is committed to GE-type BWRs.

In total, more than 100 BWRs, supplied by GE and its technical associates, are now operating or under construction in 11 countries.

Meeting U.S. energy needs of the 1990s and beyond

"America gave birth to nuclear technology, and as we approach the 21st century, this nation can lead the world into a new era of safe, reliable, economical, and environmentally clean nuclear power... Through the efforts of our commercial nuclear power industry, our national energy security is strengthened and environmentally harmful emissions are reduced... Now is the time for America's nuclear industry to take its rightful place in helping to meet the nation's energy needs for the next decade and the next century."

—George Bush
President of the United States
May 9, 1989

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DATE: 11/7/89

FROM: SECY Correspondence & Records Branch

Attached are copies of a Commission meeting transcript and related meeting document(s). They are being forwarded for entry on the Daily Accession List and placement in the Public Document Room. No other distribution is requested or required.

Meeting Title: Brief by General Electric on the Advanced BWR Standard Plant Review

Meeting Date: 11/1/89 Open X Closed ______

Item Description*:	Copies Advanced to PDR	DCS Copy
1. TRANSCRIPT w/Scheduling Notes & Viewgraphs	1	1
2. Statement of Dr. B. Wolfe, dtd 11/1/89	1	1
3. Booklet "Light Water Reactors: The Next Generation"	1	1
4.		
5.		
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