MR. VINE: The GT-MHR. The CANDU design I know has been working very aggressively in discussions with individual utilities around the country. And I honestly can't speak to where they stand on that, but AECL may want to comment.

I think the point here is that if that market interest isn't significant, the mere fact that there is a design out there that has a fan that wants to come in and begin to work with NRC doesn't necessarily mean it has to go to the top of the heap.

It's not a first come, first served thing. It really ought to be, "Is this design likely to be deployed in the foreseeable future in the United States?" because if it's not, you're essentially expending resources on an option that won't be used. So you wait until you're more confident that it will be used before you expend those resources.

That's the logic, easy to say, obviously a little bit more difficult to manage practically because the degree to which all of these business interests are being shared with the staff.

MEMBER ROSEN: What's a more appropriate test for a utility interest that we should apply?

MR. VINE: I think one very clear test will be as we proceed on the future, the degree of industry cost share put on the table to match DOE to bring these designs to fruition. That is really a very valid measure.

There are other ways to measure it. For example, in license renewal, especially in the early days, where utilities were a little less reluctant to formally state their license renewal intentions, there was a mechanism for confidential discussions with the staff to discuss some of these business interests that were being considered. So there are ways to communicate the interest, but I think cost-share is a clear indicator.

So here are some areas where we think real priorities should be placed, again by both NRR and RES, anything to support ESP and COL application needs. Obviously if NRR says, "I've got a technical issue I need some research on to resolve because it's going to be a generic hurdle for all the applicants," that's something we all ought to jump on, either RES on its own or industry and RES together and jointly and resolve that technical issue.

We have already talked about NEI 02-02. That is clearly what we think is an important priority. And we have recommended in one of these letters that NRC rely on the proposed PIRT redeveloped by NRR.

We think a priority should be on supporting designs that are under global design certification review. That clearly shows an intent because of the significant costs associated with design certification, there's clearly an intent to get through and deploy that design. There are obviously some generic -- there is a research where it's appropriate to collaborate.

You know, I talked about things like AIMS and construction technologies. Those are probably not appropriate for NRC research, but there are certain technology hurdles or opportunities, for example, in the I&C area, where there needs to be some clear area, if not actual work, done by RES to prepare the staff for some of these advanced technologies as they come through the process. So that is clearly an area.

And then you're out into this murky area beyond design certification where designs are engaged in preapplication reviews and you really have to decide to what degree do I expend NRC resources in that area. Again, some market interest ought to be a measure there.

And the final point, which leads into my next slide, is the issue of research not getting out in front of the applicant's own design development research work because it is really the applicant who is primarily responsible for making a safety case. And it doesn't make a lot of sense for NRC to have research programs running out ahead of the design program.

MEMBER WALLIS: On the other hand, there is no research falling too much behind.

MR. VINE: Right. So there is a balance there. This last question about getting out in front of the designer became a major point of discussion on this expert panel that I talked about that was convened a couple of years ago.

I am on this slide trying to share what the results of that debate were. There were, interestingly enough, some members of that expert panel, both on the industry side and on the public interest group side, that felt that NRC had no business doing research on advanced reactors at all.

Some of the utility executive feelings in that direction kind of went like this, "I think the Office of Research ought to be working on problems with current plants," "I don't intend to buy a new plant," "The NRC research budget is paid for out of my user fees. Therefore, I don't think NRC should be doing research on something that I don't need." I mean, that is kind of the logic that some utility execs have expressed. And I am sure there are others in the industry who feel that way. So there is a sensitivity there that needs to be appreciated.

On the public interest side, I think, if I remember correctly, it was Paul Leventhal who articulated very strongly the point. And I think he was probably involved in the legislation in '74, where they modified the Atomic Energy Act and split NRC and ERDA. He argued that all research responsibility was left on the DOE side and NRC had no research responsibility.

So he dug out the references. And you can see the quotes here. The point if you really look at the words that really establish the Office of Research at NRC, it does give NRC a specific responsibility for verifying the safety case made by the designer.

I think the next to the last bullet says it most succinctly. It says basically that the concern is about licensee submittals and the potential that the Office of Research could get in a position of assuming any part of the burden of the applicant to prove the adequacy of the license application.

The sole burden for proving the adequacy of the design rests on the applicant. The NRC must verify that that case has been made properly, but if the NRC is paying for and conducting the research to make the safety case, they can't turn around, then, and be the judge of whether that case has been made properly.

MEMBER WALLIS: The NRC doesn't do design, but I think the NRC needs to have tools --

MR. VINE: Absolutely.

MEMBER WALLIS: -- which are as good as the industry. We shouldn't be playing catch-up all the time.

MR. VINE: I don't disagree at all. And I think you see that embedded in the quotes. I mean, we debated this and I think convinced those who felt that NRC had no role here and convinced them that the charter for the Office of Research does, in fact, give them that responsibility.

I think there are some phrases I would -- the bottom bullet I think helps enlighten that. And it's paraphrased. The actual wording kind of runs as follows. It says in keeping with the concept of confirmatory assessment, it is not intended that the condition build its own laboratories and facilities for R&D or try to duplicate the R&D responsibilities of ERDA.

So the point there is it gets to your earlier comment about collaboration between NRC and DOE. This clearly encourages that. It is just trying to prevent a situation where DOE has a test facility, NRC builds a separate test facility when they could be doing a lot of work together and saving a lot of resources.

MEMBER WALLIS: Well, let's see now. We had a lot of discussion this morning about uncertainties in models and codes. It may be that industry is not doing the intellectual work necessary to develop a proper framework for handling these uncertainties. It would seem that then the NRC has to take some responsibility to provide some intellectual leadership, not wait for industry to come up with something. This isn't unimportant.

MR. VINE: There is a fine line there. I am not quite sure how to answer, but I think it is probably fair to say -- let's take a new design for which there is not currently an adequate, let's say, thermal hydraulics or maybe a core neutronics code that models that new design, there is nothing available. I think the first responsibility to develop that code rests with the applicant. If he doesn't take the initiative to develop a code sufficient to make the safety case, I don't think it -- and he may be able to obtain assistance. And maybe DOE as a partner will help in that development. I don't think it should fall on NRC as their first responsibility to develop that before the applicant does.

You know, it is also very possible that particular design may never make it to the marketplace. So the NRC --

MEMBER WALLIS: Yes. But there are certain cases where NRC is responsible for safety. So there are some certain aspects of safety, such as uncertainty in the spaces and how you incorporate it into decision-making. That would seem to be their prerogative.

So they may in certain areas want to stay ahead of it because that is their bailiwick. I mean, how do you make decisions in the presence of uncertainty? That is their job to make decisions.

MR. VINE: Right. I agree with you they have to stay ahead in terms of knowledge. But, again, I will argue that if that particular design never makes it to the marketplace, NRC spent $10 million developing a computer code that is wasted resources until you have greater assurance that that design is going to make it --

MEMBER WALLIS: Knowing how to make use of the computer code to determine uncertainties and how to fold them into your decision-making process may well be something that NRC needs to do ahead of industry.

MR. VINE: And I think maybe implied in your comment is perhaps an area where there may be generic benefits to that effort that go beyond a particular design phase, going to get insights from one that apply to another.

You know, you're into some qualitative areas. And I think you are right. How you define that line is really a management decision that the staff and Commission and you all have to struggle with.

I am just trying to alert you to the discussion and what it resulted in in this sense that at least some of the utilities are pretty sensitive about prudent use of NRC resources because they look at it as money that they're contributing to part of the cost of the --

MEMBER WALLIS: The framework issue, the framework, the technology-neutral framework, is an interesting case. You would think that it ought to be in NRC's interest to develop a framework.

MR. VINE: Absolutely.

MEMBER WALLIS: But it seems as if NRC's developing the framework.

MR. HEYMER: No. We're making the proposals. And then the NRC is going to look at those and say, "We agree with this," "We don't agree with that." And they will be responsible for --

MEMBER WALLIS: It seems a bit strange, though, that you should be telling them how they should regulate the industry.

MR. HEYMER: No. We're just giving them an idea to improve the way it is regulated.

MEMBER RANSOM: Well, I think the original act was to prevent the situation where the NRC generated the data and the utility or the vendor would come in and say, "Well, we used your data. So you should approve it," which puts the NRC then in a position of criticizing their own or having to judge their own result.

CO-CHAIRMAN KRESS: I'm reminded of all of the severe accident research that NRC did during the past decade. That was to assure themselves of the safety of all the operating reactors.

They were all licensed. They had a license. They were operating. They had met adequate protection. Now, should they have done this research or not?

MR. VINE: I would say yes up to the point where you're satisfied that there is not a significant safety issue here that you don't know about. At the beginning of that --

CO-CHAIRMAN KRESS: I think the same comment applies to the future reactors. They have to be ready to assure there is no significant safety issue that they haven't overlooked.

MR. VINE: I agree with you, but you just said the future reactors. My point is we don't know what those future reactors are.

CO-CHAIRMAN KRESS: Well, you have an idea.

MR. VINE: Yes. And you can't just guess that these 15 reactor designs are going to be built and, therefore, we need to start a research program. I think the industry would probably object if there were a big research program here on molten salt reactors.

CO-CHAIRMAN KRESS: Oh, I agree with that.

MEMBER BONACA: I dare say for future

reactors, actually, the framework will specify some need for that work to be done by the industry. I think for the past reactors, they were licensed with no specific commitments to beyond design basis.

And that's why the NRC ended up trying to get whatever they could of information to ascertain that there wasn't a safety issue that would require to go after the core licensing basis and expand it. I expect that for future reactors, -- at least that is what we heard this morning -- a licensing basis will include design basis and beyond design basis to some degree.

MR. HEYMER: And that's why we had a set of what we called events which are design, what we call design basis events. And then there is another group that we called emergency preparedness basis events, which are those things which are what we to date now call design basis. And we didn't have that up front in the current plant.

So I think that is how you deal with those issues, is that you identify a series of beyond design basis or potential accident conditions that could occur and how the designs address those. I think that was done and, in fact, in SECY-90-16, the staff made some recommendations. And they were incorporated in the ALWR designs dealing with these beyond design basis activities. That's how it was done there. We see it being a little more structured.

Should that research have been done? I think it was a good idea to do it then because we just had it on a design basis. Would it be done now? I think that is already incorporated into the process.

MR. VINE: Let me try to reduce this down to a simple issue of communication. You know, the industry is acutely aware that the staff has limited resources. And we have and can foresee a lot of future needs in the area of advanced reactor development, research, licensing, and so forth. I think it is certainly in our interest to have maximum communications between the industry and staff to project as best we can what the needs are going to be, what the priorities are going to be, what the timing is going to be so that they can meet those needs. That is all we are saying.

Maybe we don't have a good process for doing that yet. Maybe the industry is not ready to engage in that kind of a discussion yet. But as we move forward and we get to a point where that kind of a discussion is appropriate, it would really help both industry and staff to make sure we are not wasting resources in an area that will never see a plant that uses that particular technology or that particular computer code.

MEMBER BONACA: But you don't disagree with the fact that the staff needs to have some independent ability to evaluate the case the licensee is making?

MR. VINE: Absolutely. Now, whether that has to be a separate computer code or not is a separate question. I think we are beginning to talk now about the possibility of having more joint codes between industry and NRC in areas where we have high confidence in the models for a new design for which there are high degrees of uncertainty. Maybe that is not possible.

But, again, you know, that is where ACRS is very important in helping advise on those kinds of issues, where you draw the line.

MEMBER LEITCH: You had a slide about 12 or so back about issues and gaps, gaps and issues.

MR. VINE: Right.

MEMBER LEITCH: You briefly mentioned public acceptance and nonproliferation. It seems to me that in the whole issue of safeguards and security, public acceptance is going to be one of the major hurdles that we have to get by construct a new reactor. I didn't hear much of that coming out in the presentation.

MR. VINE: Let's keep the nonproliferation issue separate from the security issue.

MEMBER LEITCH: Okay. Yes. They are really two things.

MR. VINE: I think the view of the public was based primarily on data that NEI provided to us that the public acceptance issue is very well in hand. It's something that has to be constantly worked on and improved on in terms of our communications. The most recent NEI data shows greater public acceptance today than we have ever seen. And that is after 9/11. Okay?

MEMBER LEITCH: As I talk to my friends and neighbors, I don't get that sentiment at all.

MR. VINE: That is what the data shows. The issue of nonproliferation is a legitimate and important issue as we look at international deployment, but it's not an issue for U.S. deployment. And then the whole question of how we move forward post-9/11 in advanced reactor development is an issue that the staff and industry have to talk about. But it's probably going to be done in the context of the kind of discussions that are going on right now on what the appropriate measures are for the current plans and, again, with the same falloff we have used here with enhanced safety not heading down the path and creating a double standard that says "This class of plants has to be able to do this, but this class of plants has to do something completely different."

Where is your constant philosophy of adequate protection if you've got different standards? We have got to work through all of those kinds of questions.

MEMBER LEITCH: I am sure your view of construction costs and so forth -- well, maybe I should ask the question, rather than say "I am sure." Does your view of construction costs have any estimate of costs of hardening some of these?

MR. VINE: The utility requirements document had as one of its 14 key policy requirements enhanced sabotage protection. That was focused primarily on plant layout and not on the major, major hardening activities.

Now, the designs are for various reasons, severe accident management reasons and others, more robust than our current plans. So we think that the safety is going to be even better than our current plans. But we haven't engaged in a detailed discussion with the staff on it.

Adrian, do you have anything?

MR. HEYMER: Yes. As Gary said, the utility requirements document and the three certifications did incorporate some additional features. But the whole issue of security barriers, measures to be taken, and how we deal with that is still playing out. I think that still has to be assessed and estimated, and it is an issue that needs to be looked at.

I think as regards the public confidence, when something happens of an event of the magnitude of sort of 14 months ago, there is uncertainty. And people get concerned.

But I think if you look at the results of recent exercises that have been done by independent organizations, it shows that the nuclear plants at the moment are very well-protected compared with some other industrial facilities that might present some hazard to the public. But that whole issue has got to play out. You make a good point.

MEMBER ROSEN: Gary, I would like to come back to your earlier comment about the staff and the industry having the same codes, working towards just having one code. Would that extend to PRA codes; in other words, if you believe that the staff and the industry could have one thermal hydraulics code, work on it together and jointly, jointly use the same code, rather than two separate codes to do the same thing?

MR. VINE: In theory. I need to kind of step back.

MEMBER ROSEN: Would that extend to the staff and the industry having one model for, say, South Texas rather than having the SPAR models to -- you know, the South Texas, very advanced South Texas model and the SPAR models that are probably at 30 percent of the South Texas model.

MR. HEYMER: There have been several discussions about that very issue. One point is perhaps the NRC needs some sort of independent look at it. But, on the other hand, if I am a licensee and I give NRC the complete PRA and say, "That is what I am using. These are the assumptions" and they may agree or disagree with the assumptions but reach some understanding between you both, "These are the assumptions. We are going forward," then you are working from a common document, I think it would help enormously in some of the discussions that are going on with the SDP determinations, where you seem to get into "Well, that is what the SPAR model says, but this is what my model says," et cetera. So I think that is a good observation.

MEMBER ROSEN: Well, I'm just using Gary's point.

MR. VINE: I need to clarify my point. This was just a beginning informal discussion about "Is this possible?" We have no plans. We have made no formal proposals. But I think in areas where we have reasonably high confidence, it is certainly something we ought to discuss.

MEMBER RANSOM: In the past, these issues, it seems to me, have been taken care by the fact that the NRC information is public domain. Then the utility or vendor wants to protect his information as being proprietary.

So, consequently, there have been cases where the vendor has taken, say, NRC products, worked on them to their own needs, and then made them their own proprietary property. But it seems to me if there is a completely collaborative type area, then it has to be shared by everybody.

Would that be acceptable, I guess?

MR. VINE: And that was one of the obstacles to our attempts two or three years ago to try to get on the industry side a willingness to get down to a single set of codes. Vendor proprietary issues were an obstacle.

Looking at the whole issue now, there are significant similarities between RELAP and RETRAN, similarities with severe accident codes. We are being very open with our codes. All the utilities have it. NRC is licensed to use it. We give royalty-free licenses to all the universities. Anyone who wants to use it can basically have it. So we're pretty open with our codes. That is an area we can discuss.

(Whereupon, the foregoing matter went off the record briefly.)

MEMBER BONACA: It would give me concern, however, if I knew that all it would depend on is one methodology, particularly for thermal hydraulic analysis, for example, and there is no diverse approach, analysis that at least helps me put into context where the uncertainties are and issues.

I've got to tell you I can tell you one fact. We went from one vendor to another vendor for fuel. And we got the local analysis results. Both of them are credible vendors. What we discovered in a way is that the peak flow temperature versus the charge condition for one vendor was going down with increasing break size and the other one was going up. That was the first pretty interesting trend. I mean, we were comparing things.

If you tracked flow to the core during the blow-down, one vendor was showing flow upward. The other was showing flow downward. Everything was different. And then, however, as you began to compare and to look, you realize there was something built in conservatisms that gave you some confidence that if you had the best estimate calculation, which you didn't always perform, you had a very large margin. Much of these differences were really tied to probably some artificiality in the model, whatever.

But the fact is that I don't have the confidence that any one of these computer codes gives you the true answer. So I think it is important that a regulator is able to in my judgment view independent of the dollars to do some verification. I think it is important that, particularly examining the dollars he has, have a different root, some different approaches and something of that kind. I think it is essential for the certification of this price.

MR. VINE: We have the same concerns. So does RES. We may look at this very closely and decide we can't do it. I think we will talk about it.

CO-CHAIRMAN FORD: I'd like to bring this --

MR. VINE: There are ways of going it that solve your issue and give us more efficiency in the way the management goes.

CO-CHAIRMAN FORD: I'd like to bring this topic to a close. Are there any last questions for Gary and Adrian?

I would like to finish up. We started off this meeting today essentially just to let the members be aware of the changes in the infrastructure report so that we could go into writing our report on that document for the full information base. Plus, we had all of these gentlemen in this afternoon to give us more background.

Could we just go around the members and see if there are any last minute questions either for these gentlemen or to John and his colleagues? Graham?

MEMBER WALLIS: I don't have more. I learned some things which I think will help me in revising drafts of the research report that I think were very helpful on thermal hydraulics and model uncertainties. I think I learned about this framework.

I think we have encouraged the staff to develop a technology-neutral framework and language to some extent. Maybe we have got more material for encouraging that. Those are the three things. We have made a lot of notes.

I have done quite a bit today. It's been too much. I will need to go back and review it.

CO-CHAIRMAN FORD: Vic?

MEMBER RANSOM: Well, the main thing that I guess I have been puzzled by is there didn't seem to be much relationship between what is really going on and what is written in the advanced reactor research infrastructure assessment, which presumably we are writing a document assessing this, --

CO-CHAIRMAN FORD: That's exactly what we are doing.

MEMBER RANSOM: -- which was the HTGR focus. So it's almost inverted from what has really happened. And I am a little concerned how we are going to deal with that, I guess.

In fact, I have learned that this came from Graham Leitch, which writes it up pretty much the way it actually is in terms of this inverted structure. And, yet, I don't see very much of that in the current draft.

CO-CHAIRMAN FORD: John, would you like to respond to that?

MR. FLACK: Well, of course, things have changed since this document had begun with Exelon, as we discussed earlier, being withdrawn from the preapplication.

Nevertheless, I think the issue is how much do we do on this, recognizing these other things are coming along, which we briefed you on today. So the question, I guess, is is there a balance between this one versus the other and how seriously do we need to move forward, for example, in understanding TRISO fuel and the graphite and all of these other things? I guess that is something the Committee has to come to grips with as well as ourselves and the Commission as we move forward, you know, to look at these advanced designs.

So I think it is all in front of us. It's just a matter of sorting it out and again placing priorities and understanding on what is happening in the world today and what we think is going to happen tomorrow. And it's not an easy thing to do.

MEMBER RANSOM: Well, I think my comment was more along the lines not necessarily attacking this report but what are we reviewing.

CO-CHAIRMAN FORD: We're reviewing that report in its entirety with all appendices, which include advanced light water reactor. We will discuss this tomorrow. In the current draft, we do do that in the current.

Graham's comments are exactly on line, which is I think the way the majority of us feel. And that's the way the report will be written, our report will be written. It is on the floor for structure assessment.

Mario?

MEMBER BONACA: I cannot comment on the second part of the meeting. I wasn't here at the afternoon meeting, but I felt that this morning's presentation was helpful. I think it provided some insights in the work. I thought Steve's presentation was very informative. It was limited to the thermal hydraulic issues, but I think it is important to step into the PRA and actually analyze these issues, although there are other issues that we need to cover.

I think still that I second what Vic said, that we got information today about three advanced light water reactors that will have to be part of our evaluation. So I don't know how we are going to form it or where we are going to put it here but would like to discuss it tomorrow.

MEMBER ROSEN: Just a quick one. Given the lateness of the hour, a discussion with Gary about what test do we apply to decide where we should advise the staff to apply their resources, we need some information about who is cost-sharing? His answer was you should help, especially the research areas where there is an applicant who is cost-sharing.

We don't know who is cost-sharing. So if we knew that, it would be useful to us writing the report.

CO-CHAIRMAN FORD: In the infrastructure report, -- John, you please correct me if I am wrong -- in most of the areas, primarily for the gas-cooled reactors, there is a fair amount of reference to where collaborative programs will be occurring. There are with the United Kingdom, with Japan, with Germany, whatever. And the details of those collaborative programs in terms of cost-share or whether it is equal information, value information share, that information is not given.

MEMBER ROSEN: I think you're getting to a bigger problem than I am trying to solve. I think what I was wanting to know is which domestic licensees are cost-sharing.

CO-CHAIRMAN FORD: Oh, I apologize. I didn't understand.

MEMBER ROSEN: And if there is a list of that that somebody could provide us and maybe a little detail of how much cost-sharing there is if that is the test to apply? We are not prepared to apply it because we don't have that.

MR. VINE: I'm not sure that that information is available, but we could find out for you.

MEMBER SIEBER: Individual licensees. I don't know that you will have it available. They don't advertise that.

MR. HEYMER: Yes. There are some licensees who may be cost-sharing who may not want to go public with that information, which that is the problem Gary is relating to.

MR. VINE: I think if your question is which designs are obtaining either from licensees or from other sources, if the issue is a question of which designs enjoy market interests, you don't have to identify the individual licensees by name. You can just total up and say, you know, there is --

CO-CHAIRMAN FORD: Five, ten.

MR. VINE: -- roughly this kind of money

supporting AP1000, roughly this kind of money supporting this design.

MEMBER ROSEN: If I could get some sort of information like that that I knew was valid, I would be satisfied.

CO-CHAIRMAN FORD: Can you do that with Vic?

MR. VINE: It's a challenge. We can work together and see if that kind of information is available.

CO-CHAIRMAN FORD: I appreciate that.

MR. CORLETTI: If I just may add, I think if you really, though, look at the list of which plants are getting interest, part of that is due to the maturity where they are and how much closer they are to market.

I think when you are considering where you need research activities, that is not always the only element of who is getting market interest. You have to look at what are the safety issues associated with each one. What is the basis for your understanding of each plant design as well.

CO-CHAIRMAN KRESS: I'm glad he said that because that was going to be my comment.

The other comment I have -- I wasn't here most of this afternoon either, but I think we have to recognize that the document we are reviewing started some time ago. And the fact that conditions have changed changes our viewpoint should not be a criticism of the document. We should just recognize that. I think the staff recognizes it.

And we shouldn't be a slavish reviewer of the document as it is. We should recognize it. The staff knows these changes change. And our recommendations, research, and priorities ought to recognize the current situation, not just be a critique of the document.

MEMBER ROSEN: Just trying to use the test that EPRI suggested.

CO-CHAIRMAN KRESS: I think that is just one input. I'm in agreement with Mike. We should have other criteria. What we ought to do research.

MEMBER ROSEN: And what our criteria are should be clear to all of us. We should debate that.

CO-CHAIRMAN KRESS: We should have some criteria, yes.

MEMBER ROSEN: We should discuss that. Maybe we can this Saturday.

CO-CHAIRMAN KRESS: In our criteria, we should decide whether or not we agree with those criteria.

CO-CHAIRMAN FORD: Graham?

MEMBER LEITCH: We already reviewed revision one of this document and sent a letter on it. And there were those ten comments that I guess it was you, John, who had listed them there. And revision two is not --

MEMBER SIEBER: It's not different.

MEMBER LEITCH: -- is not radically different except that now we have two addenda -- really, three addenda. I mean, the original document becomes one. And there's ESBWR, and there's ACR-700 and then the last single page, which is just the schedule of 2003 activities. So the document has to a certain extent been updated, and we have to do that.

I think the purpose for going around the room now for comments is not really to work on the research report. That will be a future effort here in a couple of days. So I have a number of comments about that, but I will defer those until that time.

I would like to say, however, that I think the NEI document, 02-02, is really a good start. I think NEI should be complimented for taking this initiative and getting this document into this form because it was hard for me to conceptualize exactly what this framework would look like.

I think this is a good effort at getting started, not to say that, I mean, I am sure there has got to be a -- what I am saying is viewed in the sense of being, if you will, a strawman or something that we can begin discussing. I think it is an excellent starting point.

The last time we talked about this, we were talking about vague generalities, and it was hard to really know exactly where were headed in that. I think now we have got at least something to begin discussing and begin taking exception to. I didn't want to put it quite that way, but perhaps that's the case. So I really think it is a good piece of work.

That's about all I have to say, Peter.

CO-CHAIRMAN FORD: Jack?

MEMBER SIEBER: I guess when I was doing the review work and preparing the write-up for my assigned section of our response to the research report, I was wondering what it is that research is trying to accomplish.

I came to a couple of conclusions. Of course, my area is limited. It's not specific to any reactor type. So it makes it a little different than all of these others because, really, if I look at the

29 tasks in my area, most of them seem to be for the staff to maintain its knowledge base and improve it to the point where they can deal with these advanced concepts. I think that is a worthy goal myself.

I think that if the staff has to stay up-to-date has to stay familiar with the evolving technology, not necessarily do the work, not necessarily do the research, but be able to be knowledgeable or not with what is going on in the industry to be able to make judgments as to whether licensee submittals are acceptable or not.

My perception of what I read in my area leads me to that conclusion. And I think that is important. The area I reviewed was instrument and control. And there was a lot about the hardware which engineers always love, but they forgot the most important element -- didn't forget it but didn't play it up enough, which is the human being who is supposed to interpret all of this stuff that they see in the control room so when it comes time to write the final report, they will be able to comment.

My perception is I think that research is pretty much on the right track. On the other hand, when the time comes to say -- some licensee comes in and says, "I am ready to give a letter of intent," I think the research is going to be tremendously busy getting ready to review that application.

And I think it is extremely important that the industry, vendors, and the staff work together so that they can readily resolve emerging safety issues and ask the right questions. I think that my sense is that we are sort of headed in that direction.

I do think it's a mistake to pick out of six concepts or eight concepts that out there one advanced reactor type and say, "I think this is going to be the one" and then spend a lot of resources and somebody else buys something different. I think that is a mistake. I think you have to be patient and wait and build your expertise and resources in the process. So I guess that would be my comment.

CO-CHAIRMAN FORD: Bill?

MEMBER SHACK: I don't think I have anything to add after everybody's. The last man is worn out.

CO-CHAIRMAN KRESS: Next time we'll start on this side.

CO-CHAIRMAN FORD: Joe? Where is Joe?

MR. MUSCARA: Just a brief comment. Joe Muscara again. The discussion going along the lines that when we started out this plan, we were, of course, concerned with the PBMR. Now things have moved. Now we are interested in advanced light water reactors.

I would like to say that with respect to the materials work, we are still on the right track. I think with advanced light water reactors, we are looking generally at the same materials, same environments. There is not a great deal of need for additional data. On the other hand, for the gas-cooled reactors, these are the areas where we need long lead times to get our work done.

So I think the emphasis for the materials work still is get that work doing for the gas-cooled reactor so that when they come back three or four years down the road, I think we have been lucky. We had this breather where we can develop the information we need so we can ask the right questions when it comes back on the table.

CO-CHAIRMAN KRESS: I think with the respect to the question of wasting money on concepts that never come to light, I think you just have to accept that that is going to happen.

You can't be completely prescient and know what is going on. You just have to anticipate. And if you have good enough reason to expect something is coming in the near future and there are long lead times, I think you just have to go ahead and do it.

MEMBER BONACA: I have just one question I want to ask, if I could, because I wasn't here and I am very intrigued. You talk about the framework and this overhead that you presented regarding strong PRA emphasis to us in these categories.

All we are doing, option two, now, I agree with the approach that it has to be very much risk-informed. But if it is technology-neutral, it means that it would be applicable to light water reactors, advanced light water reactors, as well as advanced any plant out there that was presented this morning.

Do we know enough about those plants to really develop an adequate PRA as well as sufficient database to support the risk-informed approach? I mean, I am trying to -- I am sure you had this question before from somebody and I wasn't here to hear the answer.

MR. HEYMER: We acknowledged that we have done a lot of work in light water reactor PRAs. And there is a standard out there for the internal events. There is some work going on on external events.

It is also recognized that a PRA for the

HT-MHR may be a little bit different than a light water reactor PRA. And, therefore, perhaps there needs to be an appendix or a guideline on a gas reactor PRA, one of the things you should look at. So there is that issue.

There was also the issue that we discussed and acknowledged that important measures and the risk metrics and the performance measures for a gas reactor or the ACR700 may be different. We need to look at those and reach a determination what are those for those different types of reactors.

And you are quite right. You can't actually do something like an option two type categorization unless you have got a new understanding of those. And we acknowledged that work needs to be done in that area, but we think it's work that needs to be done based on the fact that we know that there is an application coming in.

We know that there is an interest in this area. Okay. That's something that we can have confidence that we can work on. We're going to get there. So I don't know in a short period of time if that answers your question.

MEMBER BONACA: No, I understand as long as there is the recognition that you can go to PRA as much as you can. It depends so much on experience at the basis.

MR. HEYMER: And we also had a discussion about defense-in-depth and the application of deterministic measures where there is uncertainty and the consequences are significant. And we went through that process.

CO-CHAIRMAN FORD: I would like to thank all of the speakers. John, thank you and your team. And thank you, gentlemen. We are adjoined.

(Whereupon, at 5:52 p.m., the foregoing matter was adjourned.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Reactor Safeguards Safety Research Programs and Future Plant Designs - Joint Subcommittee Meeting

Docket Number: N/A

Location: Rockville, Maryland

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

/s/ Rebecca Davis

Rebecca Davis
Official Reporter
Neal R. Gross & Co., Inc.

AGENDA FOR THE NOVEMBER 6, 2002 JOINT MEETING OF THE ACRS SAFETY RESEARCH PROGRAM/FUTURE PLANT DESIGNS SUBCOMMITTEES

Lead members/staff: Peter Ford/ Thomas Kress/Richard Savio

Key Documents RES Advanced Reactor Research Plan—predecisional copy available to ACRS on 10/7/02
DOE GEN IV roadmap document—available on 9/22/02
NEI proposed regulatory framework document— Issued

Purpose: To gather needed information for the 2003 ACRS report to the Commission on NRC sponsored research, provide a opportunity for stakeholder comment, and to discuss the initial draft of the 2003 ACRS research report.

Meeting location: NRC headquarters at Two White Flint North, 11545 Rockville Pike, Rockville, MD, 20852-2738. Room TWFN 2-B3

INTRODUCTION--- Peter Ford/Thomas Kress-----------15 minutes **8:30am to 8:45am**
Scope and purpose of the Subcommittee meeting,
Invitation for participation of attendees in Subcommittee discussions
Status of the Subcommittee's work
ACRS schedule for completion of this report.

NRR PRESENTATIONS---- James Lyons et al---------1 hour **8:45am to 9:45am**
Schedule for expected new applications and current milestones
Expected NRR user needs for evolutionary and advanced reactors.

BREAK—15 minutes

RES PRESENTATIONS----- John Flack, et al-----------2 hours **10:00am to 12:00am**
Discussion of RES's Advanced Reactor Research Plan and response to ACRS coments
NRC work on a generic regulatory framework

LUNCH-----1 hour (approximately 12:00am to 1:00pm)

DOE PRESENTATIONS--------Rob Versluis--------- 1 hour **1:00pm to 2:00pm**
Expected deployment schedule for GEN IV reactors
Research needs for US near-term deployment options

DISCUSSION AND COMMENTS FROM THE AUDIENCE-- 30 minutes **2:00pm to 2:30pm**

BREAK--- 15 minutes

NEI PRESENTATIONS------Adrian Heymer, et al------1 1/2 hours **2:45pm to 4:15pm**
NEI proposed new regulatory framework
Anticipated new applications and current schedules
NEI views on expected research needs and NRC's role in sponsoring research

EPRI PRESENTATIONS----1 hour **4:15pm to 5:15pm**

Overview of EPRI programs and completed work

EPRI views as to issues that will have to be addressed in research programs and associated schedules

ACRS SUBCOMMITTEE DISCUSSION OF DRAFT NRC-SPONSORED RESEARCH REPORT------ **5:15pm to 6:30pm**

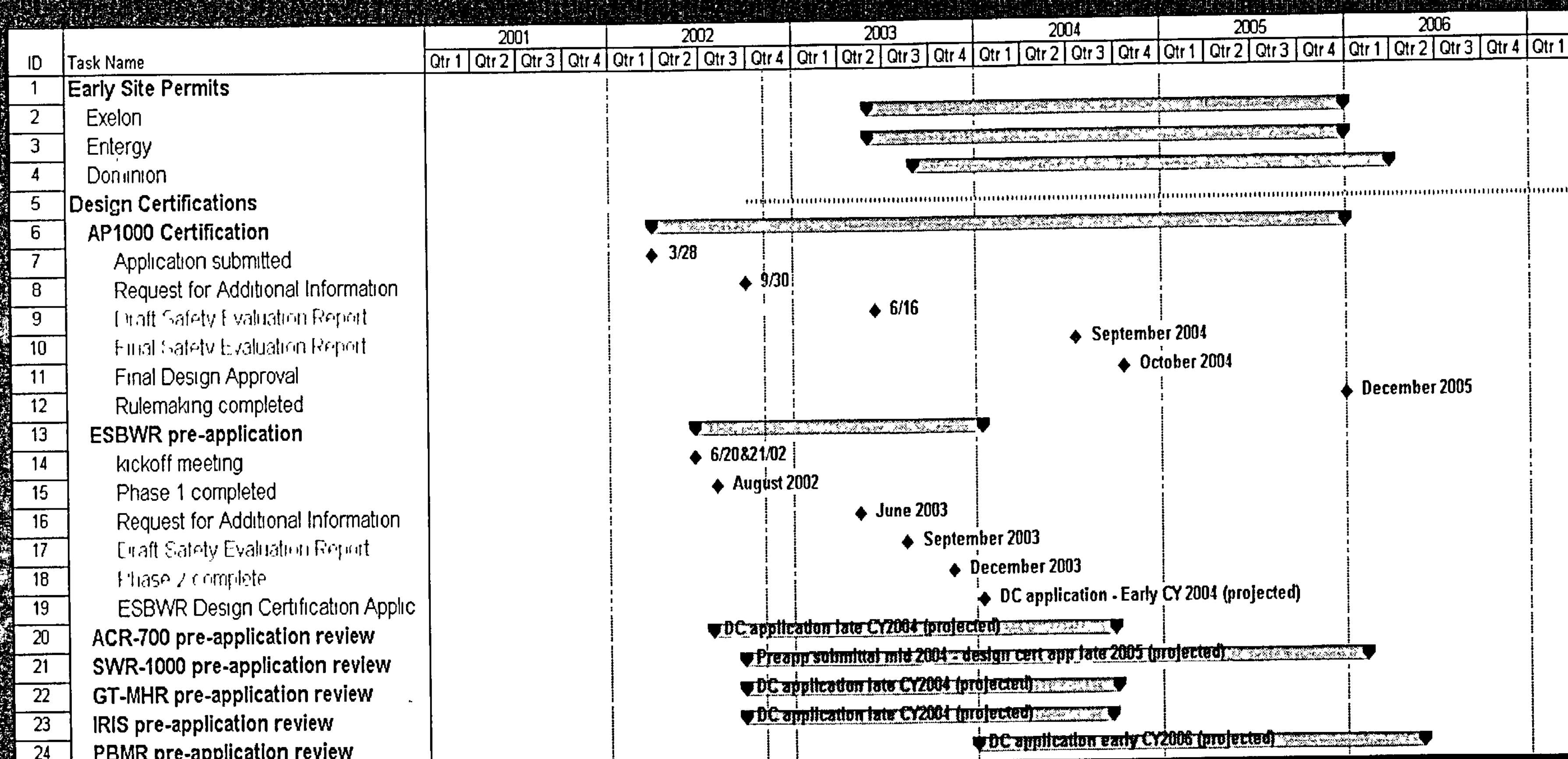
Additional discussion of the ACRS report is currently scheduled on Saturday, November 9, during the ACRS's November meeting

ACRS/ACNW contact: Dr. Richard Savio—301-415-7362/rps1@nrc.gov

Presentation to the ACRS regarding New Reactor Licensing Projects

James E. Lyons, Director
New Reactor Licensing Project Office
November 6, 2002

New Reactor Licensing Schedule



NRR User Need Requests For ESBWR And AP1000 Applications

S. Lu, W. Jensen, A. Drozd
NRR/DSSA/SRXB, SPSB

ACRS Meeting
November 6, 2002

NRR Advanced Reactor User Need Requests

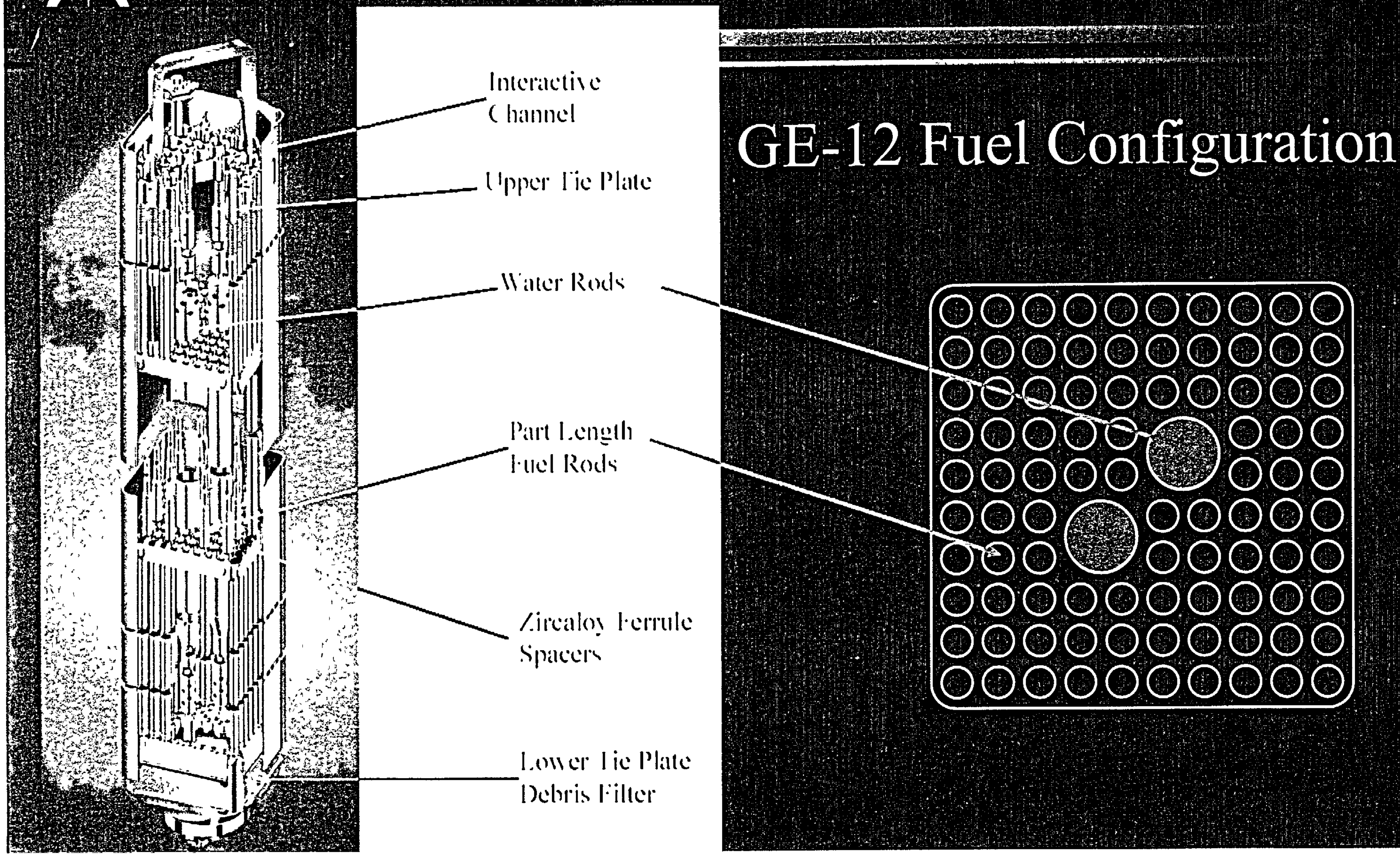
ESBWR

1. Development Of Advanced BWR Fuel Channel Models In TRAC-M Code.
   Issued on 07/03/02.
2. Improvement Of TRAC-M Code For ESBWR Pre-application Review.
   (Under Discussion With RES)

AP1000

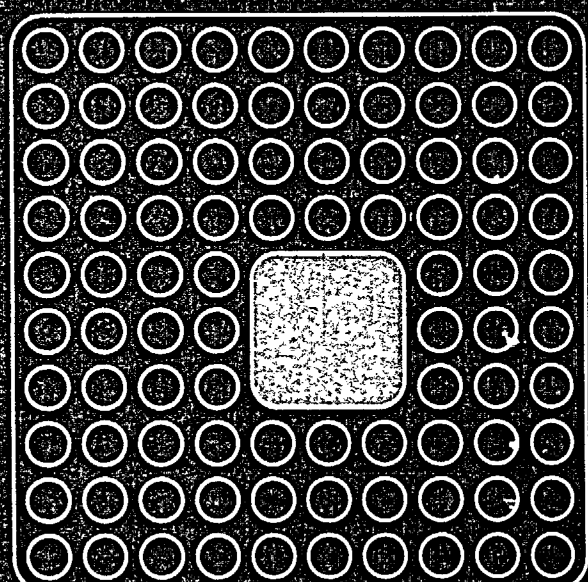
1. Technical Support In AP1000 Phase 3 Review.
   Issued on 04/25/02.
2. Severe Accident Review For AP1000 Design Certification Review.
   Issued on 05/20/02.

User Need #1: Advanced BWR Fuel Model

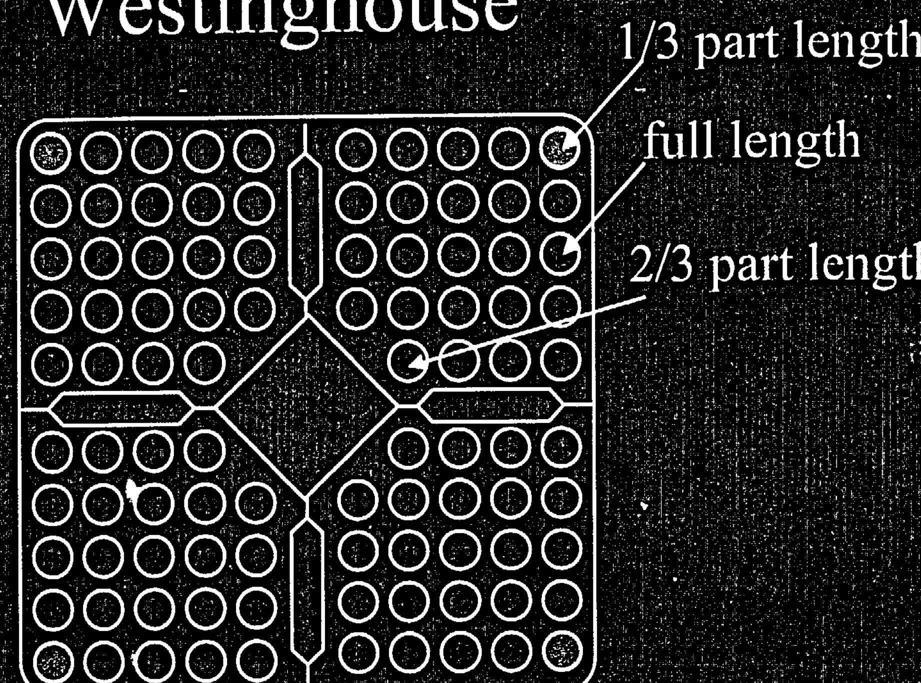


User Need #1: Advanced BWR Fuel Model

ATRIUM-10
Framatome



SVEA-96 (ABB)
Westinghouse



User Need #1: Advanced BWR Fuel Model

Features of advanced BWR fuel:

- Lower linear heat generation rate;
- Lower pressure drop;
- Higher fuel economy;
- More margins for PCT and MCPR.

Requested Assistance:

A TRAC-M model to analyze up to 12x12 bundle with part length rods and water rods.

Status: On going. First set of deliverables received by NRC on schedule (10/30/2002).

Draft User Need #2: TRAC-M Improvements For ESBWR

Unique ESBWR Safety Features:

- Closely Coupled Containment/Vessel Interactions For ECCS Operations;
- Gravity Driven ECCS Injections, etc.

NRR Confirmatory Analyses:

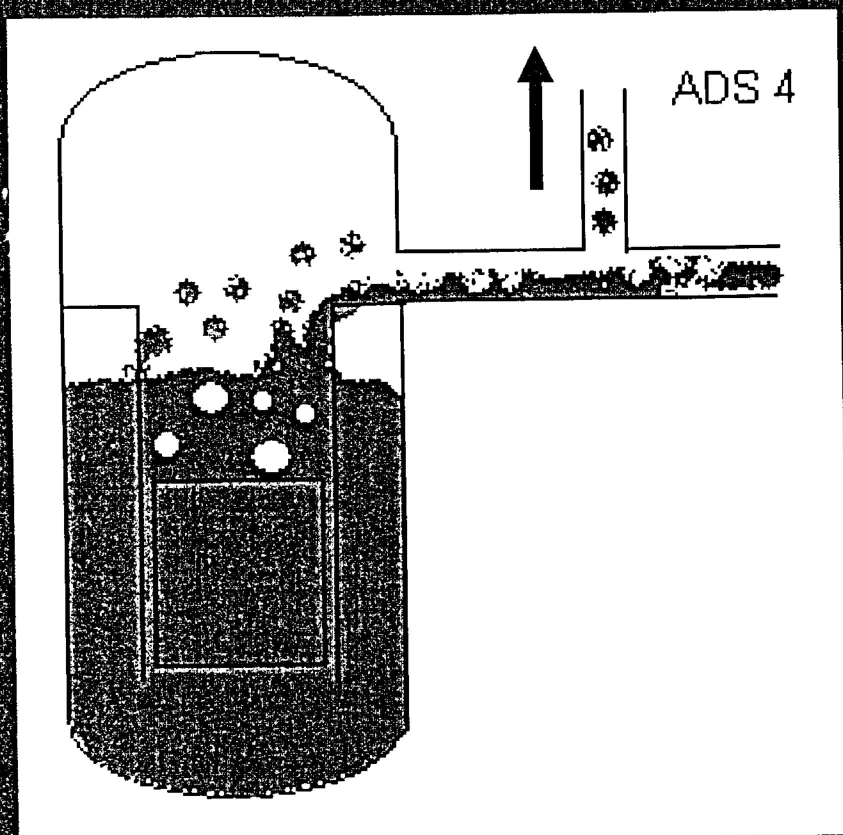
- TRAC-M code is being considered as the major evaluation tool to assist the pre-application reviews;

Other issues under consideration.

User Need #3: Technical Support In AP1000 Phase 3 Review.

- A previous user need request regarding AP1000 Phase 2 review was successfully executed.
- This user need requests RES assistance in the following areas:
  1. Review revisions of WCOBRA/TRAC to calculate liquid entrainment in the hot legs/ADS4.
  2. Review the experimental basis for the liquid entrainment correlations.

User Need #3: Technical Support In AP1000 Phase 3 Review.



Safety Concerns:

- Vessel Coolant Inventory.
- Depressurization Rate.

Status: On schedule.

User Need #4: AP1000 Severe Accident Review.

NRR SPSB requests support from RES in the following area:

1. Performing MELCOR analyses of selected risk-dominant accident sequences;
2. Evaluate the applicability of the conclusions from the AP-600 In-vessel Retention and Fuel-Coolant Interaction review.

Scheduled Tasks and Status

Provide recommended RAIs	Completed on 9/20/02
Prepare MELCOR input deck	Completed on 10/02
Review AP-600 in-vessel FCI	Completed on 10/02

Other requested tasks are on schedule.

ACRS Joint Subcommittee on Safety Research Program and Future Plant Designs

November 6, 2002

Advanced Reactor Research Plan, Infrastructure Assessment

John H. Flack
Steven M. Bajorek
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission

Overview

- Background
- Response to ACRS Comments
- Overview of SECY on Research Infrastructure Assessment
- ESBWR and ACR-700 Additions
- FY03 Advanced Reactor Research
- Summary

Key Meetings

Workshops:

- ACRS Workshop on Advanced Reactors, June 4, 2001
- NRR Workshop on Future Licensing Activities, July 25, 2001
- RES Workshop on HTGR Safety and Research Issues, October 10-12, 2001

Interactions with the ACRS:

- 491st Full Committee, April 11, 2002
- Subcommittee on Future Plant Designs, July 8, 2002
- 494th Full Committee, July 11, 2002
  - Letter to EDO, July 18, 2002
  - Response, August 29, 2002
- ACNW 136th Meeting, July 24, 2002
- Joint Subcommittee on Safety Research Program/Advanced Reactors November 6, 2002

Response to ACRS Comments
(Letter dated 07/18/02)

Response noted that:

- Priorities had shifted based on Exelon's decision to withdraw from Pebble Bed Modular Reactor (PBMR) pre-application review.

- Scope had been expanded to include additional advanced light water reactors.

- Generally agreed with ACRS comments:

  1. Focus HTGR research at the generic level.

  2. Fission product release models for TRISO key research area.

  3. Framework for licensing reactors is high priority.

  4. Important to consider fission product release for high burnup fuel.

Response to ACRS Comments (continued)

5. Selection of design-basis events to be risk-informed.

6. Use of Phenomena Identification Ranking Table (PIRT) and Planning, Budgeting and Performance Management (PBPM) process to prioritize research.

7. Research to study the relationship between coolant activity and latent fuel particle failures.

8. RES will remain cognizant of Near Term Deployment and Generation IV activities.

9. Research activities will assess the full range of ex-vessel severe accident phenomena for each reactor design.

10. The "license by test" concept, and need for large-scale testing discussed.

Framework

- Plan for "framework" is currently under development.
- Activity will build on the concept used to risk-inform Part 50 framework, i.e., utilize a top-down approach that begins with a goal supported by cornerstones, strategies, and tactics.
- Undertaking will capitalize on experience gained from risk-informing current LWRs.
- Resolution of policy and technical issues will need to be integrated.
- Will use input from NEI-02-02 and other stakeholders as appropriate

Commission Paper on Advanced Reactor Research Plan: Infrastructure Assessment

- Responds to Future Licensing and Inspection Readiness Assessment (FLIRA) Commitment.
- Identification of technology gaps (infrastructure needs) in terms of expertise, analytical methods, tools, data.
- Identified research is not NRC specific, i.e., applicants are expected to play a key role.
- Domestic and international cooperative research agreements are an important element.
- Stakeholders' input critical to process.

Commission Paper

(Continued)

- Most infrastructure needs relate to non-LWRs:

  - new passive designs with little operating experience,
  - new materials and fuels in different operating conditions,
  - different severe accident behavior,
  - applicant shift towards automation, digital I&C,
  - larger number of reactor cores or modules,
  - more reliance on PRA insights.

- Scope expanded to include ESBWR, ACR-700, SWR-1000.

- Generation IV early stage of development.

- Framework research to be initiated in FY03.

Commission Paper
(Continued)

Research areas identified:

- **Reactor Safety**:

  1. Accident Analysis
  2. Reactor Systems Analysis
  3. Fuel Analysis
  4. Materials Analysis
  5. Structural Analysis
  6. Consequence Analysis

- **Nuclear Materials**

- **Nuclear Waste Safety**

RESEARCH ISSUES RELEVANT TO THE ESBWR AND ACR-700 ADVANCED LIGHT WATER REACTORS

Stephen M. Bajorek
Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research

Meeting of the Advisory Committee on Reactor Safeguards Subcommittees on Safety Research Program and Future Plant Designs

November 6, 2002

INTRODUCTION

- There has been a re-emergence in design certification activity for advanced water reactors in over the past several months
- Several designs now under various stages of review

Design	Applicant	Type
AP1000	Westinghouse	Passive PWR
ESBWR	GE	Passive BWR
SWR 1000	Framatome ANP	Passive BWR
ACR-700	AECL	LW Cooled / HW Moderated
IRIS	Westinghouse	Passive PWR

Objectives / Outline

- Summarize features of ESBWR and ACR-700 that are likely to require additional code and/or model development
- Identify the Division's initial thoughts on those nuclear, thermal-hydraulic, and severe accident physical processes of most importance to ESBWR and ACR-700

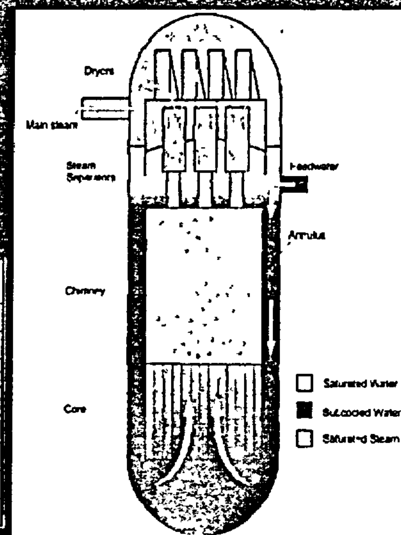
Why Are There Research Related Issues ?

- Passive safety features result in transients dominated by natural circulation and flows driven by small driving heads
- Some "traditional" accident scenarios eliminated by design
- New plant components and design concepts
- State-of-the-art in boiling, condensation and two-phase flow

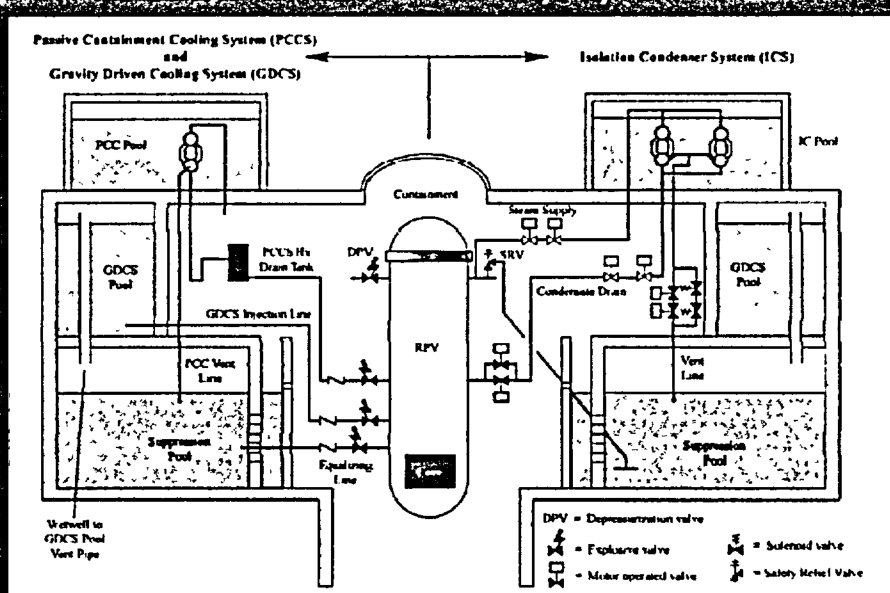
ESBWR Design Summary

- 4000 MWt / 1390 MWe BWR
- No recirculation pumps — total reliance on natural circulation
- Passive safety systems for decay heat removal

Parameter	BWR/6 Clinton	ABWR	SBWR	ESBWR
Power (MWt)	2894	3926	2000	4000
Power (MWe)	950	1350	670	1380
Vessel height (m)	21.9	21.1	24.6	27.7
Vessel diameter (m)	5.5	7.1	6.0	7.1
Fuel Bundles (number)	624	872	732	1020
Active Fuel Height (m)	3.7	3.7	2.7	3.0
Power density (kw/l)	52.4	51	42	54
Number of CRDs	145	205	177	121

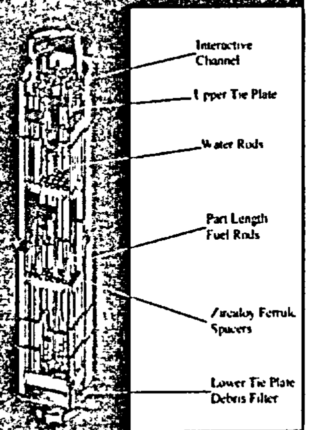


ESBWR Passive Safety Systems



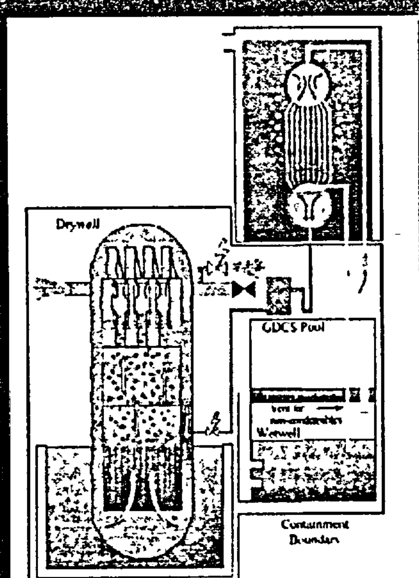
ESBWR: Fuel & Neutronics Issues

- ESBWR fuel will be similar to GE-12 fuel bundle design, which includes water rods and part length rods. Active core is 3.05 m (compared to typical 3.66 m)
- Power stability during startup is likely to receive attention during review. Differences affecting stability map are shorter, wider core and start-up operation without recirculation pumps



Preliminary Assessment: Existing computational tools and data probably sufficient for fuel/neutronic evaluations.

ESBWR: Passive Containment Cooling (PCC)



- Initial blowdown energy release transferred to containment heat sink (suppression pool) and PCC heat exchangers
- Long term decay heat removal is accomplished through PCC heat exchangers. Flows are driven by drywell to wetwell ΔP
- Condensate drains to holding tank before returning to vessel; non-condensable gas purged to lower wetwell

ESBWR Thermal-Hydraulic Modeling Issues

- Distribution and effect of non-condensable gas on passive component performance and natural circulation are important processes.
- Passive Containment Cooling (PCC) heat exchangers must condense steam in presence of non-condensable gas. Tests have shown periodic venting of non-condensable gas to wetwell.
- Close coupling between primary and containment. Containment pressure determined by non-condensables in wetwell airspace & vapor pressure.
- Suppression pool condensation, heat transfer & stratification.

Preliminary Assessment: Improvements to TRAC-M models for condensation w/non-condensables probably necessary. Code assessment for integral tests involving natural circulation and for tracking distribution of non-condensables also necessary.

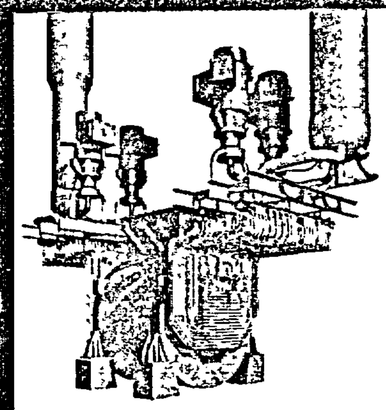
ESBWR Severe Accident Issues

- ESBWR severe accident strategy assumes drywell flooding. Improved ex-vessel cooling may prevent lower head failure.
- Other severe accident issues expected to be similar to those in conventional BWRs.

Preliminary Assessment: Existing computational tools (MELCOR) expected to be sufficient. No significant modeling or experimental needs identified.

ACR-700: Advanced CANDU Reactor

- 1982 MWt / 731 MWe
- Light-water coolant (in fuel bundles)
- Heavy-water moderator (in calandria)
- Slightly enriched uranium fuel (2%)
- Negative void reactivity coefficient
- Modular horizontal fuel channels
- On-power refueling
- Conventional steam generators (2) and heat transport pumps (4) above core

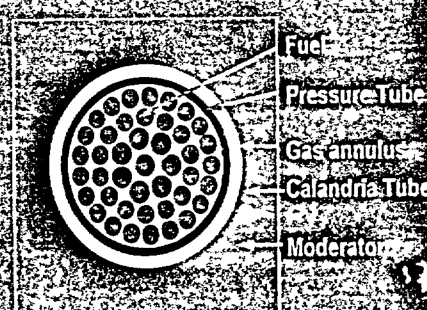


Emergency Core Cooling System

- **Accumulators for high pressure injection**
- **Low pressure pump injection for long term decay heat removal**

ACR-700 Fuel & Neutronics Issues

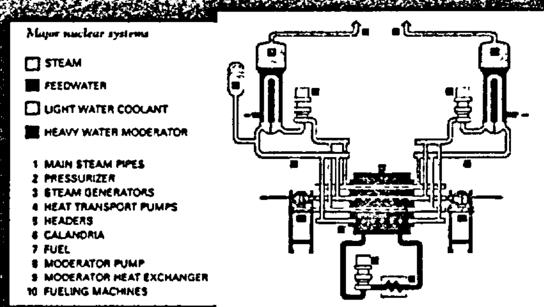
- A thermal-hydraulic coupled kinetics code (TRAC-M/PARCS) needed for ACR-700 transient analysis
- Modeling is complicated by the CANFLEX design, two enrichments, 4% dysprosium in central elements, reactivity feedback of LW coolant and HW moderator
- Validation needed for reactivity feedback from LW coolant / HW moderator
- Nuclear data libraries need updated
- Potential data need for fuel rod burst and pellet-clad interaction



Preliminary Assessment: Difficult geometry but kinetics infrastructure probably sufficient. Possible need for fuel data

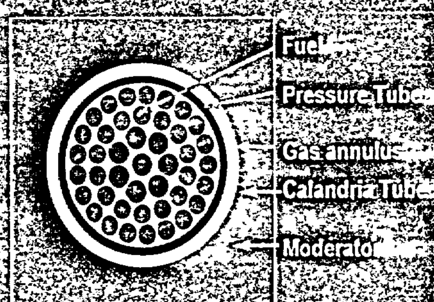
ACR-700 Thermal-Hydraulic Modeling Issues

- Existing staff thermal-hydraulic codes (TRAC-M and RELAP) designed for vertical rod bundles. Need to model/assess codes for horizontal flow patterns and pattern transitions in fuel bundle.
- Lateral quench and rewet processes, formation of dry patches within pressure tube. CHF and post-dryout behavior in fuel.
- Two-phase flow distribution from inlet/outlet headers to pressure tubes.



ACR-700 Thermal-Hydraulic Modeling Issues

- Heat transfer between pressure tube and calandria tube. Pressure tube "sagging" may occur during some accident scenarios, resulting in contact between pressure tube and calandria tube.



Preliminary Assessment: Several thermal-hydraulic processes expected in ACR-700 transients that will require model development & assessment, and may require experimental work.

ACR-700 Severe Accident Issues

- Staff severe accident code (MELCOR) designed for vertical cores. Modifications and new models will be necessary to simulate accident progression in ACR-700 core
- Code modifications necessary for
  - Pressure tube / calandria tube failure
  - Fuel failure propagation
  - Debris / melt progression
  - Calandria and shield tank failure

ACR-700 Severe Accident Issues

- Potential need for additional data for
  - Melt relocation stages in horizontal core geometry
  - Heat transfer to moderator from sagging fuel and pressure tube

Preliminary Assessment: Severe accident modeling for ACR-700 may require a significant effort. Modification of MELCOR may be necessary, and several physical processes may not have a suitable experimental database

Relevant Research Activities

- Office of Research (RES) experimental and code development plans will evolve as proposed systems reach Design Certification stage
  - ESBWR Advance Research Plan (draft)
  - ACR-700 Advanced Research Plan (draft)
  - SWR-1000 Advanced Research Plan (not started)
  - IRIS Advanced Research Plan (not started)
- Current relevant projects include:

TRAC-M / CONTAIN Coupling
TRAC-M BWR Specific Developmental Assessment
Review of INEEL Recommendations for CANDU

Summary

- There has been re-newed activity and interest in advanced light water reactors in 2002
- For new applications (ESBWR, SWR-1000, ACR-700, IRIS) focus is on identification of issues (fuel & neutronics, thermal-hydraulics, severe accident) and physical processes of importance that may require infrastructure development

Planned Activities for FY03

FY03 research activities center on:

(1) expanding current capabilities,
(2) establishing cooperative agreements,
(3) performing scoping studies.

Areas include:

- Framework
- Accident Analysis (PRA, Human Factors)
- Systems Analysis (T/H Analysis, Nuclear Analysis, Severe Accident Analysis)
- Fuels Analysis
- Materials Analysis
- Structural Analysis

Conclusion and Status

- Infrastructure gaps are primarily associated with non-LWR designs, although some ALWR infrastructure needs were identified.
- Premature to include Gen IV at this time
- FY03 activities primarily focus on establishing cooperative agreements, and expanding current codes and modeling capability
- Infrastructure assessment due to the Commission in November 2002
- Policy issue paper due to the Commission in December 2002

DOE Outlook on Future Plant Deployment

Joint Meeting of the ACRS Safety Research Program/Future Plant Designs Subcommittee

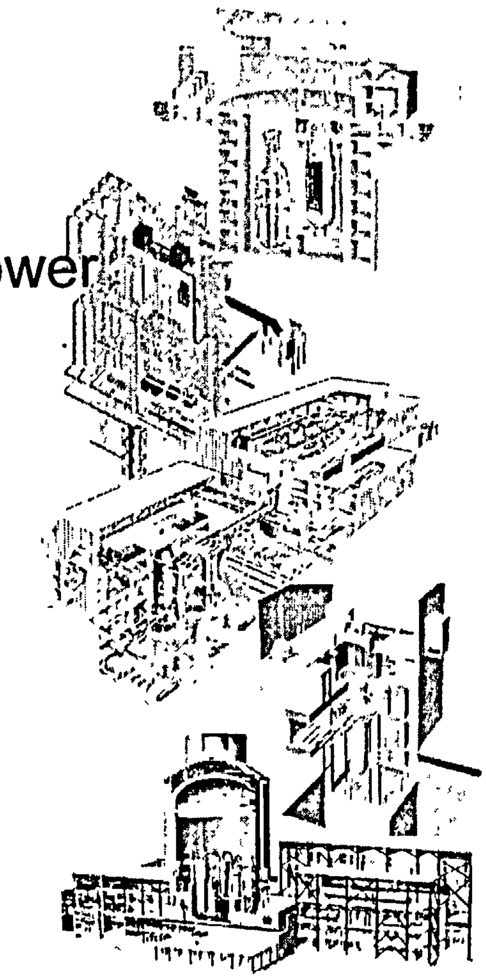
Dr. Rob M. Versluis
Office of Advanced Nuclear Research
Office of Nuclear Energy, Science and Technology
U.S. Department of Energy
November 6, 2002

Overview

- Near-Term Deployment of Nuclear Reactors in the U.S.
- Gas-Reactor Fuel Development and Qualification
- Generation IV R&D Nuclear Energy Systems

Near-Term Deployment - Nuclear Power 2010

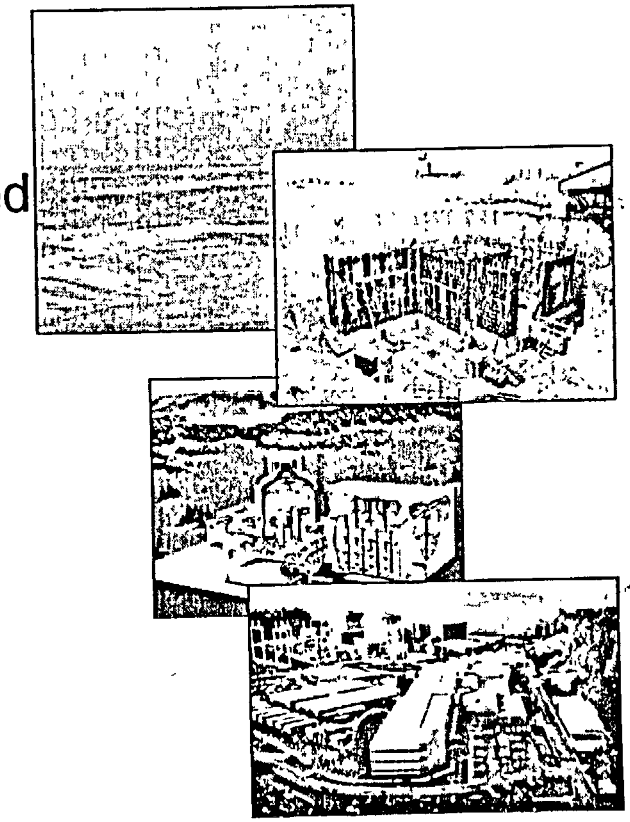
- New initiative unveiled February 2002
- Based on Near-Term Deployment Roadmap
- Public/private partnership to:
  - Explore sites that could host new nuclear power plants
  - Demonstrate new regulatory processes
  - Develop advanced reactor technologies



- ***Goal - Achieve industry decision by 2005 to deploy at least one new advanced nuclear power plant by 2010***

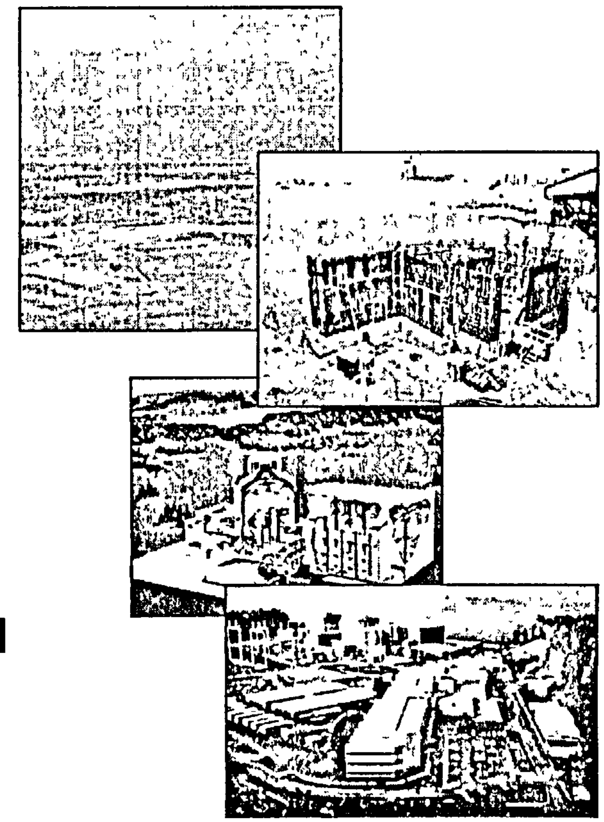
Nuclear Power 2010 - Activities

- **Regulatory Demonstration Projects:**
  - Early Site Permit (ESP) - 3 projects awarded
    - Applications to NRC in FY 2003
  - Combined Construction and Operating License (COL)
    - Earliest initiation in FY 2004
    - Earliest application to NRC FY 2005



Nuclear Power 2010 - Activities

- Reactor Technology Development Projects
  - **Advanced Reactor Design Certification (DC)**
    - Solicitation planned in November 2002
    - Up to 2 awards
  - **First-of-a-kind engineering for a standardized plant**
    - Schedule driven by COL activities
  - **Assessment of Construction Technologies and Schedules**
  - **Systems, Materials and Component Testing**
    - Canned-rotor pumps
    - Direct-cycle helium turbine
    - Helical steam generators



Nuclear Power 2010 - Role of NRC

- **Near-Term Deployable Designs (2010-2015)**
  - Likely — ABWR, AP 1000, ACR 700
  - Less Likely — SWR-1000, ESBWR, GT-MHR, PBMR
  - Not likely — IRIS

Nuclear Power 2010 - Role of NRC

Evaluation, Assessment, Confirmatory Testing and Analysis in the following areas:

- **I&C HMI**
  - Digital instrumentation and controls
  - Human-machine interface
  - Safety-grade software
- **Fuels**
  - Gas-reactor fuel performance and fabrication
  - ACR 700 fuel assessment
- **Materials**
  - Structural materials for gas-reactor and ACR 700
- **Thermal-Hydraulics and Neutronics Analysis**
  - Passive safety systems -- model validation
  - ACR 700 models
  - Gas reactor thermal hydraulics and physics
- **Innovative construction technologies and first-of-a-kind components**
- **Use of international codes and standards**

Advanced Gas Reactor Fuel Development and Qualification --A Shared Need for NP-2010 and Generation IV

R & D
- Fuel particles
- Materials
- He systems technology (850°C)
- Computer codes
- Fuel cycle

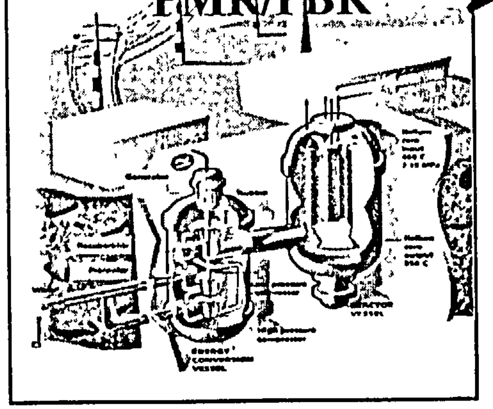
VHTR

GFR

Improved sustainability

> 950°C for VHT heat process

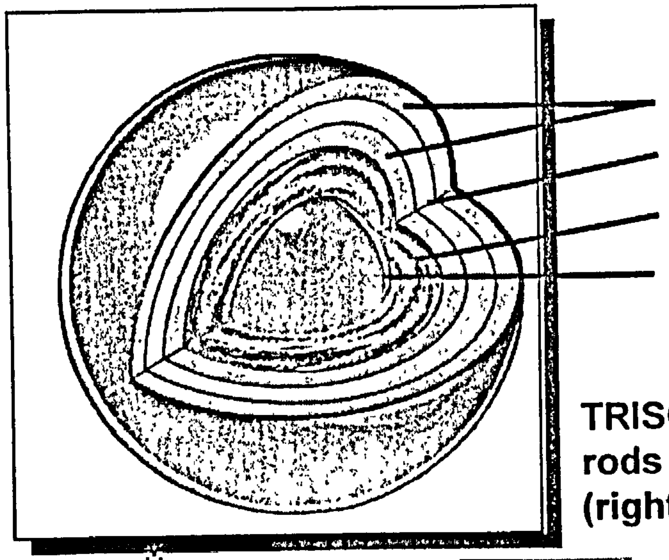
PMR/PBR



R & D
- Fast neutron fuel
- Fuel cycle processes
- Safety systems

R & D
- VHT materials
- IHX for heat process
- ZrC coated fuel
- I-S cycle H2 production

GR Fuels -- Ceramic Fuel



GENERAL ATOMICS

L-029(5)
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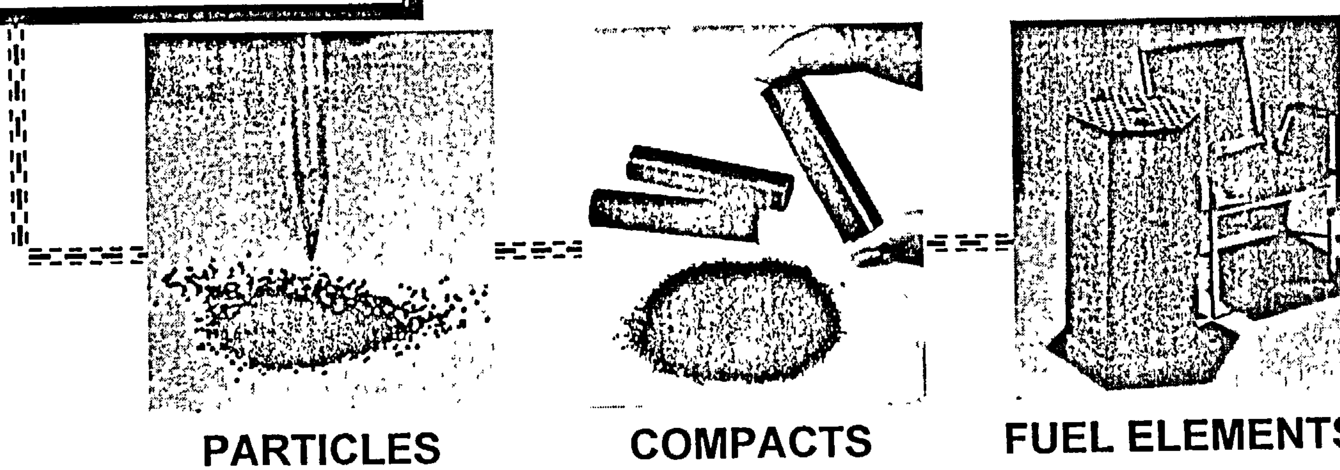
TRISO Coated fuel particles (left) are formed into fuel rods (center) and inserted into graphite fuel elements (right).



AGR Fuels - Builds on a Solid Foundation

Hydrogen Production

Very high temperature
Advanced fuels

Electricity Generation

ZrC

SiC

Peach Bottom	U.S. HTGR Programs (60's, 70's, 80's, 90's)	NPR
German coating process		FSV

Overview of Gas Reactor Fuel Program

- Build on U.S. capability, technology to incorporate best German fabrication experience into U.S. fuel manufacturing capability
- Manufacture of high quality coated fuel particles for irradiation and accident testing (LEU with GT-MHR focus)
- Design and fabrication of irradiation testing capsules for ATR tests
- Provide irradiation data, PIEs to demonstrate improved gas reactor fuel manufacturing process
- Build foundation required for U.S. pursuit of Generation IV gas-reactor development

Reactor Fuel Program -- Major Program Goals

- Manufacture high-quality fuel kernels, particles and compacts to get improved manufacturing specifications and actual test specimens
- Improve understanding of how TRISO fuel characteristics and fabrication process relate to fuel performance
- Demonstrate gas reactor fuel performance during normal and accident conditions by performing irradiations, safety testing, and PIEs
  - Eight irradiation capsules planned for ATR irradiation testing and PIEs
- Improve gas reactor fuel behavior and fission product transport modeling capability
- Reduce market entry risks associated with gas reactor fuel production and qualification

Reactor Fuel Program -- Schedule

- Program extends through 2012
- Qualification tests complete 2010
- FY 03 Work concentrates on:
  - Fuel kernel manufacture, coating process development, and QC methods development
  - Making first fuel specimens for the first irradiation capsule design
  - Designing first capsule and formulating ATR test specifications
  - Initiating fuel performance modeling efforts, getting thermochemical and thermophysical properties

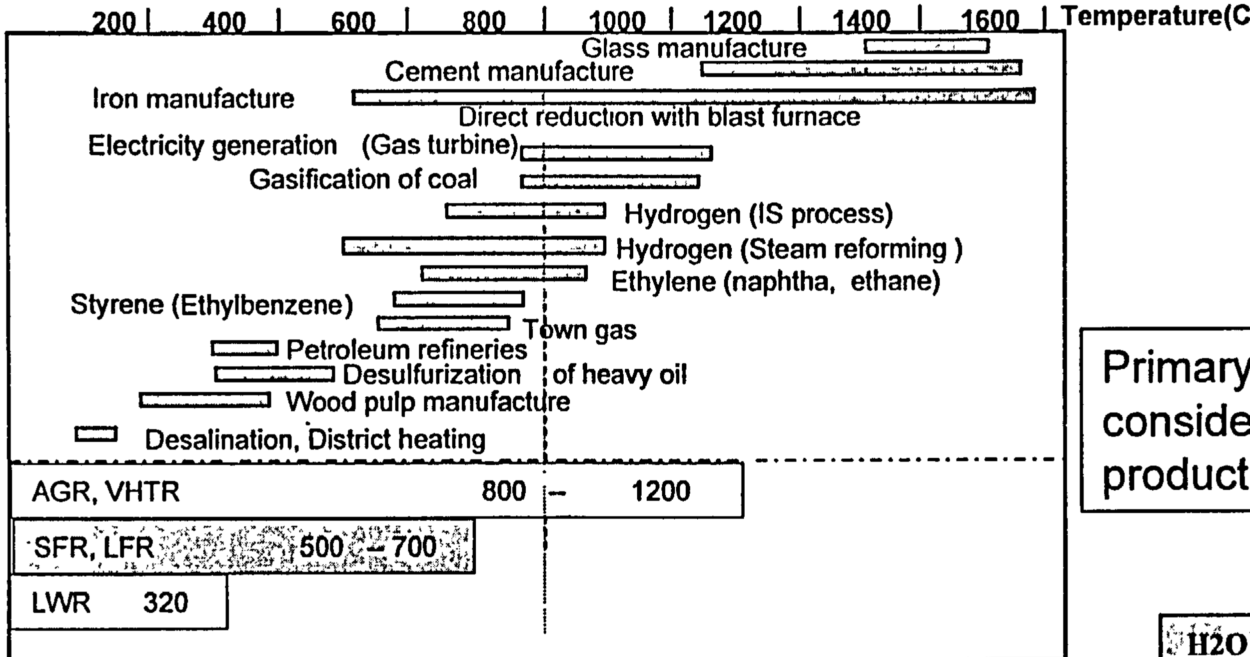
Gas Reactor Fuels Program -- Schedule (continued)

- **FY 04 work concentrates on:**
  - Continuation of fuel manufacture, properties testing
  - First capsule insertion (October 2004)
  - Early feedback to fabrication process
  - Initial fission product and gas release transport studies in kernels

Generation IV Gas Reactors

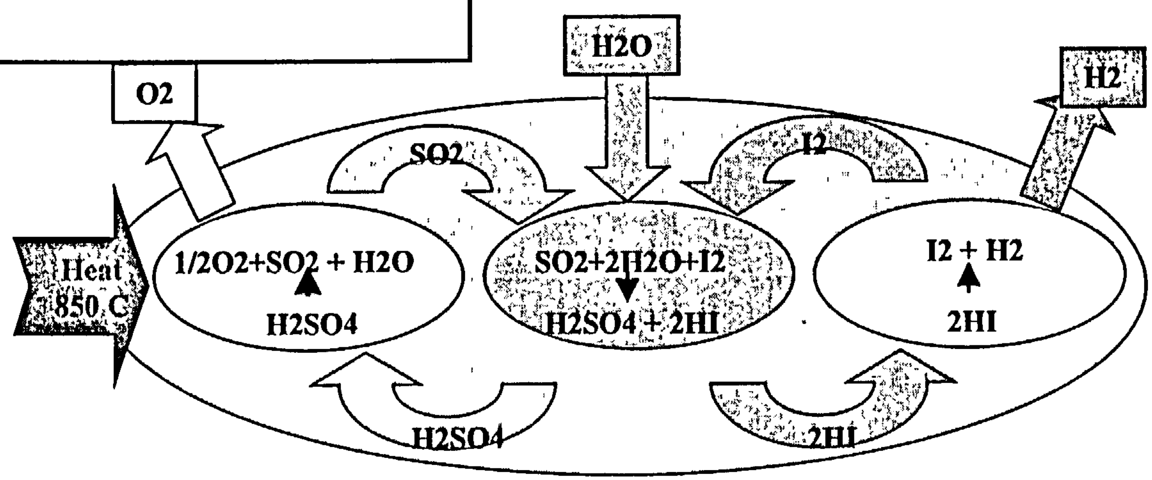
- **Very High Temperature Reactor (VHTR)**
  - Primary mission -- Nuclear heat applications
  - Secondary mission -- Electricity production
  - Deployable by 2020
- **Gas Fast Reactor (GFR)**
  - Primary mission -- Electricity production, actinide management
  - Secondary mission -- Nuclear heat applications
  - Deployable by 2025

AGRs -- High Temperatures Enable a Range of Process Heat Applications

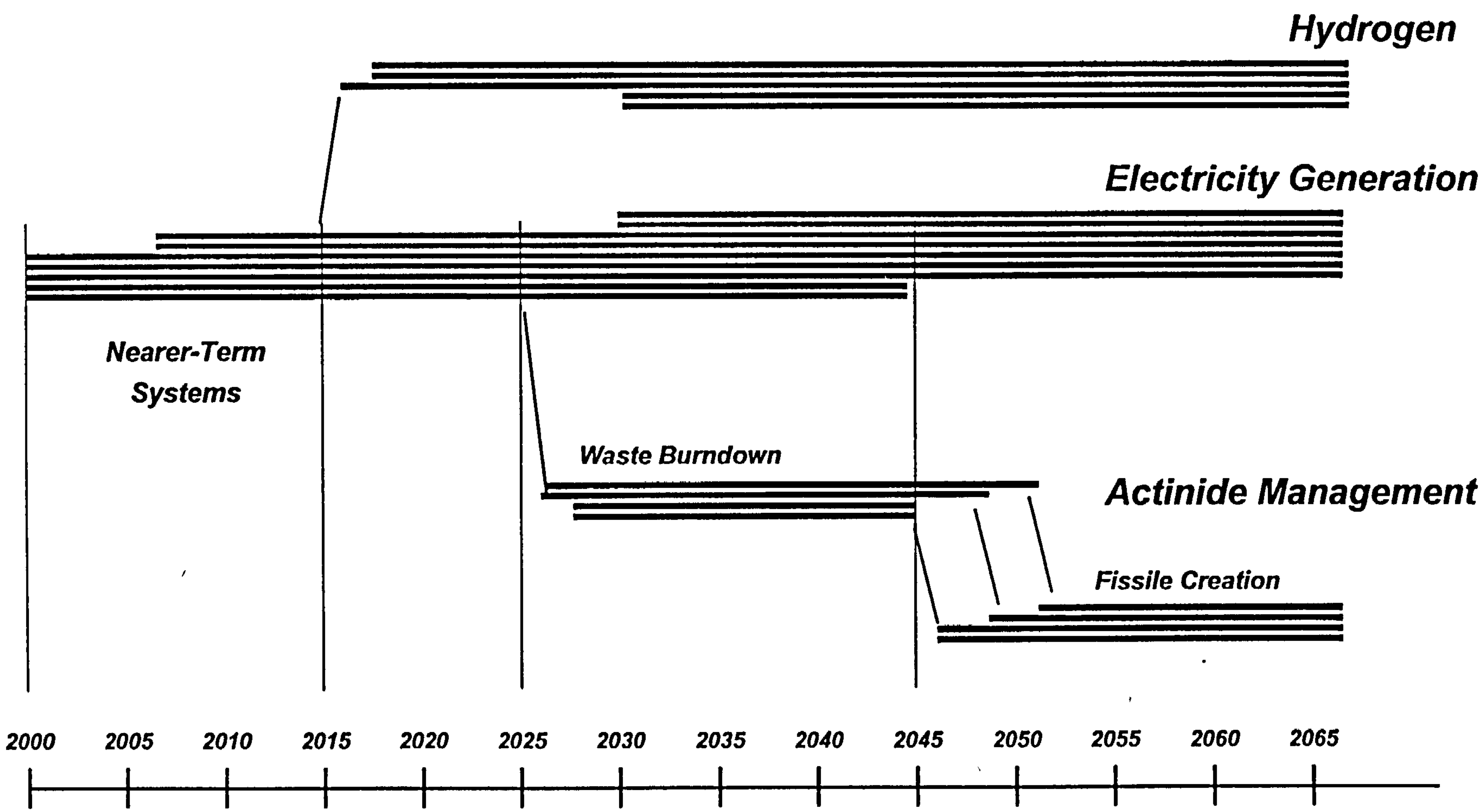


Primary nuclear application considered for VHTR – H2 production

Thermochemical cycles for Hydrogen production >750 C

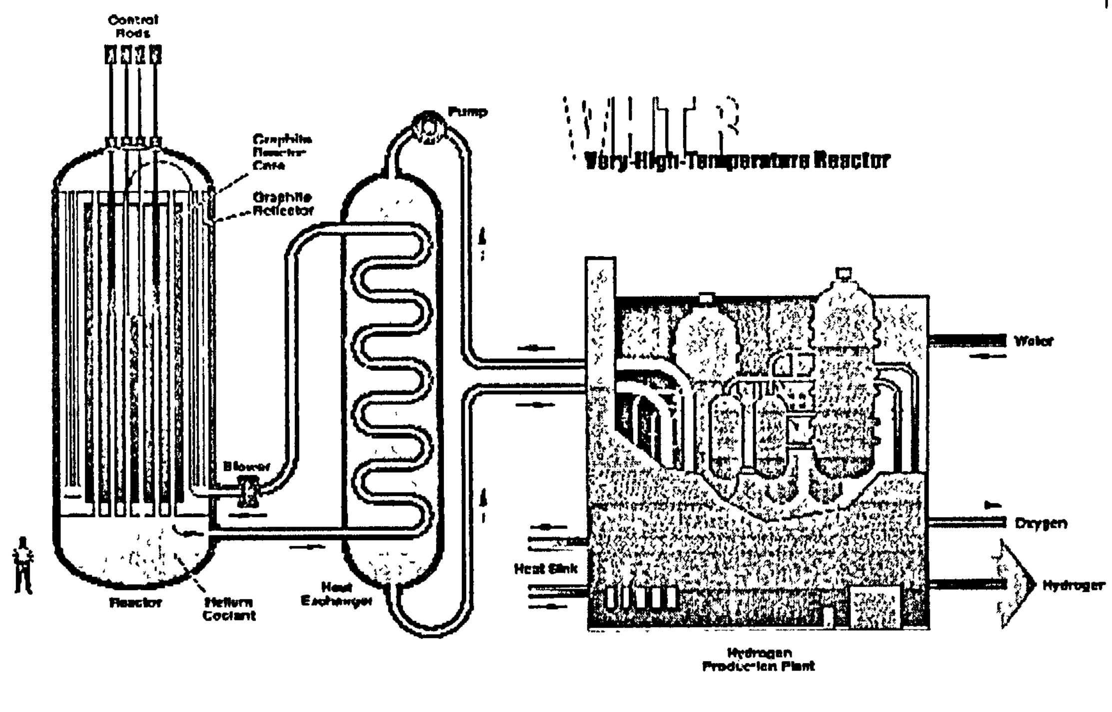


Important Missions for Generation IV



Very High Temperature Reactor (VHTR) -- Description

- Thermal spectrum graphite-moderated helium-cooled reactor
- Supplies high-temperature process heat (1000+ °C) for nuclear heat applications (e.g., hydrogen production)
- Fueled by ceramic-coated (U,Pu)-oxide particles in prismatic or pebble bed configuration

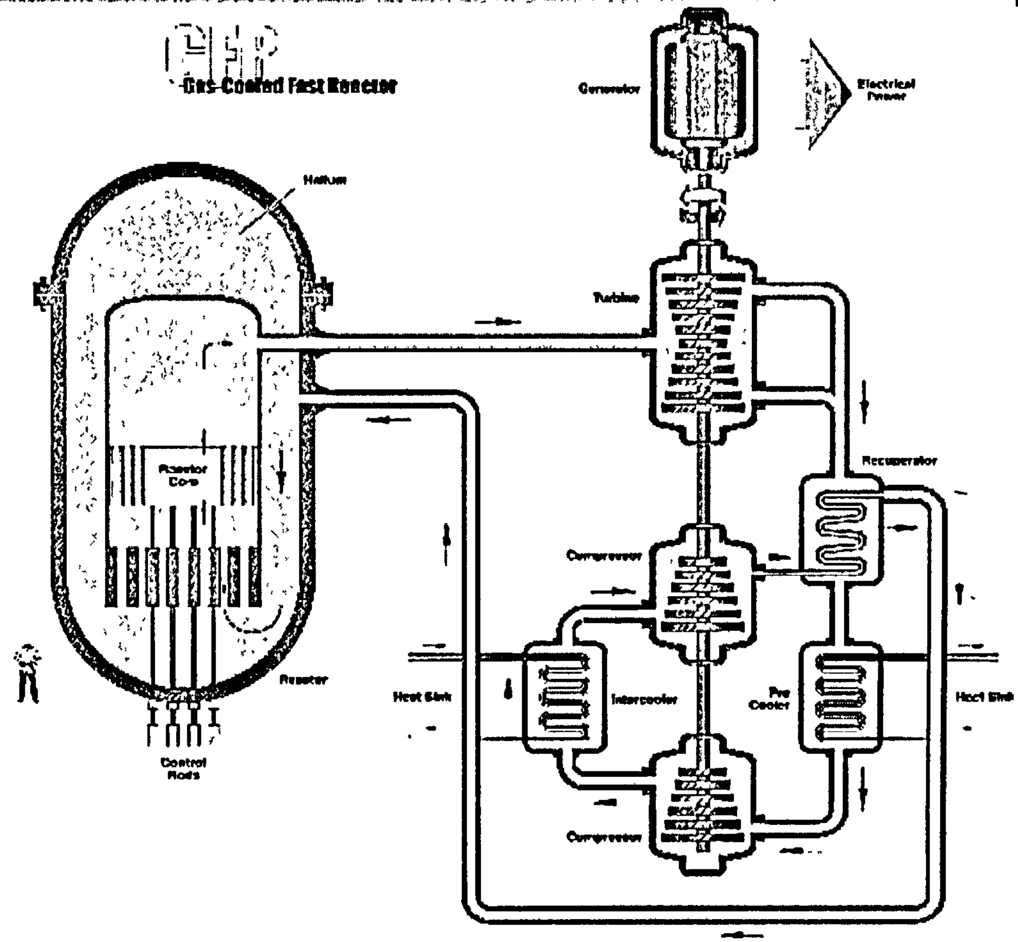


Very High Temperature Reactor (VHTR) -- R&D Needs

- **Novel fuel and materials development to allow**
  - Increasing output temperature from 850 ºC to above 1000 ºC
  - Maximum fuel temperature of 1800 ºC
  - Permit fuel burn-up of 150-200 GWD/MTHM
  - Uniform core temperatures
- **Energy coupling technologies for use of nuclear heat (e.g., hydrogen production)**
- **Development of direct-cycle helium turbine for electricity production**

Gas-cooled Fast Reactor (GFR) -- Description

- Fast spectrum helium-cooled reactor
- Direct-cycle helium turbine for electricity production
- High temperature will also allow for hydrogen production (outlet 850 ºC)
- Fueled by closely packed ceramic-coated (U,Pu)C kernels or fibers or ceramic-coated solid solution metal fuels



Gas-cooled Fast Reactor (GFR) -- R&D Needs

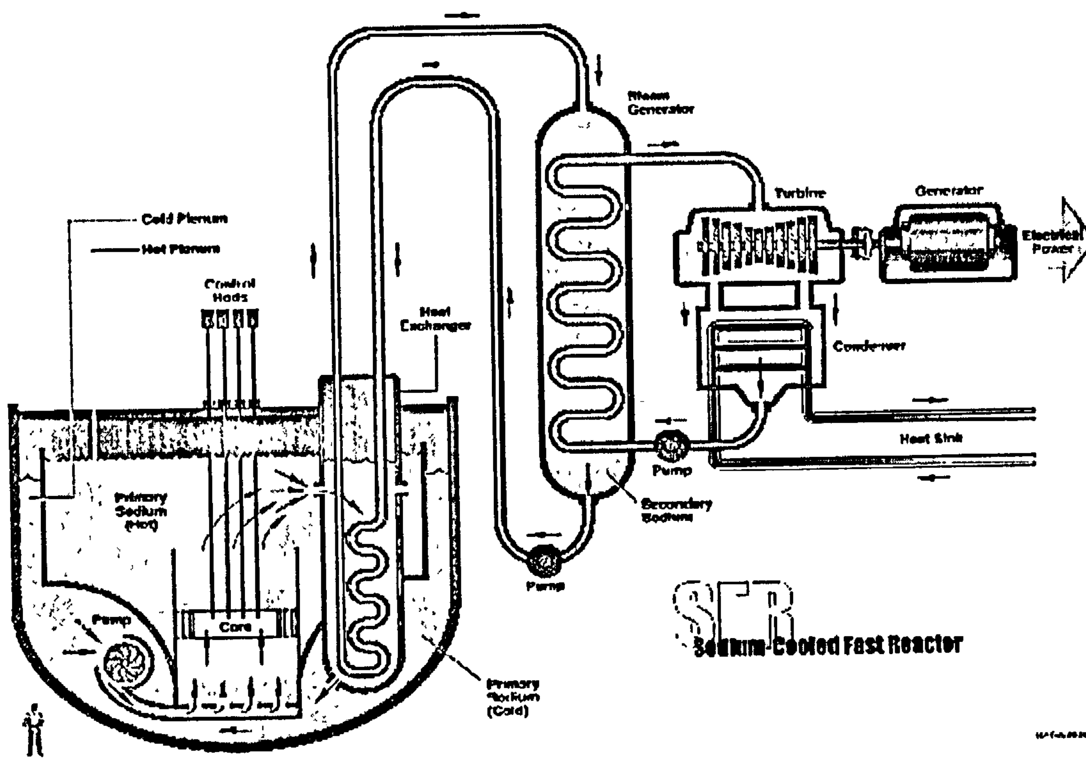
- Fuel forms for fast-neutron spectrum
- Materials research for fuels and structural components
- Optimal core design
- Reactor safety improvements (e.g., decay heat removal systems)
- Fuel cycle technology including spent fuel treatment and fuel re-fabrication
- Development of high-performance helium turbine for electricity production
- Energy coupling technologies for process heat applications (e.g., hydrogen production)

Other Generation IV Reactor Concepts

- **Sodium-cooled Fast Reactor (SFR)**
  - Deployable by 2020
- **Supercritical Water Reactor (SCWR)**
  - Deployable by 2025
- **Lead-cooled Fast Reactor (LFR)**
  - Deployable by 2025
- **Molten Salt Reactor (MSR)**
  - Deployable by 2025

Sodium-cooled Fast Reactor (SFR) -- Description

- Fast spectrum sodium-cooled reactor
- Outlet temperature is 530-550 °C
- Used for electricity production and actinide management
- Fueled by (Pu,U)-oxide fuel or (U,Pu)-alloy metal fuel

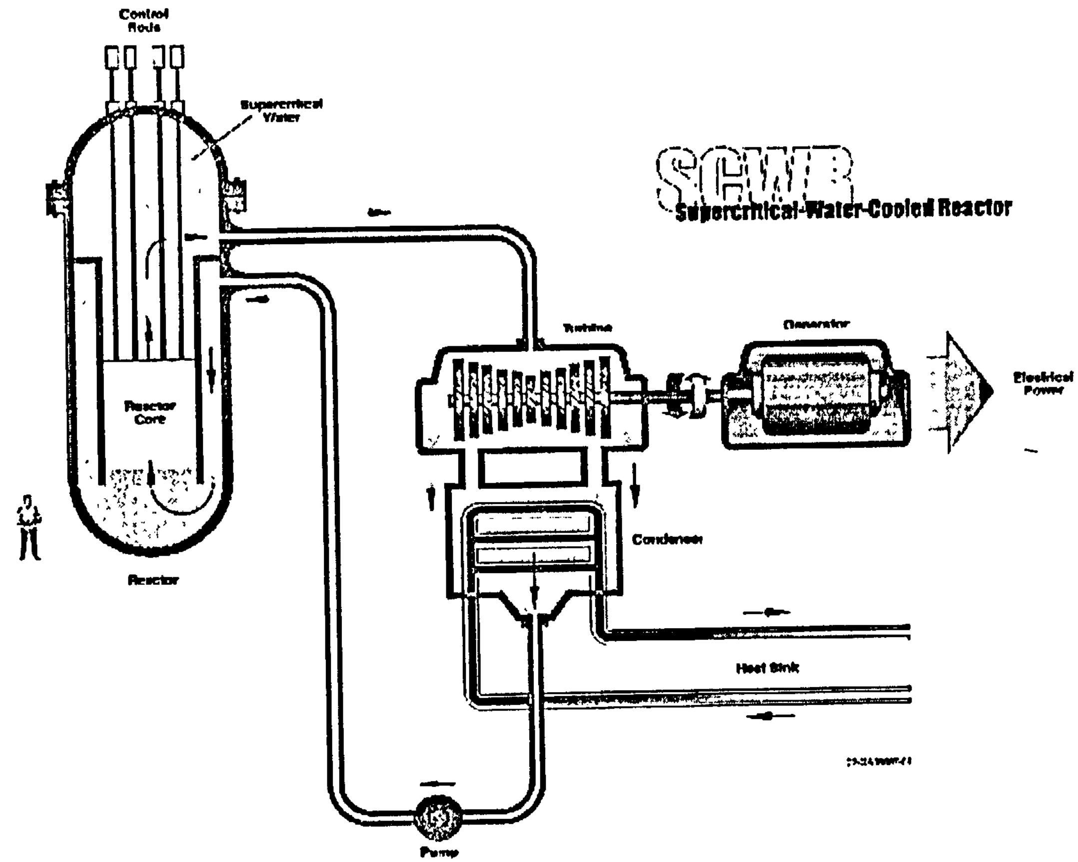


Sodium-cooled Fast Reactor (SFR) -- R&D Needs

- Passive safety response improvements
- Accommodation of bounding events
- Capital cost reduction
- Scale-up of spent fuel treatment technologies to accomplish high minor actinide recovery
- Development of minor actinide bearing fuel fabrication technology with remote operation and maintenance
- In-service inspection and repair

Supercritical Water-cooled Reactor (SCWR) -- Description

- Thermal or fast spectrum supercritical water-cooled reactor
- Outlet temperature 510 ºC
- Used for electricity production and for actinide management when fast spectrum is used
- Fueled by conventional LEU fuel

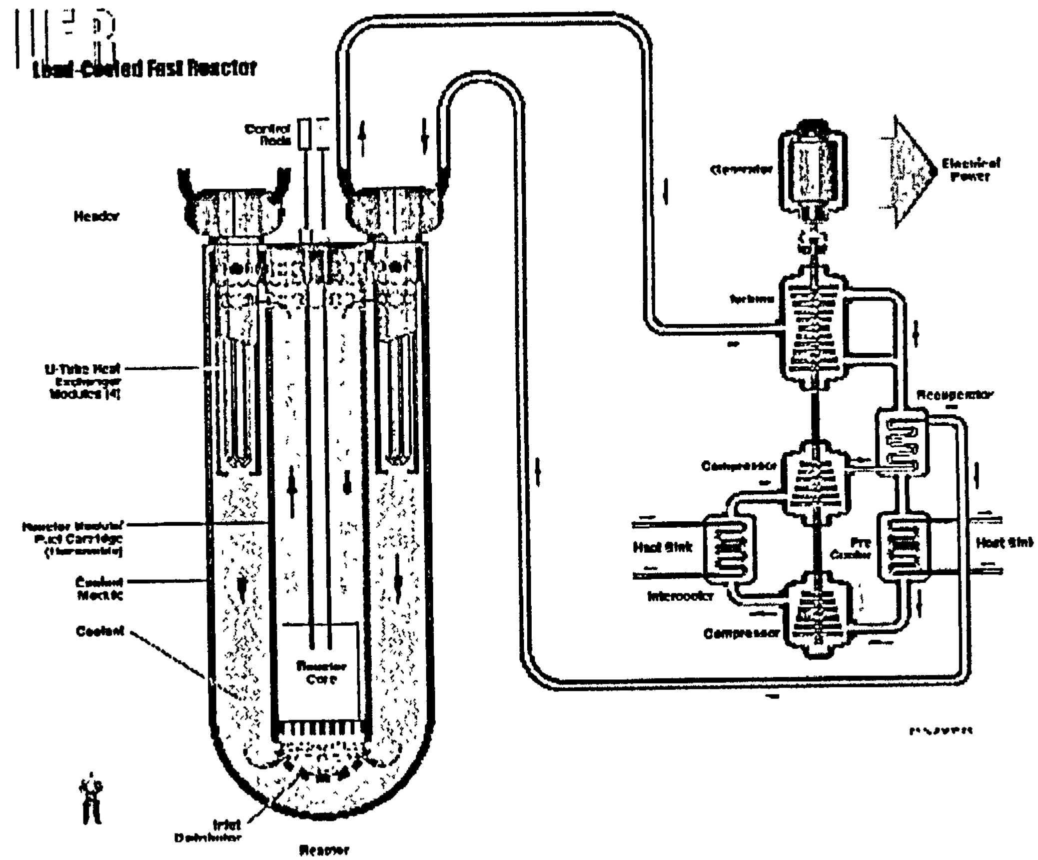


Supercritical Water-cooled Reactor (SCWR) -- R&D Needs

- SCWR safety, including power-flow stability during operation and LOCA behavior and response
- Plant design
- Materials and structures
  - Resistance to corrosion, cracking, embrittlement, creep
  - Dimensional and microstructural stability
  - Stability in high radiation fields
- Advanced fuel cycle development for fast reactor option

Lead-cooled Fast Reactor (LFR) -- Description

- Fast spectrum lead-cooled reactor
- Outlet temperature between 550 and 800 °C
- Used for electricity production, actinide management and nuclear heat applications
- Higher temperature version used for nuclear heat applications.
- Fueled by (U, Pu) metal alloy or (U, Pu) nitride

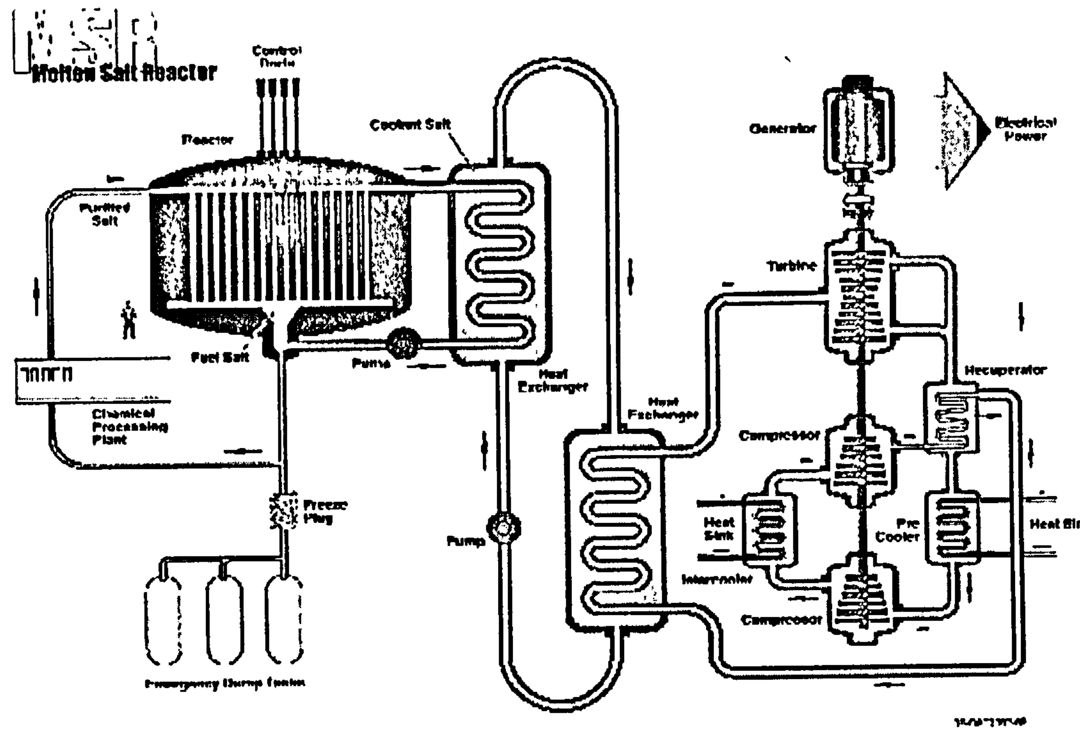


Lead-cooled Fast Reactor -- R&D Needs

- **Fuels and materials research**
  - Nitride fuels development, including fuel/clad compatibility and performance
  - High-temperature structural materials
- **LFR systems design**
- **Energy coupling technologies for use of nuclear heat**
- **Reduction of capital costs**
- **Fuel cycle technology**

Molten Salt Reactor (MSR) -- Description

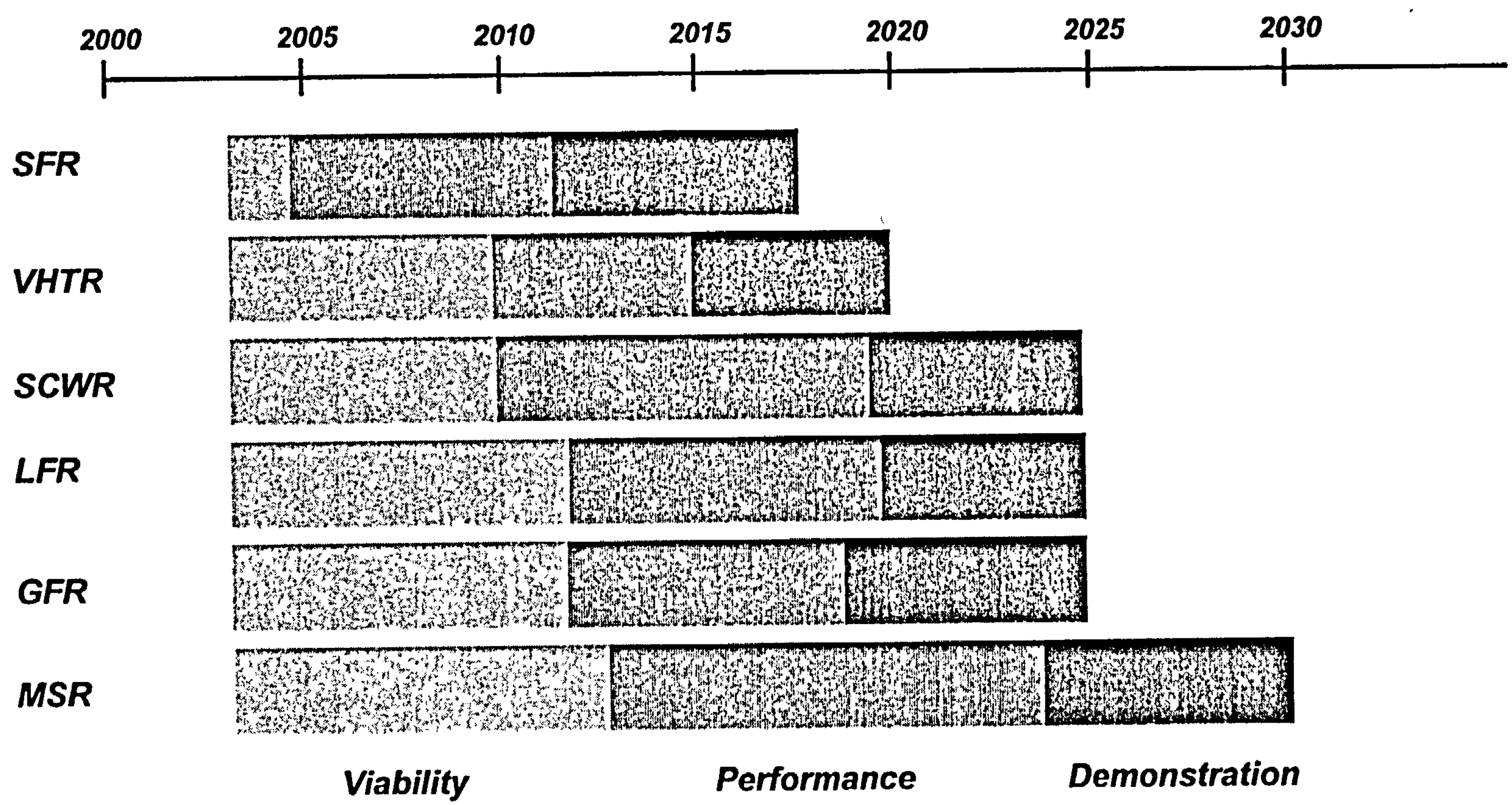
- Thermal spectrum molten salt-cooled reactor
- Uses dissolved U, Pu and TRU fluorides as fuel source
- Outlet temperature between 700 and 850 °C
- Used for electricity production and actinide management



Molten Salt Reactor (MSR) -- R&D Needs

- **Viability Issues**
  - Solubility of minor actinides and lanthanides in salt and mitigation of material precipitation problems due to saturation of salt
  - Lifetime behavior of salt
  - Materials compatibility
  - Salt processing
- **Performance issues**
  - Fuel development
  - Materials performance and stability
  - Detailed conceptual design studies

Concept Development Phases



EPRI Programs and Views on Advanced Reactor Research

Joint Meeting of ACRS Subcommittees on Safety Research Programs and Future Plant Designs

6 Nov. 2002

Gary Vine
Sr. Washington Rep., EPRI
202-293-6347
gvine@epri.com

EPRI

Presentation Overview

- EPRI's Nuclear R&D Programs· participation, scope, strategic planning
- Industry Linkage
- Collaboration with NRC and DOE
  - Memoranda of Understanding
  - NRC-Industry Collaboration -- Historical Perspective
  - Collaboration While Maintaining Independence
  - RES-EPRI MOU. Areas of Cooperation
- EPRI R&D on Advanced Reactors; Enhanced Safety
- DOE Near Term Deployment Roadmap
- EPRI views on issues to be addressed in research programs and needed timelines

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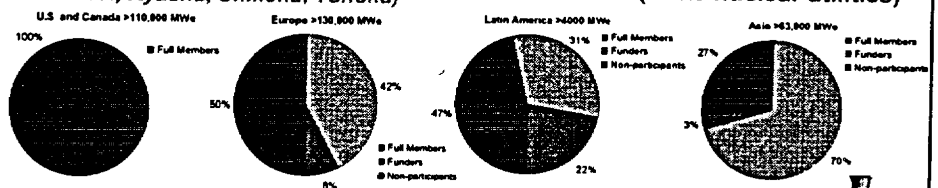
EPRI Nuclear Program Participants

- *Belgium (Electrabel)*
- *Bulgaria (NEK)*
- Brazil (Eletronuclear)
- Canada (Ontario Power Generation, Bruce Power, New Brunswick, Hydro Quebec)
- *Finland (TVO, Fortum)*
- France (EdF)
- *Germany (RWE, E ON)*
- Italy (SO G.I.N.)
- *Japan (TEPCO, Chubu, Chugoku, Hokkaido, Hokuriku, JAPC, Kansai, Kyushu, Shikoku, Tohoku)*
- *Korea (KEPCO)*
- *Mexico (CFE)*
- *Netherlands (NRG)*
- Romania (Nuclearelectrica, S.A.)
- *Slovenia (Krsko)*
- *Spain* (Iberdrola, *UNESA, Endesa, Union Fenosa, Nuclenor)*
- *Sweden (OKG, Vattenfall, Barsebaeck)*
- *Switzerland (KKL, KKM, NOK)*
- *Taiwan (Taiwan Power Company)*
- *United Kingdom* (British Energy)
- United States (all 28 nuclear utilities)



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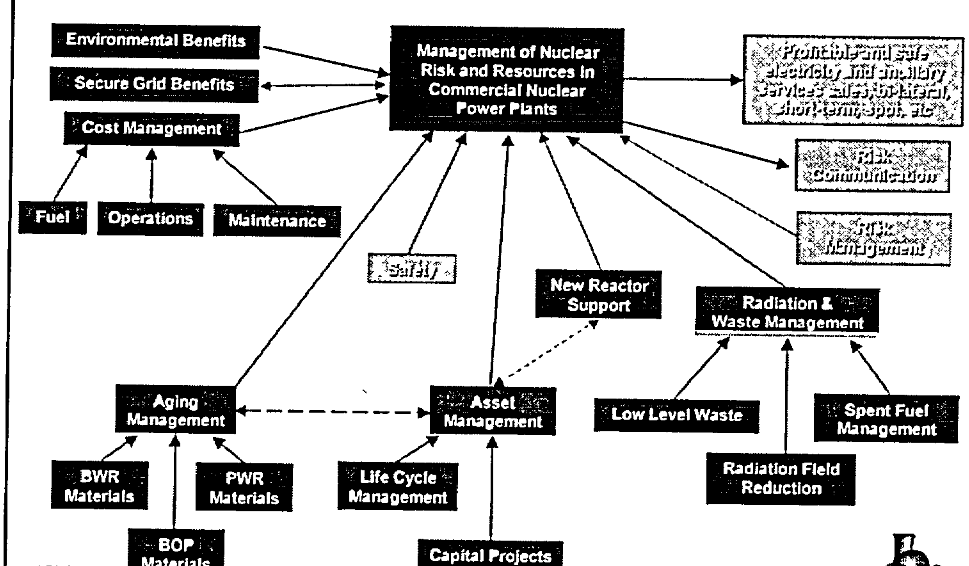
EPRI Nuclear Power Business Organization to Address Future Business



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Nuclear Strategic Plan (NSP) Strategic Objectives

- Maintain safety and promote public acceptance
  1. Preclude safety event surprises
  2. Allay concerns of public safety
- Maximize productivity of existing assets
  3. Achieve maximum plant useful life
  4. Improve plant capacity, reliability, and availability
  5. Develop technology to address material aging
  6. Add cost-effective innovation to existing plants
- Facilitate waste disposal
  7. Resolve on-site spent fuel and waste issues
  8. Resolve technical high-level waste issues

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Strategic Objectives (cont.)

- Promote deployment of new reactor systems
  9 Evaluate evolutionary and new designs including gas-cooled
  10 Adopt advances in manufacturing and construction technology
  11 Provide basis for simplified licensing process
- Maintain critical infrastructure
  12. Optimize technology transfer and collaboration
  13 Employ advances in information technology to design & operations
  14 Meet increasing demand for skilled, productive work force
- Improve risk management
  15. Achieve cost-/risk-focused decision-making in regulation, operation, and design
- Optimize fuel utilization
  16 Advance the use of high-performance fuel
  17. Develop high-utilization fuel cycles to extend resources

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Value of Nuclear Strategic Plan

- Provides opportunity for the market to help define the future and to identify and prioritize R&D needs
- Permits a robust plan for dealing with uncertainties and timing and funding issues
- Permits a quantification of the value of R&D for decision-making and resource allocation
- Supports Industry's Vision NEI's Vision 2020
- Provides opportunity to influence government R&D policy

NEI Industry Linkage INPO

- EPRI/INPO/NEI Memorandum of Agreement (MOA):
  - Commitment to cooperation, mutual support, close communications, minimizing overlap
  - Agreement to share data, reports, websites, etc.
  - Maintains comprehensive list of technical liaisons
- Growing trend for coordinated/linked/common advisors
- Growing opportunities for joint planning (strategic, tactical)
- Improving relations with NSSS Owners Groups, Vendors

Memoranda of Understanding among EPRI, DOE and NRC

- NRC, DOE, and EPRI have executed bilateral MOUs with each other
- NRC (RES) - EPRI MOU:
  - Executed Nov. 1997
  - Basis for cooperation of data phase of R&D
- DOE-EPRI MOU:
  - Executed Sept. 1999
  - Basis for cooperation on all LWR R&D
  - Initial focus: NEPO Program
- DOE-NRC MOU executed in 1999

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NRC - Industry Cooperation in R&D -- a Perspective

- Extensive collaboration among NRC, DOE, EPRI, NSSS Vendors on nuclear R&D in 1970s, early 80s
- R&D collaboration rare during last decade
  - Legal concerns with "independence"
- Independent R&D became obstacle to issue closure
  - Lack of agreement up-front on definition/scope of issue
  - Lack of agreement on R&D needs, assumptions, data
- What has changed?
  - Greater appreciation of common R&D goals
  - Diminished resources for R&D suggests leveraging
  - Risk-informed regulation encourages convergence on R&D assumptions, data, models, etc.
- RES and EPRI both encouraged to increase collaboration

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NRC-Industry R&D Collaboration – Without Compromising Regulatory Independence

- RES-EPRI MOU focuses on data needs and joint efforts to collect the data needed to support issue resolution.
  - Collaboration limited to defining issue & data needs, joint collection of data, including review for completeness and accuracy, data validation, formal reporting to decision-makers.
  - Collaboration does not extend into efforts to develop specific solutions to regulatory issues. RES provides research results to Program Office(s); EPRI provides same data to NEI/industry
  - NRR/NMSS independently develop NRC's regulatory position; NRC interaction with industry on issue resolution is via NEI.
  - Issue resolution greatly enhanced because NRC and industry are starting with the same technical basis for resolution –fewer disagreements over whose data should be used.
- No "conflict of interest" under this process.

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Research Cooperation under EPRI/NRC MOU

- Formal Addenda to MOU on
  - Testing of High Burnup Fuel
  - Fabrication Flaw Distribution in RPVs
  - Fire Risk
  - Treatment of Proprietary and Commercial Info
  - Welding of Highly Irradiated Materials
  - Dry Cask Storage Project at INEEL
  - Seismic Behavior of Spent Fuel Storage Cask Systems
- Other areas of cooperation:
  - RIR: RI-ISI, PSA Standards, other RI issues
  - Steam Generator Tube Integrity
  - Aging Issues (e.g , cable aging, fatigue, corrosion, SCC, crack initiation)
  - Digital I&C, S A close-out, Advanced Reactor R&D, etc.

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Examples of Research Successes

- License Renewal – twenty years of research on aging of SSCs, combined with "Life Cycle Management" programs set the stage for regulatory acceptance of cost-effective license renewal
- ALWR Program – 15 year, industry-DOE multi-phased effort to:
  - Identify & resolve regulatory issues applicable to new designs
  - Develop detailed owner/operator requirements for new plants
  - Develop new passively-safe designs and achieve design cert.
  - Complete First-of-a-Kind Engineering on two ALWRs
- Steam Generator Management Program (SGMP) – 25 year effort to identify and manage wide range of degradation mechanisms. Program evolved to manage regulatory issues, new inspection technologies, better materials in replacement SGs, enhanced water chemistry guidelines, etc.

-- Close relationship with NEI and INPO key to implementation

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Other R&D Successes

- Development of PRA techniques, models, and data
- Resolution of LBLOCA and severe accident concerns
- BWR pipe cracking and vessel internals cracking resolution
- Application of digital controls to nuclear safety & plant equipment
- Development of safe, more reliable high burnup fuel
- Improved equipment reliability and maintenance technologies
- Improved inspection & repair technologies w/ reduced rad. exp.
- Improved spent fuel storage and transportation technologies
- Advanced analysis methods for SNF repository assessment
- Integrated chemistry strategies to optimize fuel & materials mgt
- Advanced seismic hazards analysis methods

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ALWR Program Perspectives

- Started in 1983 with utility executive survey "What would it take to rekindle US utility interest in the nuclear option?"
  - Nuclear power plants must be:
    - **Safer and simpler,** with greater design margins
    - **Competitive** with other forms of generation
    - **Standardized**
    - **Pre-licensed** by the USNRC
  - Supported making improvements to established LWR technology, rather than develop radically new concepts
- Developed Utility Requirements Document (URD) as "bid spec" for designers; basis for standardization & regulatory stabilization
- Strategic Plan to Build New Nuclear Power Plants (1990-98) integrated all project-specific and institutional "building blocks"
- Utility consensus with major international participation

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Enhanced Safety in New Nuclear Plants

- Severe Accident Policy and Advanced Reactor Policy Statements:
  - expectation for enhanced safety (E.S.) directed to vendors
  - encouraged industry, not regulations to provide enhanced safety
  - industry responded Utilities, via URD, set E.S requirements
- Utilities needed to be able to decide how best to comply with regs.
- Utilities needed to design-in extra margins for investment protection, operational flexibility, flexibility for siting and emergency response, assured licensability (i.e., margin for analysis and R&D uncertainties)
- "Vendor or EPRI goals that go beyond our regulations should not be imposed as requirements" (SRMs SECYs 90-102 & 311)
- Commission disapproved reqt for 10E-5 CDF (SRM SECY90-016)
  - Imposing utility requirements avoids Commission Safety Goal Policy
- S.A rulemaking for ALWRs could not be justified (1989-93)
- "Applicable Regs" (proposed 9/92), disapproved (12/96)
  - "AARs" circumvented Backfit Rule & all above Comm. Policies
- Absorbing E.S. features into regs is counterproductive

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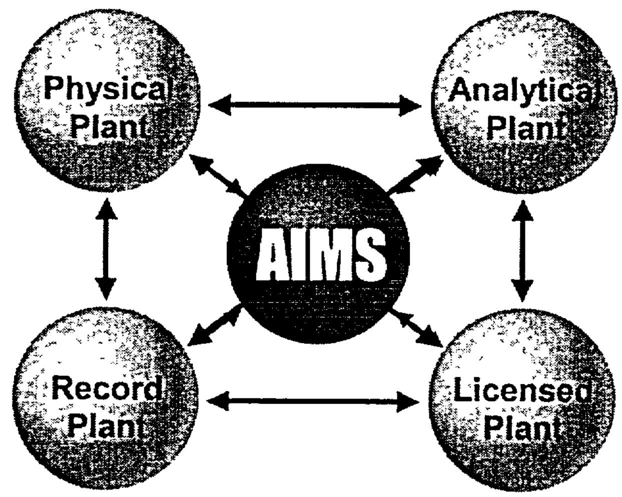
EPRI's Current New Nuclear Plant Programs

- EPRI Projects of "Generic" Applicability
  - Information Management System
  - Construction Modeling
  - Early Site Permit
  - Combined Licenses
- Vendor LWR Design-Specific Projects
  - Westinghouse AP1000
  - GE ESBWR
- EPRI Projects on HGTR Technology
  - Inspectability and Maintainability
  - Silver Isotope Behavior and Management
  - Helium Seals
  - Economics of Hydrogen Production

Advanced Information Management (AIMS) Approach

- Operating plants have experienced difficulty in managing licensed bases
  - Too many separate databases
  - Too costly to manage and resolve integrity issues
- AIMS addresses these issues
  - Integrated off-the-shelf products
  - Implementing AIMS approach for AP1000

Viewed As One Database In AIMS



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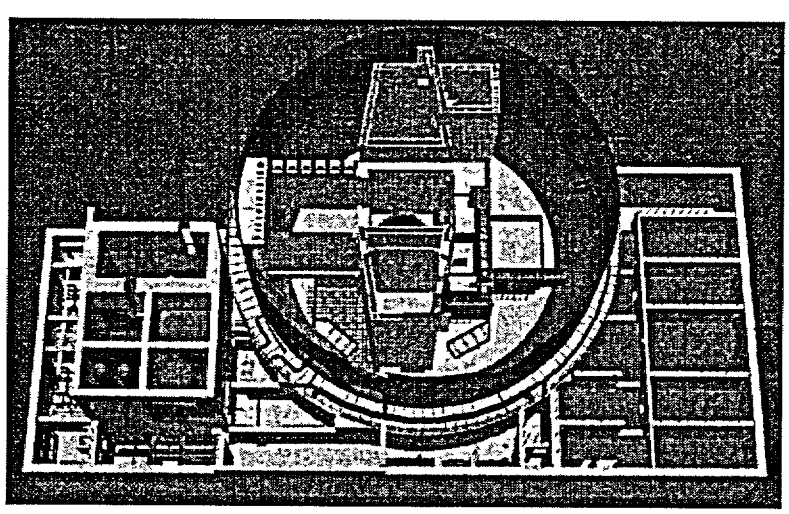
Construction Modeling



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Benefits of Construction Modeling

- Develop improved construction sequencing to improve overall time
- Verify accuracy and achievability of schedules
- Eliminate problems before they are encountered in the field
- Generate increased investor confidence in construction schedules

ESP Products

- Industry Guideline for Preparing an ESP Application
- Siting Guide: Site Selection and Evaluation Criteria for an ESP Application
- ESP/COL Model Program Plan

LWR Design-Specific Projects

- Vendor Initiatives
  - Westinghouse - AP1000
  - GE - ESBWR

- EPRI provides:
  - direct (W) or indirect (GE) financial support
  - plus monitoring regarding utility design requirements

- Large plants based on passive technology Projected costs ~ 30% below ALWR program's estimated costs for already certified plants

HTGR Projects

- Auxiliary Bearings
  - Technical Status and R&D Requirements Evaluation
  - Auxiliary Bearing Materials Assessment
- Inspectability and Maintainability
- Silver Isotope Behavior and Management
- Helium Seals
- Graphite Materials Design Data
- Materials Assessments
  - Metallics
  - Composites
- Economics of Hydrogen Production (on-going)

U.S. DOE Interactions

- EPRI has a long history of cooperation with DOE:
  - Various MOUs & Cooperative Agreements for Joint R&D
  - Public-Private Partnerships Cost-shared R&D Programs
- Current EPRI-DOE cooperation:
  - NEPO (Nuclear Energy Plant Optimization) ~$5M/year DOE funding
  - NP2010 (DOE/industry program to build new plants this decade)
- Significant EPRI role in advising DOE on its R&D programs.
  - Nuclear Energy Research Advisory Committee (NERAC)
  - Generation IV Roadmap NERAC Subcommittee (GRNS)
    - Near Term Deployment Roadmap
    - Generation IV Goals, program direction, and Roadmap
  - NEPO: Coordinating Committee for Joint Strategic R&D Plan; NERAC Operating Plant Subcommittee, Long term R&D Plan, etc.

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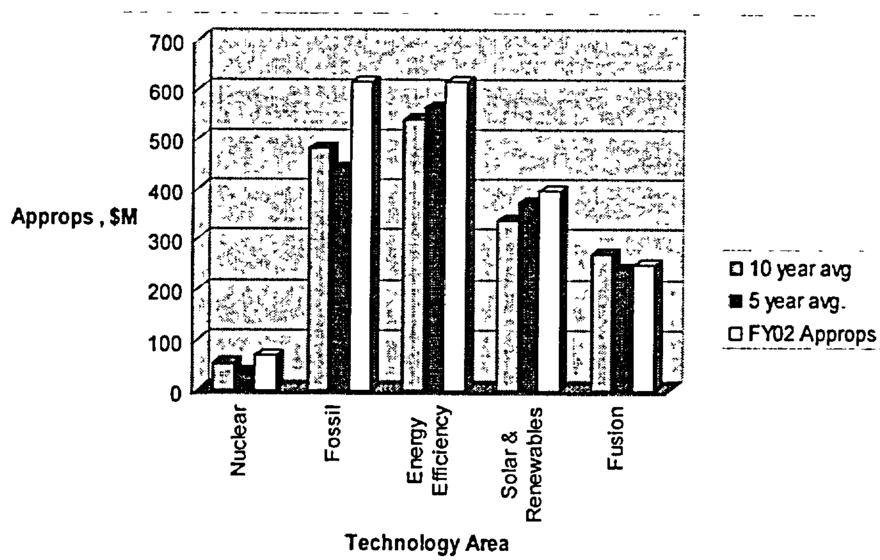
Energy Supply R&D at DOE by Technology Area



Near-Term Deployment Group

- Mission - Identify the technical, institutional and regulatory gaps to the near term deployment of new nuclear plants and recommend actions that should be taken by DOE.
  - Orders by 2005
  - Multiple plants in commercial operation by 2010
- Participants - multi-disciplined nuclear industry group
  - Nuclear Utilities - Duke, Southern Nuclear, Exelon
  - Reactor Vendors - Westinghouse, General Electric, General Atomics
  - National Laboratories - ANL, INEEL
  - Academia - Penn State
  - Industry - EPRI
  - Government - DOE-NE
  - NERAC

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NTD Designs Evaluated

Eight designs were evaluated by the NTDG for possible deployment by 2010:

Design	Supplier	Features
ABWR	GE	1350 MWe BWR, design certified by NRC and built and operating in Japan
SWR-1000	Framatome ANP	1013 MWe BWR, being designed to meet European Requirements
ESBWR	GE	1380 MWe passively safe BWR, under development
AP600	Westinghouse	610 MWe passively safe PWR, design certified by NRC
AP1000	Westinghouse	1090 MWe PWR with passive safety features Higher capacity version of AP-600, not yet certified
IRIS	Westinghouse	100-300 MWe integral primary system PWR, under development
PBMR	ESKOM	110 MWe modular direct cycle helium-cooled pebble bed reactor, currently planned for construction in South Africa
GT-MHR	General Atomics	288 MWe modular direct cycle helium-cooled reactor, being licensed for construction in Russia.

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NTD Roadmap: Generic Gaps/Issues

- Five generic "gaps" identified -- significant obstacles to NTD; subject to recommendations (i.e., needs priority attention by industry and government to permit NTD by 2010).
  - Nuclear plant economic competitiveness
  - Business implications of deregulated electricity marketplace
  - Efficient implementation of 10CFR52
  - Adequacy of nuclear industry infrastructure
  - National Nuclear Energy Strategy
- Four generic "issues" identified -- not necessarily obstacles to NTD -- longer term in nature, less critical to NTD; need to be monitored and managed. Progress should be made on each to allow nuclear energy to reach its full potential.
  - Nuclear safety
  - Spent fuel management
  - Public acceptance of nuclear energy
  - Non-proliferation of nuclear material

NTD Roadmap Conclusions

- New nuclear plants can be deployed in the U S in this decade -- with sufficient, timely private sector investment
- To have new plants operating by 2010, O/Os must commit to orders by ~2003. Requires very near term action
- Economic competitiveness is key area of uncertainty
- Efficient implementation of Part 52 is most urgent
- Excellent candidates available. Certified designs ready; other candidates show promise for improved economics
- Achieving near term deployment will require close collaboration between industry and government.

NTD Conclusions (continued)

- Selections of new projects must be market driven and primarily supported by private sector investment, but government support is essential, in the form of:
  - Leadership and effective policy
  - Efficient regulatory approvals
  - Cost sharing of generic and one-time costs
- Industry-Government collaboration essential to success
  - Will provide needed resource leveraging
  - Will greatly enhance investor confidence
  - Better standardization of designs and processes

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NTD Roadmap Recommendations -- an Overview

- A "Phased Plan of Action" with three phases
  - Regulatory Approvals
  - Design Completion
  - Construction and Startup
- "Dual Track" implementation for both ALWR & Gas-cooled
  - Both tracks required to address different market scenarios
- Market-driven initiatives, with DOE cost-sharing of regulatory-related generic & 1st-time design-specific costs
  - DOE $ only for initiatives that obtain ≥50% private sector funding
  - ESP and COL demonstrations
  - Design Certifications (ALWRs) and COLs w/o DC (gas reactors)
  - First Time Engineering Completion
- Development of National Nuclear Energy Strategy to complement new National Energy Policy

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NTD Recommendations: A Phased Plan of Action

- Phase 1: Regulatory Approvals
  - Develop generic guidance for ESP, COL, ITAAC
  - Industry and DOE cost share (market-driven initiatives):
    - ESP and COL applications to demonstrate processes
    - Complete DC (FDAs for gas reactors) for selected designs
    - Risk-informed, performance-based regulatory framework being developed (may be applied as elements become available)
- Phase 2: Design Completion
  - Complete detailed engineering for at least one design in each track (ALWR, gas-cooled) to allow deployment by 2010
    - Industry and DOE cost share (market-driven initiatives)
- Phase 3: Construction and Startup
  - privately funded but supported by appropriate government incentives

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New Plant Implementation

- Economics/business case for new plants: daunting
  - capital costs, deregulated marketplace, reg. uncertainty
- Cannot achieve Vision 2020 without help from DOE
  - must have cost-sharing of 1-time costs, level playing field
- Public-Private Partnership: MUST be market-driven
  - marketplace must select designs and sites, not government
  - O/Os must be able to manage new projects w/o strings
  - must maintain dual track approach until plant orders start
  - Unified utility leadership required for stable success path
- Phased approach needed to build investor confidence
- First plants built must be across-the-board successes
  - "just go build something" mentality is counterproductive

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EPRI Views on NRC Advanced Reactor Research Program

- Primary References for EPRI views presented today:
  - Expert Panel Review of NRC Research Programs
    - Letters from Dr. Ted Marston to Dr. Kenneth Rogers dated 2 Oct. 2000, 14 Feb 2001, and 12 March 2001
  - Response to FRN request for identification of anticipatory research projects, and for comments on factors that should be considered when anticipatory research topics are prioritized
    - Letter from Dr. Ted Marston to Dr. James Johnson, 5 June 2002

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Priorities for NRC Resources

- Industry priorities for both NRR and RES work on advanced reactors: matters that support Near Term Deployment
  - Designs lacking current market interest should be given low priority at NRC, including research efforts
  - Commission supported market-interest-based prioritization ('90)
- Specific priorities for research
  - Support for ESP and COL application needs
  - New [technology-neutral] Reg. Framework (EPRI recommended that NRC rely on the proposed Part 53 developed by NEI)
  - Support for designs under Design Certification review
  - Collaborative generic research (e.g., enabling technologies, I&C)
  - Support for designs engaged in pre-application review, if:
    - Market interest verified
    - RES doesn't get our front of applicant s design development/research

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Roles and Responsibilities

- Primary responsibility for making safety case for a new reactor design rests with applicant, including supporting research if needed
- NRC role is to confirm safety case has been made
- 1974 Energy Reorganization Act (ERA) requires RES to not engage in research that is licensee/vendor responsibility in support of a submittal:

  "The regulatory agency should never be placed in a position to generate, and then have to defend, basic design data of its own The regulatory agency must insist on the submission of all of the data required to demonstrate the adequacy of the design contained in a license application or amendments thereto. This requires professional competence in the regulatory agency to make such determinations as whether substantive data are lacking or whether experimental or analytical data provided by an applicant or licensee are scientifically adequate."
- The sole ERA concern relates to licensee submittals and the potential that RES could get in a position of "assume [ing] any part of the burden of the applicant to prove the adequacy of a license application."
- ERA "It is not intended that the Commission build its own facilities for R&D"

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EPRI Recommendations to RES on Longer Term Research Priorities

- Library of realistic data/methods to resolve regulatory issues
  - Replace data that is out of date, excessively conservative, etc.
- Research to support NRC's timely review of YM licensing app.
- Technologies to improve plant performance & reliability (e.g., I&C)
- Technologies for generic regulatory improvement (e.g , RIR)
- Materials degradation, crack growth, inspection/mitigation/repair
- High Burnup Fuels
- Advanced reactor work to support licensing applications
- Monitor industry research on human-machine interface

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New Regulatory Framework & Future Plant Research Needs

ACRS Subcommittee Meeting

November 6, 2002

Adrian Heymer, NEI

(202-739-8094, e-mail aph@nei.org)

NEI

Need for a New Framework

- Adjust & improve regulatory safety focus
  - Risk-analyses, operating experience and new technical information indicate that regulations may not be correctly focused on those matters that have safety significance
- Current regime based on LWR technology
- Renewed interest in non-LWR designs provides impetus for a technology neutral regulatory approach
- Change management & cultural issues

NEI

Development of New Framework

- NEI Task Force – Vendors, utilities, consultants developed NEI 02-02
  - Defines need & safety benefits
  - Principles & acceptance criteria
  - Regulatory bases and framework
  - Draft regulations to help identify & emphasize issues
  - Frame and emphasize policy and technical issues
  - Catalyst to start the discussion process
- Proposed rule language is secondary to the public discussion on the issues

NEI

Framework

- Strong PRA emphasis
- Two SSC categories
  - Safety-significant & industrial
    - SSC categorized using process based on risk-insights – Similar to Option 2
  - Programmatic requirements only focus on safety-significant equipment
- Minimal change to design & configuration control processes
- Focus is on new plants
  - Potential for use by existing plants providing provisions are satisfied

NEI

Baseline Cornerstones

- Modeled on ROP Framework & Cornerstones
  - Initiating events & prevention
  - Mitigation
  - Functional barriers to radionuclide release
  - Emergency preparedness
  - Safeguards – physical security
  - Radiation safety
  - Worker radiation safety
  - Defense-in-depth
- Design, mitigation, operational, administrative elements

NEI

Mitigation

- For LWRs
  - Design to assure that initiating events (AOOs, PDBEs & PPEs) have mean CDF $<10^{-4}$/yr
  - Mean Large Release Frequency from AOOs, PDBEs, PPEs, & EPBEs $<10^{-5}$/yr
- For non-LWRs – criteria to be determined in design approval activities
- Need for plant performance monitoring, configuration controls & condition monitoring

NEI

Barriers to Radionuclide Release (Containment)

- Focus on functional barrier requirement not terminology
- Sufficient functional barriers to radionuclide release to assure mean frequency of a Large Release from all initiating events defined in the regulations $<10^{-5}$/yr
  - Large Release
    - Release of volatile radionuclides that could result in a prompt fatality to a member of the general public

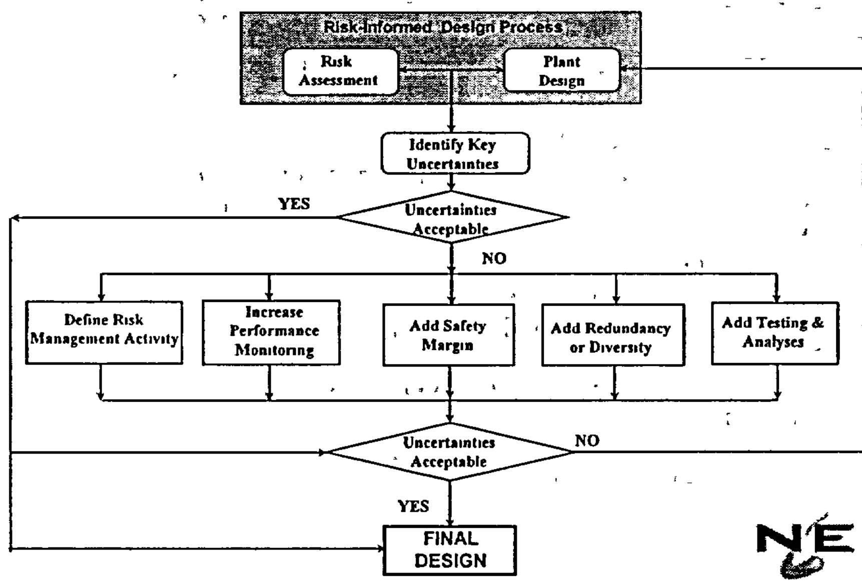
NEI

Defense-in-Depth

- Should be defined
- Integration of :
  - Process,
  - Probabilistic insights, and
  - Application of deterministic design and operational features
    - Compensate for events that have high uncertainty and significant consequences

NEI

Defense-in-Depth Process



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Examples of New Framework

- EQ (§50.49), ECCS (§50.46 & App. K) not replicated in new Part
  - Incorporated into design specifications that, when implemented, satisfy mean probability requirements
- Codes & Standards
  - General requirement relating to use of consensus codes and standards
    - No equivalent regulation to §50.55a
  - Applicable codes & standards for safety-significant equipment approved in design approval/licensing process
    - Listed in design specific Reg. Guides & licensee FSARs
    - Controlled through §50.59

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Use & Approval of Non-US Codes, Standards & Designs

- Establish protocols with foreign national nuclear regulatory agencies to exchange information on designs, codes and standards that have not been approved for use in the US.
- Need for reciprocity
- NRC review should take into consideration information and approvals made by foreign national regulatory agencies
- Long range activity for establishing reciprocity in approvals of reactor designs
  - Secondary to the establishment of protocols for taking credit for technical reviews by foreign regulatory agencies

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Potential Areas for Additional Research

- Issues identified in the development and implementation of technology neutral NRC requirements
  - What are acceptable and unacceptable uncertainties?
    - Define key uncertainties
  - Risk metrics for non-LWRs that reflect the intent of the LWR surrogate safety goals of CDF and LERF
    - Acceptance criteria and importance measures
  - Determination of early/late radionuclide release methodologies

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Potential Areas for Additional Research

- Materials issues, as identified through pre-application process
  - New cladding materials
  - New nuclear fuel configurations
- As identified by the periodic NRC-industry interactions and regulatory interactions on pre-applications
- Scope of research defined by market interest, issues raised in pre-application process & in operational feedback
  - Unique reactor component designs or component materials that US licensees wish to use

NEI

Example of Potential Research Needs Linked to a Specific Reactor Design – Westinghouse IRIS

NEI

EXAMPLES OF IRIS RESEARCH PROGRAM NEEDS

Testing

In-Vessel Components

- Helical steam generators (e.g., T&H behavior, parallel channel stability)
- Immersed spool pumps (bearing and insulating material for nuclear applications qualification)

Integral Effects

- Response of thermal-hydraulically coupled vessel/containment to small and medium LOCAs

10/29/02 VG 1

BNFL Westinghouse

EXAMPLES OF IRIS RESEARCH PROGRAM NEEDS (Cont'd)

Analysis

Assessment and Development of coupled evaluation models for integral systems

Operation

Advanced control and diagnostic systems

- Silicon carbide in-core instrumentation
- Electromagnetic acoustic transducers

Licensing

Risk informed regulation

10/29/02 VG 2

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