UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

MEETING WITH THE ADVISORY COMMITTEE ON

REACTOR SAFEGUARDS (ACRS)

+ + + + +

THURSDAY

APRIL 7, 2005

+ + + + +

The Commission met in open session at 1:30 p.m., at the Nuclear Regulatory Commission, One White Flint North, Rockville, Maryland, the Honorable Nils Diaz, Chairman of the Commission, presiding.

COMMISSIONERS PRESENT:

| | |
|---|---|
| NILS J. DIAZ | Chairman |
| EDWARD McGAFFIGAN | Commissioner |
| JEFFREY S. MERRIFIELD | Commissioner |
| GREGORY B. JACZKO | Commissioner |
| PETER B. LYONS | Commissioner |

NRC STAFF PRESENT:

Dr. Dana Powers
Dr. George Apostolakis
Dr. William Shack
Dr. Mario Bonaca
Dr. Graham Wallis

P R O C E E D I N G S

CHAIRMAN DIAZ: Good afternoon. We are pleased to be here with the Advisory Committee on Reactor Safeguards. The committee supports the Commission in resolving many of the technical issues that confront the agency. We look forward to a good meeting.

I would like to at this moment tell you that due to some conflicts that I have in my schedule, I am going to be here during your presentation, and then I will have to leave. But I'm going to leave you with the quite capable questioning capability of my colleagues. So you probably will not miss me. And if you do, that's too bad.

(Laughter)

COMMISSIONER MERRIFIELD: Mr. Chairman, and I as well. I am here until around 3 o'clock and I may get pulled out of here as well. My regrets if that happens.

CHAIRMAN DIAZ: Any comments?

COMMISSIONER McGAFFIGAN: Mr. Chairman, this is, in all likelihood, is my last meeting with ACRS, and I just want to say at the outset how proud I am of how they and their colleagues at ACNW carry on their activities. I think they are a unique asset in government. I'm glad the Congress had the wisdom, when it was writing the Atomic

Energy Act, to create this body.

As Dr. Wallis, in a private meeting earlier today pointed out, one of the trade press got my remarks at the Regulatory Information Conference wrong. And he listened to the audiotape and knows what I said was, aside from ACRS and ACNW, which I put on a very high pedestal, I believe that the quality of scientific advice that the government gets has deteriorated significantly during my 30 years in government.

But it was meant to be praise and it didn't turn out that way, I think in Nuclear News Flashs or whatever. But it is just an extraordinary capability, to think about the capability of the people we have had on these advisory committees over the years I have been here and the amount of hours they dedicate to public service and the outstanding way they come at us. And they also come at us not always with a consensus which I always appreciate.

I know those powers, addenda, or dissent or whatever, the Wallis dissent, the Apostolakis dissent, the Bonaca dissent, the Shack dissent, but I think that this is a uniquely qualified -- and I know they have them, the government needs more advisory committees like this. Stay with an issue year in and year out. They grow up with issues. They understand the issues at the root detail.

That is not the case for all entities trying to advise the government.

So thank you, Mr. Chairman.

CHAIRMAN DIAZ: Thank you, Commissioner McGaffigan. Any comments?

COMMISSIONER JACZKO: I just want to say I think this has been three days of good information about reactors and look forward to another good briefing.

COMMISSIONER LYONS: I'm looking forward to meeting you folks individually and continuing interactions.

CHAIRMAN DIAZ: With that, Mr. Chairman, the floor is yours.

DR. WALLIS: Thank you, Mr. Chairman. Thank you, Commissioners, for your kind remarks.

It is a pleasure for me to introduce this presentation by the ACRS and to welcome the two new Commissioners, Commissioner Lyons and Commissioner Jaczko.

Well, as you see from the agenda, I will make a few opening remarks describing some of our activities, and since we last met, outlining our future activities.

The rest of the agenda consists of more detailed presentations by my colleagues on five separate topics.

Is it your wish, Mr. Chairman, that we go through all of these and then we have the questions at the end?

CHAIRMAN DIAZ: I believe so.

DR. WALLIS: Okay. Then that's what I will do.

So let's have the first slide, the overview.

Since we last met with you, we have issued 24 reports which are commonly known as ACRS letters. About half of these concern the topics which we will discuss in detail later. And I will just mention a few of those other topics which will not be discussed later by my colleagues.

The first one on this slide is 10 CFR 50.69. It's an important example of risk-informed regulation. We approved the draft rule and moved it forward towards implementation.

The next slide.

We are part of the process for approving the mixed oxide fuel fabrication facility. Our letter recommended approval of the construction authorization and described some features of the plant that will require more thorough examination at the design stage. I note that the Commission issued the construction permit at the end of last month. The next item, after a few attempts, the staff presented us with a satisfactory resolution of GSI-185, and we recommended that it be resolved.

The rule on post-fire operator manual actions is mentioned on this slide as an acknowledgment of the importance of fire risk as a component of the overall risk of many plants.

The next slide.

We have had several activities in the area of future plant designs. We completed our review of the AP1000. We concluded that there is reasonable assurance that it can be operated without undue risk to the health and safety of the public.

This was an input to the Commission's decision to grant final design approval last September and to issue the design certification rule for public comment.

As a result of our experience, we issued a letter describing the lessons we had learned. That's at the bottom of this slide.

And in the middle of it, we have reviewed the pre-application submittals for the Canadian ACR-700, and the General Electric ESBWR designs.

Continuing our activities with future plant designs, we are reviewing the staff's work on a technology neutral framework for new plant licensing. We support this long-term effort, as we believe that the agency will need such a framework in order to evaluate future reactor designs that are markedly different from current light water reactors on which the current regulations are focused.

We have started our reviews of early site permits. We completed our review of the North Anna application, the first ever to be processed by the agency. The process appears to work satisfactorily, although involving huge amounts of paperwork.

The next three slides list our major anticipated activities. Many are continuations of past activities. And you can see that we expect to be quite busy. I will only discuss a couple of these items.

On the first slide, thermal hydraulic codes are mentioned.

Now, for several years, as those of you who have been here will remember, we have encouraged the staff to get the TRAC code into mature form so that it can be widely used throughout the agency and set the standard for what such a code should be.

We still find that it has some way to go before it reaches these objectives.

The last item on the last slide is operating plant issues.

We make an effort to keep up with what is happening at plants, especially significant new trends or developments.

For example, one interest over the past year has been interaction between a plant and the grid, particularly during transients initiated on either side of the interface.

That's all I have, Mr. Chairman, is an overview.

CHAIRMAN DIAZ: Thank you very much, Dr. Wallis. You can continue with the --

DR. WALLIS: I have gained a little time that I or one of my colleagues may be able to absorb later on, depending on how things go.

Moving on to the first --

COMMISSIONER McGAFFIGAN: Does Mr. Apostolakis have a speaking role?

(Laughter)

DR. WALLIS: The answer is yes.

COMMISSIONER McGAFFIGAN: The time will be absorbed.

COMMISSIONER MERRIFIELD: You might say the same thing about this side of the table as well.

DR. WALLIS: Let's move on. The topic is sump performance. The first of our detailed presentations, sump performance in PWRs, not the boilers.

I note that we made a substantial presentation on this topic the last time we met with you, and what we said then is still valid today.

I will begin by describing the main technical features of interest, and then I will give you our view of them and what's been done about them.

The picture that you have represents events following a large LOCA in a PWR plant. The broken pipe is at the center of this orange circular region, which is being called the zone of influence.

The staff has determined that a certain pressure is needed to break up a given type of insulation. The sphere has a volume equivalent to that over which this pressure is predicted to occur in a jet issuing from a broken pipe.

So the insulation gets broken off in this region, and it is disbursed throughout the containment, which is illustrated here by these rather odd looking little hexagons which are flying around the containment in the picture.

Some of it is deposited in various places. Some of it

cascades down to the bottom of the containment where a large pool forms around and in the sump. These processes are plant and break specific.

If the containment sprays are switched on, the water from them adds to the streams, washing debris to the sump, including small debris that was resident in the containment before the LOCA and sufficiently damaged coatings.

After the reactor loop depressurizes, the recirculation phase of the event starts, the core is cooled by water which is drawn from the sump which is equipped with screens and pumped back into the reactor cooling system.

The detailed figure on the right illustrates just one of many designs of the sump and screen system, and it shows three features which restrict the flow of debris to the pump.

Now, a major concern is to what extent the accumulation of debris on these screens may produce such a high pressure drop that the pump will be unable to operate satisfactorily. And there is also some interest in what happens to debris which succeeds in passing through the screen.

The next slide summarizes the recent regulatory responses to this situation.

The staff issued Reg Guide 1.82, Version 3, November 2003. It specified the phenomenal which I have just described and quite a few others which would require analysis. It specified the phenomena which would require analysis.

The Bulletin, 2003-01, requested that licensees respond to two alternatives, either a statement that their emergency core cooling system and recirculation of functions have been analyzed and are in compliance with all existing regulatory requirements. That was the first alternative.

The second alternative was a description of interim compensatory measures to reduce the risks associated with the degradation of ECCS performance due to this debris blockage effect.

All licensees, I believe, except one chose the seconds option, which was to describe interim compensatory measures.

These responses show that quite a few steps could be taken in plants to reduce the risk from these events.

The Generic Letter, 2004-02 requested licensees to perform evaluations of their emergency core cooling system recirculation functions and to take additional actions to ensure system function in the light of identified effects.

Responses to the first part of this letter recently have been received by the staff and we have not yet had a chance to review them with the staff.

The NRC has also sponsored research on these topics. Many results were gathered in a technical basis report. And some new results were developed for the pressure dropped through a bed of fibers and particles for a limited range of conditions. Recently,

chemical effects have started to be investigated.

To assist licensees in responding to the Generic Letter, NEI developed a guidance document and the staff produced an SER which modifies and supplements it.

Now, we had several comments. And I will just summarize some of the major ones from these activities. The Reg Guide described many phenomena, many requirements, but it gave very little guidance on how to meet those requirements.

The technical basis report described a great deal of work but did not give guidance on how to interpret and use it.

The Generic Letter asked for calculations, analyze the phenomenon, predict what happens and so on. Approved guidance on how to perform these calculations was not available at the time the letter was issued.

We examined the NEI guidance, and we concluded that it contained some errors and inadequacies. Some of these are fundamental in nature.

Unless corrected, these errors and inadequacies make it difficult to perform a viable, practical technical analysis of some of the constituent phenomena.

Earlier in our review, we commented that the phenomena was so complicated and plant specific that alternative solutions to long-term cooling should be sought. And the real purpose of this whole exercise is to cool the core by one way or another.

This was partially answered by responses to the bulletin. The responses to the bulletin indicated that there were sources of water which could be conserved and used and the operators could take certain actions and so on. And so there were other ways to reduce the risk of not keeping the core cool. But we think that this area is still worth further study.

We also recommended that risk information should be used to guide the development of solutions to the problem.

We believe there is a need for additional research, for example, chemical effects in the pool and on the screen, the influence of coatings, the effects of non-homogenous and of time on the pressure drop on the sump screens and downstream effects. These are some examples.

And we expect to be briefed by RES during the summer about the research which they are undertaking.

That is all I have, Mr. Chairman, on the sumps.

CHAIRMAN DIAZ: Okay. You can continue.

DR. WALLIS: I will move on to my colleague, George Apostolakis, who Commissioner McGaffigan has been so eager to hear.

DR. APOSTOLAKIS: Okay. My subject is CFR 50.46. This is, of course, the ECCS rule which is considered as the cornerstone of the current regulations of the Commission. And risk-informing it raises some very interesting issues as well regarding the philosophy of the regulations, defense-in-depth and so on.

This rule was promulgated more than 30 years ago when the Commission did not have the benefit of risk information. And I'm trying in the next slide to show pictorially what the situation was.

On the horizontal axis, I have the break sizes, and vertical axis is the frequency of a particular size or greater, so this is a complementary cumulative distribution. The curve that is shown there that shows, of course, that the probability of exceeding a certain size decreases as the size goes up was not known at that time.

So people being conservative and cautious they said, okay, let's go all the way to the guillotine break, double end of the guillotine break of the largest pipe in the plant, on the right there, and impose requirements, which are now widely believed to be conservative, requirements regarding the analytical methods that can be used to demonstrate that the plant can handle this break and the assumptions that the analysts are allowed to make in demonstrating this.

Since then, of course, we have received results of many risk assessments for the plants. We have seen results that show that LOCAs do not contribute significantly to, due to pipe breaks, core damage frequency, for example, for a number of reasons. And that small LOCAs are much more likely than large LOCAs.

In fact, I was looking at the PRA the other day preparing for this, and it turns out , and I think these are pretty typical results, the dominant contributor was station blackout leading to failure of pump seals and that was almost 50% of the contribution to CDF.

So given this new information now, this risk information, the question is whether we can do better with this figure, this rule, than what we have now.

So the idea in the next slide is proposed that we consider -- can I have the next slide, please -- a break size that is called a transition break size, TBS, such that for breaks smaller than the TBS, the current requirements, conservative requirements will be preserved. But for breaks greater than the TBS, we will relax them.

Again, it is important to bear in mind here that this is an enabling rule. It does not -- if it's approved, it will not change anything at the plant. And it comes down to confidence, that's really what it is. It is a matter of confidence, how much confidence do you want to have. And again, as somebody has said, how forgiving do you want the plant to be for unexpected occurrences or incidents.

Now, the staff has proposed and the ACRS supports what I have there in the box that even for breaks greater than the TBS, all the way to the double ended guillotine break of the largest pipe, the licensee should demonstrate that the configurations that they operate the plant in, they can cool the reactor in case of a break and the long-term cooling is also assured.

Now, what is coolable geometry? For the time being, that definition that already exists in the books will be used, but in the future, it may be revised. Also the methods that the licensees can use to

demonstrate that they can actually cool the reactor can be -- well, will be different from their conservative requirements right now. But, again, the Regulatory Guide will describe what acceptable methods will be.

And the committee felt very strongly that this Regulatory Guide will be critical to the success of this rule. So we are looking forward to interacting with the staff when the staff starts preparing this guide.

This is an enabling rule, as I said, in the sense that nothing will change. But the licensees will, if they wish, can come back to the Commission with a request for change, operational changes, for example, using the risk-informed approach. And the committee agrees with the staff that the principles and methods of the Regulatory Guide 1174 that guarantee that these changes are small, acceptably small, were acceptably small has been defined by the Commission that this is the way to go.

There are some questions as to how much of what is in the Regulatory Guide should be in the rule itself. But that is more of a detail than an objection.

The issue of risk bundling, this means that the licensee can come to the Commission and propose changes that will be related to LOCAs, but also will include other changes at the plant. And the total will have to satisfy -- to be below the Commission's allowed increases, if there is an increase.

The committee supports that, although the committee also would be very much interested to see what the public comments will be on that issue because the staff is requesting public comments.

So, in essence, what we are saying here is that the committee has -- is supporting the staff's position on these matters.

Now, where is that TBS? This is a question. Life would be much easier if we were able to say it's this size. As usual, we can't.

The Commission has directed the staff to define TBS as the break for which there is a frequency of ten to the minus five per year or less, that the break would be greater. The problem is that the curve I showed in the first slide is not unique.

And here I'm just showing for illustration, three different curves. So if you draw the horizontal axis line from ten of minus five, you see that you get three values for the TBS, which may differ significantly. And the reason why you get different curves is because there are uncertainties in the minds of experts, the way the expert opinions are processed, but also the assumptions, other methods that experts are making.

And of course, the perennial issue that the regulator has to worry about, what if something that I have never thought of happens, which is a traditional defense-in-depth approach.

So in this particular case, we have had an expert opinion elicitation exercise. And the committee has interacted with the staff several times on this.

The decision makers, the regulatory staff is fully aware of the uncertainty of doing such exercise, and they list a range of break sizes, for example, PWR, if one chooses to go with the mean values from the experts that are between five inches and seven inches. And on top of it, of course, again, we would allow the defense-in-depth extra size, and the question is, of course, how much should that be?

The staff for PWR is proposing that it should be the largest pipe attached to the primary coolant loop. And they give reasonable arguments, but this is something to be discussed further.

One other thing that may inform this process is what we have in that box there, that a lot of people are talking about the safety benefits that will result if this rule is adopted. But we have not really seen a rigorous quantitative assessment of these benefits.

So, the way we see these is that the expert opinion and elicitation exercise informs the decision-making process of selecting the TBS. It's one of the inputs, in other words, but we would really like to see also a quantitative evaluation of these other safety benefits regarding, for example, the containment spray system or the start up time for the diesels and others, in order to be better informed when we select the actual TBS.

The remaining slides, more or less, repeat a lot of the stuff that I have said, but let's go over them.

On Slide 19, the major, of course, recommendation is the first bullet, that both the report and expert opinion elicitation and the proposed draft rule should be issued for public comment.

Then, the other two bullets I have already covered on 20.

The second bullet is maybe a little puzzling to people. This is very important, though. That when we do exercises like this, where we elicit the opinions of experts, we are not doing it because we really what to know what expert X knows or expert Y.

We want that group of experts to develop or to help us develop a distribution that is representative of the community of experts out there. I don't want, after I do all this, to have a guy come from an obscure laboratory someplace and so say, no, no, no, the pipe breaks frequency is this.

Now, this was not emphasized in this particular exercise. On the other hand, this is not a major or even a minor drawback because they were very careful when they selected the group of experts. So we believe that it was a representative sample of the experts, of the expert community.

So even though they were not really explicitly asked what do you think the community thinks, we believe that the final distribution is very close to what one would get even it one had asked that question.

And the final slide.

The first bullet repeats what I said earlier about the expert opinion results. Informing the process, that should not be taken literally

that this is the result and we should go with it. There are other issues that one may want to consider.

And the last bullet is again, that we would really like to see this quantitative evaluation of the safety benefits to be able to be better informed when we actually say this is the TBS and these are the reasons for it.

So with 3.36 minutes remaining I yield the floor back to the Chairman.

CHAIRMAN DIAZ: Thank you very much, Dr. Apostolakis.

DR. WALLIS: We move along to the next one. The next presentation is about the PTS reevaluation project and will be given by Dr. Bill Shack.

DR. SHACK: The ferretic steels that we use for reactor pressure vessels undergo a transition from tough ductile behavior at high temperatures to brittle behavior at low temperatures.

For unirradiated vessels, this is not a problem. The vessel operating temperatures are well above the ductile brittle transition temperature.

However, radiation increases the transition temperature.

In the 1980's, there arose a concern that thermal transients involving rapid cooling of the vessel could cool the vessel into this embrittled region lead to failure. Thermal shocks in which the pressure remained high were thought to be the largest threats, so we came up with the pressurized thermal shock.

The NRC in the '80's developed the PTS rule to prevent such failures. The rule introduced a screening criteria for the transition temperature of the vessel. And as long as the ductile brittle transition temperature remained above the screening temperature, the probability of vessel failure was very low.

Next slide, please.

It was recognized even in the '80's that the estimates they had of the screening for the temperatures were quite conservative. But again, it is a complex problem involving many aspects and it is difficult to grasp all the uncertainties.

But again, there is a number of plants during the original 40-year license. Only a few plants are approaching that original conservative screening temperature. A larger number of plants would approach the screening limit during the license renewal period. So it becomes a larger concern and it has more impact.

Even the original impact was quite substantial in the sense that the plants introduced flux reduction programs. Essentially, they made the reactors more inefficient in order to reduce the irradiation reaching the vessel.

The staff has undertaken a reevaluation of, and to tried to develop a technical basis for a revised PTS rule. This reevaluation project includes a comprehensive study of the scenarios that lead to PTS. And this again is a PRA kind of requirement.

One of the unique features here is that in the original analyses, people looked at various scenarios that might lead to rapid cooling of the vessel, but they ignored things like operator actions that could mitigate those scenarios or operator actions that could, essentially, aggravate the scenarios. Both of them were tried to be considered in the current reevaluation process.

We also tried to do more realistic evaluations of the thermal hydraulic of the PTS scenarios. Again, everything depends on the temperature to which the vessel is lowered and the rate at which that is lowered. So these thermal hydraulic uncertainties have a big impact on the potential for thermal shock.

Another large uncertainty are the distributions of flaws within the vessel. Again, normally, we think of most of these flaws as being present in the wells. Flaws occur in wells in kind of a natural way. RES undertook an evaluation of some vessels that had been constructed but plants were cancelled so they become available, did a characterization of those and have developed more realistic distributions for flaw density and geometry. Again, another important ingredient in trying to get a more realistic understanding of the potential for thermal shock.

Finally, one has to do an analysis of the impact of these temperatures and the vessel materials on the fracture behavior that's done with a fracture mechanic's code. They have improved the fracture mechanics analysis code that was, again, over the models that were originally used and originally developed in the 1980's, and have a much better characterization of the uncertainties associated with the embrittlement of the vessel.

And finally, all these were done with a systematic consideration of the uncertainties. Rather than trying to bound answers initially, they essentially considered the uncertainties as best they could. Again, obviously, you occasionally have to introduce some conservatisms where you really can't characterize the uncertainties, but an attempt was made to systematically characterize the uncertainties associated with every aspect of this project.

The next slide.

Just shows that this has been a project of considerable interest to us. We love projects with equations and codes and numbers and data and results. And just sort of go through this list.

Next slide, please.

One of the things that you not only have to evaluate the frequency of the vessel failure, you have to decide what is an acceptable frequency of vessel failure. And we have defined or the staff has defined vessel failure here in terms of a propagation of a through wall crack.

Now, the real consequences of this will depend on the actual size of the crack. If we just propagated a small crack, we might have a very small leak, and the consequences would be very small.

Obviously, a large crack that immediately split the

pressure vessel would have enormous consequences. The large cracks would lead to core damage, large asymmetric loads on the piping and containment.

The staff has made the argument, because we are in a pressurized thermal shock, you have lowered the temperature. The good news about this is that that essentially lowers the energy of the whole system. So the threat to the containment, even for a fairly large crack, might not be as large as you think.

But to avoid the complexity of determining the containment response, it's conservative to assume that vessel failure leads to core damage and LERF, and use the LERF criterion as the acceptability criterion, to assume that every vessel failure, every propagation of a through wall crack leads to a release to the environment.

So that is a conservatism that is introduced.

COMMISSIONER McGAFFIGAN: Mr. Chairman, even for me, and I am sure for our two new members, are you saying -- do you have a number for the criteria?

DR. SHACK: One times ten to the minus six.

COMMISSIONER McGAFFIGAN: Okay. You are comfortable with that number, that's what that slide says?

DR. SHACK: Yes.

When you look at the results of the analysis on the embrittlement of the vessel and the acceptance criteria, you find that the current screening criteria on the, essentially the embrittlement temperatures that you can reach, are very conservative.

The staff has carried out this analysis for three particular cases including two vessels which are among the most embrittled and most susceptible to PTS in the fleet. And again, you show that the vessel failure frequencies remain very low even through a full period of license renewal operation. So they are down in the ten to the minus eight region, well away from your screening criteria or your acceptance criteria.

One of the other benefits from this effort has been the improvements to the probabilistic fracture mechanics code, and what we have learned about the characterization of irradiated materials and the development of more realistic flaw distributions. It is not only useful to understanding the impact of pressurized thermal shock, but could also provide a basis for reducing unnecessary conservatism in limits on heat up and cool down.

So, again, vessel embrittlement has important consequences not only during accidents, but actually during operational considerations.

A project of this magnitude it is important, essentially, to protect the investment that the NRC has made by a thorough and comprehensive documentation that can be subject to peer review and helps build confidence and usefulness in the results.

We reviewed the initial draft technical basis report, and

we thought that it needed substantial revision to describe some of the basic phenomena issues and approaches more clearly.

The staff did undertake a peer review.

Next slide please.

And we believe the external peer review was very valuable. The reviewers brought up some important issues. And the staff response to the criticisms and the questions that the peer reviewers raised, we believe, has strengthened the technical basis that has been developed for the PTS project.

The documentation for the project is not yet final. They have made substantial progress on it. I think we will have documentation that really does preserve the effort and the information that's been developed. And we believe that it's been an impressive technical achievement by the staff and its contractor.

Mr. Chairman.

DR. WALLIS: Thank you. I know Dr. Shack, as did everyone else, met his time commitment. The next presentation is by Mario Bonaca on license renewal and extended power uprates.

DR. BONACA: Good afternoon. I will start with license renewal. I will not read through my first slide. I think the slide speaks for itself.

We have had a significant workload associated with license renewals. For next year we are planning seven interim reviews and six final reviews.

In addition to the review of license renewal applications -- next -- we are also reviewing updates to the generic license renewal guidance, specifically the Standard Review Plan, the GALL report, and Regulatory Guide.

We continue to review improvements to the license renewal process. We are in good communications with staff on changes which are being planned. And also, we are reviewing interim staff guidance on the license renewal issue when it comes about. Typically this is an interim guidance between updates on significant issues to ensure that the licensees address consistently requirements of the rule.

Because of effective communication between the staff and the industry, license renewal applications are becoming more consistent in their interpretation of components and acceptable aging management programs. As a result, the last three applications have come to us with no open items, and our reviews also are becoming more routine. And they should be that way.

We have had opportunities to contribute to the effectiveness of license renewal.

Next.

COMMISSIONER LYONS: Can I interrupt just to ask what the GALL report is?

DR. BONACA: It is a Generic Aging Lessons Learned.

COMMISSIONER LYONS: I thought I was learning the

various acronyms. But I have discovered in reading this today that some I haven't heard.

DR. BONACA: I think we have a list of the acronyms in the back.

Next slide.

Our comments and recommendations have resulted in a number of outcomes.

A Generic Letter is being considered by the staff concerning the failures of inaccessible underground cables that disable accident mitigation systems. These are typically medium voltage cables not qualified for most environments. There have been a significant number of failures that were not detected until a demand was placed on the equipment power by the cable.

The Generic Letter would essentially request a licensee to assess the adequacy of their surveillance program to ensure these kinds of failures are detected.

We also recommended that adequate information on time limiting aging analysis associated with reactor vessel embrittlement and verification by the staff be included both in the license renewal application and the SER, for the information required for us to perform our assessment. You may remember, I brought up this issue about a year ago.

Next page.

We have recommended that steam dryers be included in scope of license renewal for Dresden and Quad Cities. They definitely meet the definition of passive long lived components whose failure could cause impact on safety related equipment.

We have proposed a number of revisions to the GALL report to ensure that, first, the inspection frequency for buried piping is adequate. Here is the issue of periodic versus opportunistic inspections. The GALL report recommends periodic inspection. Licensees, of course, would rather go with opportunistic ones. And I think we have reached some compromise which is an acceptable position in the new guidance.

Also, we propose revisions to assure that aging management of steam dryer cracking due to flow induced vibration is addressed. Same issue that we sought for Dresden and Quad Cities.

Next page.

We have recommended that for plants which have recently gone through EPUs, extended power upgrades, and have really not accumulated experience at that level, license renewal be approved but then before they step into license rule they perform an evaluation to assess the commitments they have made to address aging management -- aging problem -- degradation are adequate also at the EPU level.

I would expect that would not be an extensive evaluation, but I think would allow to capture some of the consequences of the EPU -- we have seen a number of those -- and capture them in the

aging management programs.

COMMISSIONER MERRIFIELD: I'm sorry. You need to clarify that.

I know the language you used but could you briefly walk through the timing of which would come first.

DR. BONACA: Sure. Let me give you an example. The example is the one on Dresden and Quad Cities. They had an EPU, and in the first part of the operation, they had a significant number of events happening, including the steam dryer failures.

But if you look at the license renewal that came to us, all the operating experience addressed previous experience. It did not include this new operating experience.

So, the concern is that over the next year or so -- in fact, the BWR OG has identified a significant number of components failures, most of them are minor but they should be captured in aging management programs.

So it would take some time for them to accumulate sufficient information to perform these evaluations. So the requirement will be the one of performing these assessments before they step into the actual license renewal period. Looking back at this additional experience, making sure that whatever they have committed to in license renewal is adequate, also at the EPU level.

COMMISSIONER MERRIFIELD: So you are saying at the time when they will have been granted a license renewal?

DR. BONACA: Yes.

COMMISSIONER MERRIFIELD: But at the time when they go from the 40 years of their original term to the 41st year, at that point, they would have to make a report on the information that they have received from the time they obtained the license renewal to the point they would actually take advantage of the license renewal?

DR. BONACA: Exactly. And that's really capturing some of this information. I would not expect that it would be a significant effort. It would be purely a review of operating experiencing, and the question is it inconsistent with what we assumed in the license renewal.

Finally, we have also recommended that Research study the need for phosphate limits at sites of plants applying for license renewal. Typically, the acidity of soil and ground water on concrete is based on criteria of PH, chlorides and sulfates, and we question whether phosphates should also be in the criteria, and they are looking at that.

Now, I will move on to extended power uprates. Since we met a year ago, we have reviewed Waterford 3. That was an 8% extended power uprate. Not much higher in percent than we normally review which is stretch power 5 percent; typically we don't review.

This was the first review that NRC has performed using the EPU review standard RES-001. And we feel that the results are very good. I think we thought it was a good review, a good application also.

The EPU is similar to the one that we reviewed previously for Arkansas 2.

In our letter, we essentially supported the staff recommendation that large-transient testing not be waived because other approaches are more appropriate in this case. Specifically, approaches include a testing program for each plant modification supporting the EPU as well as an evaluation of interactions among the modifications.

This recommendation on our part was not unanimous. You may remember, two of the members dissented with that.

Clearly, there is some engineering judgment that is being used. But the letter we provided to you recommends or supports the staff decision to waive the test.

Next page.

For Waterford 3, calculations were performed of health analysis, and identified a generic concern regarding a boron concentration and precipitation issue during the LOCA. This concern does not affect in any way Waterford 3.

And the reason is that for this EPU conservative analysis is the most threat to the significant margin to the boric acid so the ability limit would be maintained. That is assurance the long-term cooling can be successfully achieved at Waterford.

The concern is more tied to the identification of a weak technical basis for evaluating the boron precipitation issue when the concentration of boric acid becomes close to the solidity point of boric acid. There are tests that are more qualitative than quantitative. Concern is that you may come to an evaluation where margin is less, and therefore, is difficult to leverage information available to make a judgment.

And we essentially encourage the staff to develop a more effective basis from what exists, probably, for a quantitative assessment of phenomena influence in boron precipitation.

Finally, we concluded that the EPU should be authorized.

Moving on to the next page, I have listed here the 5 EPU requests that will come to us. None of them is in front of us yet, but we expect to be involved in them.

My presentation is over.

DR. WALLIS: Thank you.

The next and final presentation will be by Dana Powers. The subject is the differences in regulatory approaches between the U.S. and other countries.

DR. POWERS: In one of your previous communications to us you asked that if in the course of our work we observed any emerging divergences in either the safety or safety regulation of plants in other countries, that we report back to you.

What I'm here to do today is to give you a status report and to assure you we will be doing that.

On the first slide, we do have an opportunity in our work

to interact with colleagues from other countries, and so there is some opportunity to observe some types of changes occurring in regulatory systems. I have to assure you that the focus is on BWRs and PWRs. We don't have a lot of interaction with either CANDU systems or gas cooled systems. But I think BWRs and PWRs are a primary interest right now.

We thought it would be useful in undertaking this task first to send you a baseline report of where the regulatory systems stand as they do now. And Mr. Hossein Nourbakhsh from our staff put together, I thought, a nice report that discussed some of the similarities and differences in regulatory systems in various countries.

I think if you look at these regulatory systems, the first thing you are struck by is that there is a strong influence of the American system. This is not all together unsurprising because we are, after all, the first to have to establish a regulatory system for safety.

The plants continue to have great similarity of design. And so we would hope there would be a similarity of safety focus. This is certainly the hope that exists in Europe, that we not have gross divergences developed in regulatory systems.

There is a strong sense within the world's reactor community that accidents taking place any place, in fact, take place every place. So they are sensitive to accidents occurring in other countries.

The other overwhelming sense you would get is that there is a great deal of similarity with respect to deterministic analysis and some of the philosophy of those deterministic analysis.

Defense-in-depth appears in nearly all regulatory systems. ALARA appears in the regulatory systems -- well, there is the exception. Our colleagues in the United Kingdom, of course, feel an obligation to demonstrate that the British and Americans are two people separated by a common language, and so they call it as low as reasonably practicable.

There are differences in the particulars of implementation. And you see this not only between the United States and the European countries or the Asian countries, you see it actually within Asia and within Europe. Some of the details of quantitative nature and implementing defense-in-depth.

There is some effort going on, especially in the European communities, to get what they call harmonization of their regulatory philosophy and a certain commitment to a required level of safety.

Quite frankly, it is my perception that this effort to harmonize the regulations among the various states is not going especially well. You can imagine the challenges that might be faced politically when you have to give up some sort of a safety regulation. It is not easy as you gentlemen, of course, are well aware.

There are some divergences that may be appearing, and I list a couple on the next slide.

PRA is a technology that is being adopted, espoused and

exercised in just about every nuclear country. The use to which PRA results is different.

And the United States, of course, where we have had 30 years of experience with PRA and honed our techniques quite well, we are making aggressive use of it as part of our regulatory strategy.

In many of the other countries, it is still looked upon as an adjunct to the more deterministic approach to safety analysis of nuclear plants. It is recognized to be a mechanism for getting an integrated view of plants but more as an addition to, rather than a supplement for, the deterministic analysis.

We also see, especially in Europe, some greater attention being given to actions that one might take in the event of a severe accident, so-called accident management measures, where they take a more aggressive approach to it and incorporate it as a regulated activity rather than an activity we leave to the licensee itself.

There has been some concern that there may be differences in the approach to some of these issues we discussed today such as some blockage in vessel head penetration. In fact, we find none. That the status of understanding in the various countries is about the same. And in fact, there is a fairly substantial international effort to try to solve these as a nuclear community rather than on a country-by-country basis.

Let me just conclude that, indeed, we shall do our best to be aware of any emergency divergences that might appear in the regulatory or safety approaches in the various countries and report to you as we identify them.

DR. WALLIS: That concludes our presentation, Mr. Chairman.

CHAIRMAN WALLIS: Thank you, Dr. Wallis, and members of the committee. I do appreciate the presentations and the efforts that are behind the presentations.

At the present time, I'm going to have to excuse myself and leave you in the able hands of Commissioner McGaffigan and on the questioning hands of my fellow Commissioners. And I wish you well.

COMMISSIONER McGAFFIGAN: Commissioner Merrifield?

COMMISSIONER MERRIFIELD: Thank you very much.

First off, in terms of a --

COMMISSIONER McGAFFIGAN: Why don't we go ten minutes, and I think that will leave time for a potential second round.

And with Commissioner Merrifield, we will give you as much as up to 15.

COMMISSIONER MERRIFIELD: I think 10 will be sufficient for me.

I think the first comment I want to make which we have not touched on today, we have had a change since the last time we had ACRS in front of us. And that is a staffing change.

Recently from a management perspective, we have moved Ashok Thadani over to ACRS. And I wanted to make a public acknowledgment of the fact that I think this is a significant change. And certainly, one which incorporates the seriousness and high regard in which the Commission holds ACRS, the desire to have a greater degree of nexus and connectivity between our staff and ACRS. And I think this is an excellent thing.

This change, I think, is an excellent thing for the agency as a whole and certainly the relations between ACRS and the Commission. So I did want to publicly acknowledge the fact that we have taken someone with extraordinary experience in the agency and someone with whom we hold high regard and placed them in a position of importance in relation to the committee.

On the issue of sump performance, I guess there are a couple of questions that arise coming out of that. I looked at the nature of the letters and the interchange between the staff and the committee.

One of them -- we have a variety of letters here. So I apologize for my -- we had a December 10th letter in which, obviously, on behalf of the committee, then Chairman Bonaca said at the bottom line that you "continue to believe that both the safety evaluation and the Nuclear Energy Institute guidance document contained technical faults and limitations that will have to be corrected at some stage in order for the methods to be sufficiently robust and durable to support sound regulatory decisions."

In a minority additional comments, our current chairman made a comment, "To justify actions which may have a major impact on operating plants, the staff needs to do a better job of explaining the rationale for regulatory decisions, particularly with a technical bases. and assumptions are questionable."

There are other letters that contain similar types of language. And in a discussion we had today, obviously, you outlined some of the concerns that the committee continues to have.

I guess my first question associated with this issue in particular, PWR sump performance, how do we get to a point where we can improve the level of interchange between our staff and ACRS to resolve some of these issues?

And where we've got some professional disagreements here, do we have really the right mechanism for resolving some of those, and do you have any suggestions for improvement as to how these interactions and dialogue could take place?

DR. WALLIS: We do operate in a fairly formal way. We give advice, and the staff is free to take it or not.

We do occasionally on a sort of one-on-one basis meet with the staff to try to clear up some things. But we can't do that too much. We can't do it as a committee.

I think from our point of view, there comes a point where we have to simply let go and say we have said what we think is right, and it's now up to the staff to take it or not take it.

I don't know what else we can do. We don't manage the staff. We don't make their decisions.

I do understand that some of the industry has taken our comments seriously. That's from talking with people.

And I think, eventually, if we are right on some of these issues, they will turn out to have to be considered.

I think the big risk is if the staff is wrong, and proceeds to accept something which then turns out to be unacceptable, then, the job has to be done again.

COMMISSIONER McGAFFIGAN: Commissioner Merrifield, without taking from your time, this sort of formal process, for instance, have you been briefed as a subcommittee on, say, the latest Los Alamos/University of New Mexico results? Are you kept abreast? as this issue moves along?

DR. WALLIS: We have not heard about that for some time. What you mean by the latest I'm not sure. But we have not had a presentation.

COMMISSIONER McGAFFIGAN: I'm not trying to take time.

Dr. Powers seems to be saying yes. That may be because he is a New Mexico-based person.

DR. POWERS: Well, in fact, we have completed an examination of one of these research programs as part of this quality research reviews that we are doing on that particular individual task. And that's, what, two months old. But that's not very old.

DR. WALLIS: That's right. It's work which they did last year.

COMMISSIONER McGAFFIGAN: There apparently -- again, we have heard recently of results that may lead to -- well, one of your recommendations will be implemented by the staff. There will be more research on chemical --

DR. WALLIS: Well, you may be ahead of us.

COMMISSIONER McGAFFIGAN: I don't like being ahead of you. But I will turn it back over to Commissioner Merrifield.

COMMISSIONER MERRIFIELD: I mean, I have been hearing -- I think part of where I was going with this question and, you have gotten there before me, which is fine, and that is I think that this is an issue, obviously, that the staff treats with a great degree of seriousness as do the utilities. And I think, perhaps, there has been additional work and information in the period since the last letter came forward.

And obviously, you had to take a snapshot in time because that was when you had the last letter to the Commission. But, obviously, we need to make sure that that keeps updated so that we are getting the freshest information from all of you for the decision making effort.

DR. WALLIS: Right. I have not seen it on our schedule. So I assume that the staff has not made our staff aware that they are

ready to present new information to us.

It is certainly noted that we ought to follow this up.

COMMISSIONER MERRIFIELD: Setting that aside briefly, I would say one of the outcomes I think some utilities are taking from this is to say we need to increase the amount of the strainer room.

Have you looked at that issue? Obviously, one can study all kinds of things, but if there is simply a practical application to resolve the underlying problem, is that something that you all have looked at and thought maybe that might be the right way to go about it?

DR. WALLIS: Well, it is clear that with a big enough strainer, you can do it. The difficulty comes in whether it will fit in some of these plants.

I think that there is a question of how big it needs to be. You have to make some decision about how big it needs to be. So there has to be some criteria and acceptability.

And my view is we have not really got to the solution yet. The staff is still finding out what the problem is. It is asking the utilities to make calculations so that they can determine if there is a problem or not.

And the solution part is coming later in the year. We have not really looked at that at all yet. I'm sure we will.

I know that the French have been reviewing increasing the size of strainers by an order of magnitude. But I don't think it has yet been implemented. But that seems to be the solution they are going for.

It is the most obvious one, perhaps. But there are strainers that do other things, there are active strainers and strainers that clean themselves, and so on, which may be a better solution.

We have not gotten to that stage yet.

COMMISSIONER MERRIFIELD: Okay. On slide 29, you noted in NUREG-1809, thermal hydraulic evaluation of pressurized thermal shock needs to be substantially revised.

And I'm just wondering, without going into too much level of detail, if you can explain what you think are the revisions that are needed? You had a chart in here that talked a little bit about the timing of all of the work that has been done on pressurized thermal shock, and I think some of us are looking for the end of the tunnel as to when we are going to come to a policy resolution of where we want to go on this. If you could give some sense of where you think that may be?

DR. SHACK: I believe that research is ready to provide this information to NRR for rulemaking. I believe that the technical basis is adequate.

The criterion that they have used, the one times ten to the minus six based on the LERF requirement, is, in fact, more conservative than the criterion that was used in the development of the original 1980 rule, which was five times ten to the minus six and was more a CDF kind of requirement.

The technical basis arguments makes arguments for why the application to the three plants is generic for the whole fleet that we have to consider. And I think that has to be reviewed.

But I think there are good arguments there. But there is still additional work that needs to be done in rulemaking. But the technical basis is adequate to do that. And the documentation of that technical basis is nearing a satisfactory approach.

COMMISSIONER MERRIFIELD: I will withhold any more questions. I will make one last comment.

As you well know, the issue of the review of ACRS on research, matters of research is one that I have been very interested in during the time I have been on the Commission. And I would be interested separately to get a little bit better understanding of some of the research products that you intend to review in the coming year and the methodology you will be using to go through those.

But that is an issue for, perhaps, a separate briefing for me.

Thank you.

COMMISSIONER McGAFFIGAN: Thank you very much.

Commissioner Jaczko. And I do warn you that when you were out of the room, I tried to, since I was one of those who you were probably addressing at the Reg Info Conference, I tried to correct the pronunciation of your name. And I may have just messed things up further. But I did my imitation of you.

COMMISSIONER JACZKO: No. It sounded fine.

I wanted to talk a little bit about something I talked about yesterday in our new reactor Commission meeting. I asked a question about the Standard Review Plan for new licensing activities. And one of the things that I learned there is that we have a document and parts of it are -- a large chunk of it was last revised in 1996. Those revisions are still in draft, as I understand. And only a very small part of that has been has been updated since 2000.

And you mentioned in your overview slides, I think, Dr. Wallis, that this is something that's on the list. And Commissioner McGaffigan made the point yesterday that this is often at the bottom of lists. And I noticed I think, on the slide now, it is at the bottom of your list as well.

DR. WALLIS: The very bottom, I think.

COMMISSIONER JACZKO: I think it is the very bottom.

DR. WALLIS: Let's see where it is.

COMMISSIONER JACZKO: Slide 7.

And I just wondered if you could talk a little bit about what kinds of activities you have planned in that area, what you think the priorities are that would need to be addressed with the Standard Review Plan?

DR. WALLIS: I'm trying to think of what your question is.

COMMISSIONER McGAFFIGAN: There actually are actually several -- as I understand the staff process, God help me, I

have yet to look at a Standard Review Plan in eight and two-thirds years here, if I have, it was a mistake. But there are many Standard Review Plans for different purposes, license renewal, and --

DR. WALLIS: All kinds of Standard Review Plans. This is a very generic thing.

COMMISSIONER JACZKO: This would be the Standard Review Plan particular for new licensing. And I'm not sure that that's something you --

DR. WALLIS: Did you have in mind for new kinds of reactors?

COMMISSIONER JACZKO: For light water -- a Standard Review Plan -- not necessarily for new licensing but licensing light water reactors.

DR. WALLIS: I don't know that we have any activity on that.

John, did you want to say something.

MR. LARKINS: The staff has an activity to update the whole Standard Review Plan. They are going through updating codes and standards in there. We are working with them to do that in parts as the staff develops them.

COMMISSIONER McGAFFIGAN: This is the SRP for advanced -- for new reactors.

MR. LARKINS: This is for 0800, I believe it is.

COMMISSIONER JACZKO: Yes. And I think that was the document we were referring to yesterday.

I just raise that again because I think this is something that -- and I think one of the reactions we got from yesterday was that this is something that really right now, we are kind of making do, and as we, perhaps, begin a new arena of reactors –

DR. WALLIS: I mentioned this technology neutral framework which would be very useful. If we have that framework, then we would have sort of a intellectual map which would enable to us now look at the Standard Review Plan or maybe conceive a new Standard Review Plan or for the staff to conceive it.

So I would very much personally, not speaking for the committee, like to see this sort of intellectual map of how one should go about writing regulations and things for a new reactor.

COMMISSIONER JACZKO: And that's one of the issues that we often, as Commissioner McGaffigan said yesterday, we often put these things near the bottom of the list but they are very important for the process.

DR. WALLIS: They may become very important.

COMMISSIONER JACZKO: Exactly.

COMMISSIONER MERRIFIELD: Just for clarification, because perhaps my take was a little different than yours.

I didn't take it from the staff's comments that they thought that the 1996 version of the Standard Review Plan was inadequate in a way that would question our safety review. Perhaps there could more

efficient and effective ways with an updated plan.

Unless you got a different view, I didn't think that there was anything that said it was inadequate to meet our safety mission.

COMMISSIONER JACZKO: I think that was -- I guess that was, in many ways, the -- I didn't feel that I got an answer to that. And I don't know -- I think that's something that because of the -- there is a large, as I said a large portion of that is out of date, that it is unclear whether it is sufficient or insufficient. I think that's where we stand, and certainly why I think it would be helpful to hear from you folks about that.

DR. WALLIS: Yes.

COMMISSIONER McGAFFIGAN: Again, we are not trying to -- neither Commissioner Merrifield or I are trying to take from Commissioner Jaczko's time, but I'm of the same view as Commissioner Merrifield.

The reason these things don't score high is that it's usually a safety and security benefit, but they made interim changes. And that stuff sort of piles up and not all in one place, but they are making do.

And whether it's the standard review -- if it is being used all the time -- and Dr. Bonaca talked about the Standard Review Plan for license renewal and extended power uprates, if they are used all the time, they are updated. And the industry and the staff make it a high priority.

If they are not used all the time, my sense is -- and I'm looking at the EDO -- that it is a lower priority because you can make do.

COMMISSIONER JACZKO: And I guess my point is that, obviously, when we are talking about licensing, we are not doing -- other than licensing renewals, we are not doing licensing activities. So the Standard Review Plan for that, for big things is not being used and not being updated.

And my concern is that we may find ourselves, if we are in the situation where we are doing that, that because we have not been updating it, that nobody is really made it a priority to take a look to see if it is adequate at this time.

I agree that if there are documents that we are using on a regular basis, we probably have a better patchwork of information. So it's more the issue of those documents which we may be called upon to rely on in the near future that we are taking a look now to make sure that those are adequate.

COMMISSIONER MERRIFIELD: Okay. I mean, not to belabor this, and that's perhaps a question we can ask the staff. But I want to -- there's sort of a nuance in the terms. I sort of take the word "adequate" to mean already fulfilling our safety mission through that document.

There's a difference between that and is that the most efficient way that we can use to conduct that review.

We conducted number of license renewals before we came up with a generic lessons learned program which made the license program more efficient in our review. That does not raise an inadequacy on the part of the earlier license renewals before we did the GALL. But it does make the review after the GALL more efficient.

That was my sense of the analog between those reviews. It's a fair question.

COMMISSIONER JACZKO: That is an issue for the staff. And I think I would say to you that I think it is something that in your role if you are looking at these things --

DR. WALLIS: In the case of AP-1000, we didn't need a new review plan. The old one was fine. In the case of power uprates, this committee actually recommended that there be a new review standard, and it was very well produced by the staff.

COMMISSIONER McGAFFIGAN: We do about 1,500 licensing actions per year in NRR. And there is a Standard Review Plan that guides a lot of that licensing activity and is exercised, but not all at once.

MR. REYES: If I could just add. When you do a particular licensing action, and you mention we do between 1,100 and 1,500 a year, depending on the budget. We use that every time we do a licensing action, because it's about a system.

And you have to go back and look at the Standard Review Plan on that system and make sure of tech spec changes. So these documents are used all the time.

Now, 1996 is when -- the last plant that was licensed in this country was Watts Bar 1 in 1996. That's where the number comes from.

But these documents are being used.

Now, you have an excellent point which is that for knowledge transfer, we should update our infrastructure.

COMMISSIONER JACZKO: Right. And again, I don't want to belabor this but I think the point being -- I will just close with this -- I mean, the point being that we have many new safety guidance that is not currently reflected in our Standard Review Plan. And in particular if we get into situations in which we may lose that knowledge that's embodied in personnel right now that we are making sure that that is documented as well and that our Standard Review Plan affects what is our most up-to-date safety guide.

DR. WALLIS: Maybe you should also look at reg guides. There are some reg guides that have been around an awful long time.

COMMISSIONER JACZKO: The next thing I wanted to ask about. This is something we talked about, it's differences in regulatory approaches.

And, Dr. Powers, you mentioned that, I think, in your slide that there are some differences appearing with European countries, in particular, you talked about a greater attention to severe accident management measures.

I'm just wondering if you can expound upon that a little bit? I was not quite clear what that referred to.

DR. POWERS: In many of the European countries -- you can't treat Europe as a monolith -- they are interested in harmonizing their safety approaches. That's going to be difficult to do.

But in many of the European countries, the accident management measures take a larger role in the regulatory process because of the licensing structure they have created.

They don't have fixed term licenses. But they do demand that about every ten years a plant go through a rather substantial review of its licensing base, what we would call a licensing basis.

And they are required to stay abreast of modern technology and less tied to what you would call historical licensing basis.

As we developed an understanding on the progression of severe accidents and things that you can do to mitigate the radioactive release, they are asked to incorporate that into their planning.

So you see things like vented filtered containments being incorporated into plant designs, sand bed filters in the French reactors.

You see also a lot of attention toward mitigation measures with respect to iodine and things like that. A little more aggressive attention to it. There's no real precise translation, because you see an inherently stronger emphasis on land contamination in the safety concerns than there might be in this country. A little different.

Does it translate into a common currency of risk to any significant? Not yet. But if it goes further, you know, if you see continuing emergence, then you might actually start to see a divergence in approach. So we keep our finger on the pulse there.

COMMISSIONER JACZKO: One other thing just on this topic. You talked about there is differences in use of quantitative risk assessments. And it seemed to open your discussion saying that in many ways most of the world follows largely a similar model, the largely similar plant designs and all. And a lot of that is derivative on NRC activities.

It seems that there is some slight differences, as you mentioned, in the use of quantitative risk assessments.

Do you get the impression that the international community is waiting, in many ways, to see what our experience is with moving in that direction and they will likely follow or will they likely stay where they are in the near future?

DR. POWERS: Again, I don't think you can treat Europe or Asia in any monolithic sense here. I think it is different in different countries.

I think in some countries, they are skeptical about any degradation of the underlying safety philosophy based on risk. They are perfectly willing to use risk to augment that.

In other countries, I think you're right. I think it's let's see

how this comes about, how it works, let them exercise it a little bit. And if things look good, we will move in that direction.

COMMISSIONER JACZKO: Who do you think is in that first category?

DR. POWERS: I think that it will be long time before you see the Germans moving into what I would call risk-informed regulation, where they change any of their deterministic analyses based on risk assessment.

I think will you see in Finland and in France much more openness to what can we get out of risk and a more integrated view.

I like to always look at this as when these plants were first created, they were far too complicated for one to grasp them. And so we relied on the model of the chemical engineering industry, which thought in terms of unit operations, and they broke the plants down into trains and things that you can comprehend, and optimized them individually with respect to safety.

PRA gives us a chance to look at things in a much more integrated fashion. And in fact, if you look at the chemical industry nowadays, they have evolved from the unit operation type of philosophy into this much more integrated kind of view.

And so we would like to think we are new, we're not all that new here, and I think you see an openness to that. They may not have taken the same steps we have taken now. But if I had to put money on the table, I would bet you would see an evolution in that direction.

I think you see similar things taking place in Asia. I think you will see the Koreans much more open to evolution in this direction. The Japanese may be a little more conservative.

COMMISSIONER JACZKO: Thanks.

COMMISSIONER McGAFFIGAN: Commissioner Lyons?

COMMISSIONER LYONS: I want to start with a question, if I may, on the review of the mixed oxide fuel fab facility. It was not one of the ones you specifically discussed, but my question is fairly general.

I had heard a little bit, I just heard the words "red oil" before. And I appreciated your discussion that it is neither an oil nor red.

DR. POWERS: It is not an oil and it may not be red.

(Laughter)

COMMISSIONER LYONS: And you address this as one of the potential areas that needs further clarification as it moves through the analysis.

I was curious on the extent to which we are getting information from experience in other countries with MOX fuel fab and the extent to which we are either following the practices in other countries, particularly France?

In other words, is this a phenomena that is going to be unique to our plant or is this a phenomena that is well understand

elsewhere?

DR. WALLIS: Dr. Powers will answer this question.

DR. POWERS: Red oil is something that we have known about in the course of doing solvent extraction for nuclear materials. I think 1963 is the first report I remember of the occurrence of red oil.

It is endemic to any solvent extraction process using radioactive material and tributyl phosphate, normal paraffinic hydrocarbon aqueous extraction, where in the recovery or the evaporation cycle, things gets overheated, you find this unstable oil developing.

And do we know exactly what it is? No. Because every time we have an event with red oil, we destroy the evidence in that event.

And what's evolved is a set of standard practices to avoid ever getting red oil. And those practices with the solvent extraction are pretty universal.

They are observed in the MOX fuel fabrication facilities and recovery facilities in France. The new facilities being developed in Japan observe those extractions. So it is empirical understanding.

There's been some fairly good experimental work to try to reproduce red oil formation in the laboratory. Some of the best was, in fact, down at Los Alamos in recent years. But it takes place episodic, where every time there is an event there is a laboratory investigation to try to understand.

The problem is they can make things that look oilish and be unstable. You can never persuade yourself this is exactly what was created in the event that occurred.

An understanding exists but it's very practical in the sense of don't let the stuff get over a certain temperature maximum. Don't let the organic phase age too badly and get too many decomposition products built into it when it goes into the evaporators.

You can contrast this with the hydroxy mean decomposition reaction, where we have detailed kinetics and we know exactly what is going on and we can even predict when it will occur. We don't have that kind of you understanding about red oil.

You ask about do we follow what's going on in other countries.

It is extremely close in the case of the MOX fuel fabrication facilities, since they are patterning the facility after one that is in La Hague, France. So it is extremely close there.

In fact, most of our information or much of our information base on MOX fuel in general actually comes from work going on in Belgium.

COMMISSIONER LYONS: Maybe it's premature to ask, but do you have reasonable confidence that this can be well enough understood to perhaps move beyond semi empirical or phenomenological models for safety into a more rigorous basis?

DR. POWERS: It is not a case of prematurity. We have

been doing these kinds of solvent extractions in this country since the Manhattan project.

This is an extremely complex, relatively rare phenomena, and a set of practical guidelines have evolved that they would like to avoid it. And I think in the letter we point out that most of the operations in the new fabrication facility, they are just adopting these guidelines -- they work fine.

You observe those guidelines, you just don't get red oil phenomena. They have one facility, one storage facility where they can't. They have a closed system. And we will be looking at that one extremely closely as they come up to the design, because they just can't comply with the guidelines there.

And they are trying a different approach. It's a venting and quenching approach. Any principle that will work, but it's one we have less experience with.

The others we have decades of experience with.

COMMISSIONER LYONS: You are describing it in a way that the ACRS and perhaps the Commission should pay careful attention to this as the process moves ahead.

I guess I get just nervous when we talk about phenomenological rules of thumb that have worked for a long time but every once in a while they don't work.

DR. POWERS: I know no counter example where you have stayed within the guidelines and yet had an event. The guidelines are fairly conservative.

And I will assure you there are far, far more processes in this world that are governed by rules of thumb than there are governed by detailed phenomenological understanding.

COMMISSIONER LYONS: I'm not sure that's the good news.

I had a question on the sump performance as well. A comment is made with particular reference to GSI-191, but I think is perhaps a more general comment about it being the judgment of ACRS that there are too many gaps remaining for a technically defensible resolution at this time.

And I was just curious if there could be any speculation on what's needed to close those gaps? Is this an experimental issue, a test issue, a calculation issue?

DR. WALLIS: Try to remember, this is the paragraph where we said it may be, but it is such a messy problem.

COMMISSIONER LYONS: I can well appreciate that. It is messy all right.

DR. WALLIS: That you should look in other ways to cool the core. Is that the context where you took this from?

COMMISSIONER McGAFFIGAN: It's the December 2004 letter.

DR. WALLIS: That was the view of some of the members. I think it is appropriate that that might turn out to be the

case. When you look at all the difference between all the plants, that some of them may say we are going to find a better way to cool the core because it is a better solution than solving all this.

So we put that in as, I think, an alternative. If turns out that it's not the context in which --

COMMISSIONER LYONS: I didn't quite get that from this particular paragraph. But if that was the intent --

DR. WALLIS: I think that was what we said. Maybe my memory is at fault.

COMMISSIONER McGAFFIGAN: You need to take the time to read the whole paragraph.

DR. WALLIS: I think that's what we said.

COMMISSIONER McGAFFIGAN: Because the impression I had at the time was you were saying that this chemical affects testing and whatever that needed still to be done and the technical basis being a little squishy, maybe we had to make a deterministic judgment, by God, what the strainer size is.

That's what I thought you were saying but I don't have it in front of me. It could be, but I just don't --

COMMISSIONER LYONS: I will re-read it. It's on page 2 of your October 18th letter.

And I was, as I said, primarily trying to understand if you were recommending -- or what type of work you were recommending to further quantify the pump performance?

DR. WALLIS: I see. We were essentially, I think, saying that you don't know enough to at this time, the time we wrote that letter, that there were some gaps in knowledge -- that you don't really know enough to solve the problem by analysis.

For instance, the chemical effects hadn't been studied at that time, there's the effect of coatings, if coatings flake off, they are not really qualified for being bombarded with high-speed jets. Flakes of coating is just the sort of thing you don't want to find on the screen. They overlap and they cover up.

So I think we were right in saying that there are technical gaps which make it very difficult to reach a technical resolution at this time.

I think that's what we were saying then. I'm sorry. I thought of a different –

COMMISSIONER LYONS: And I was more fishing for what did you think we should we do to go further?

DR. WALLIS: What should you do to go further? See, we have not reached the solution stage yet. We are still gathering information.

We asked plants to make calculations and come back and tell us what the situation is.

It is very difficult to speculate on a solution until we know what the problem is.

We have talked privately among ourselves about all kinds

of alternative engineering solutions, where you try to get the debris to go somewhere else, or you build some separate thing that handles it other than a screen. You can speculate about many things. We don't have any thing to recommend.

COMMISSIONER McGAFFIGAN: For the two new Commissioners, this GSI was identified sometime around 1996 or '7 is my recollection, maybe it wasn't called a GSI.

And I'm looking at Ashok as the former Director of Research not as your staffer at the moment.

That was followed by around September 2001 just before 9-11 or maybe just after, the Research staff with Ashok's signature on it, I believe, tossing the issue back over to NRR as they understood it at the time.

Naturally, after 9-11, this did not necessarily get as high priority as some would have liked. So it slipped a while.

Very late in the process, from the point of view of a Commissioner, ACRS came in and said, have you really thought through chemical effects. This ACRS, they're not taking responsibility for the late 90's, and we been in turmoil a bit since.

Now, the fundamental question that the staff -- and I will pose it to just pile on and not take time -- is the staff at some point felt even with all the flaws that you outlined, that doing something, after having studied the issue for almost nine years, knowing that you might have to do it again, but hoping that they would not, was -- I hope I'm not -- I hate when I speak for the staff or anybody but myself -- but that was their best shot. That was their best shot at that time.

And now I think a lot of the influence of the ACRS letters, as Dr. Wallis has said, has come through. The industry reads these things. And the industry is desperate not to have a two-step process here. They would like to solve this issue now, even with the fog of uncertainty in the analysis. So they will try to do that by over engineering things.

The one entity that answered the bulletin by saying we think we are there is Davis-Besse. And I think they increased the size of their strainer by a factor of 25 or something like that. It was just enormous. And they had the room to do it. So they did it.

And that may be where others are headed except for those who can't. But this situation, I guess it is how research works.

You think you know the answer, Research thought it knew the answer in September of 2001 when they felt the regulatory basis was there to toss it over the transom to NRR. And it turns out that was optimistic.

And indeed, as I said earlier, there is even further research that I think they are looking at now at Los Alamos and the University of New Mexico to deal with this chemical effects issue based on the initial testing that has been conducted.

DR. WALLIS: I think for some plants the quantitative debris is thought to be generated by a large-break LOCA is so big that

they are going to have difficulty finding a technical solution.

COMMISSIONER McGAFFIGAN: I'm looking at Luis and Ashok. If either of them feels I did a gross disservice or even a minor disservice, they are welcome.

COMMISSIONER LYONS: Do I have time for one more question or not?

COMMISSIONER McGAFFIGAN: Yes, sir.

COMMISSIONER LYONS: On 50.46, I'm a new member here and I have a lot to learn a lot to learn what's been done in the past. But I found myself wondering if there are alternatives to the elicitation approach that were considered.

I was wondering if one could perhaps in determining the TBS, perhaps look at the vibration spectrum or perhaps other phenomena that could provide some informing of a decision besides elicitation on what the break size might be. I guess what I'm also reflecting and I have heard, sir, that are you probably the world's expert on this, is at least some queasy feeling about the use of elicitation to derive something of this importance. I'm just wondering if there is alternatives to the elicitation?

DR. APOSTOLAKIS: I think we have to explain carefully what we mean by expert opinion elicitation. It is not that you go and ask a guy what do you think. These are experts who have studied these phenomena, they are aware of all this evidence that is available.

So they are interpreting this evidence and of course, the tricky part is when they translate that evident into some probabilistic estimate, because that's where they are really on their own. There are training sessions and so on, but, essentially, you really rely on the ability of the experts to do that. Now, we are talking about and Dr. Shack here can jump in any time if he wants, we are talking about break sizes which we have never seen.

And so necessarily, somebody has to extrapolate from the current state of knowledge from what we have seen from the analysis that have been done and so on. When we say expert opinion elicitation, it is these guys that have spent perhaps a life time studying these phenomena that serve on the panel and offering their opinion.

So I'm not sure there is another way around it to tell the truth. You really need the experts to interpret the analyses that are available, the operating experience and try to extrapolate with all the constraints that science imposes on them.

COMMISSIONER LYONS: As experience develops over time, I would assume this process could lead to a different number, either larger or smaller.

Is there a plan to continue this process, to continue an evaluation and see how TBS might evolve?

DR. APOSTOLAKIS: I believe it is part of the rule that every five years or so the frequencies will be re-evaluated, yes, yes.

And that's one of the things that bothered me a little bit,

but it turned out not to be an issue. It appears that every time we do this exercise, we find that the previous exercise was inadequate but yes, every five years, we are looking.

DR. SHACK: But the numbers have generally gotten lower.

COMMISSIONER LYONS: At the same time, you are making the point that the experts from whom you are eliciting the response are in a regime where they haven't seen the phenomena.

DR. APOSTOLAKIS: Nobody has. If there is one, the person qualified to do that is these fellows. They are the most qualified, yes.

COMMISSIONER JACZKO: If I could actually follow up. That raises a question. If these are the experts and the only ones who are qualified to do this and we are getting new numbers each time we ask questions, does that raise questions about whether or not we are in a mature enough state to be doing something like this?

DR. APOSTOLAKIS: First of all, I was the first one -- it is really doing an injustice to the process to say every time we get a new number, and as Dr. Shack said, it is very often the numbers tend to go down. I think this is the only way, we have to live with this.

I think the provision of revisiting the estimates every five years is a good one because that tends to cover -- because the time scale is such that if you go back and re-evaluate every five years, it is pretty good. Things not happen in a matter of days.

DR. SHACK: That's what you would expect when people have uncertainties, they tend to make conservative judgments. So you are using all the statistical data that you have available, you do your fraction mechanic's analysis, you have to make assumptions to carry out those analyses so you tend to make conservative assumptions. So you tend to believe that although your uncertainties are large, they are large this way.

COMMISSIONER McGAFFIGAN: Somebody has said something, thankfully, not me, that has compelled Ashok to come to the microphones.

MR. THADANI: I was trying to stay away but nevertheless, Commissioner Lyons' question raised an issue that I think maybe I can help.

First of all, I think not necessarily looking at vibration spectrum, if you will, there are a number of things that these experts pay attention to that are learned through operating experience up front. And that is an integral part of elicitation techniques. So that information is actually in front of all the experts, if you will.

Second part is periodically in this case, periodically could be five years or so. Again, take a look at what have we learned through service experience. Is there a surprise out there?

Third part, an important part I think, is to be sure that you maintain capacity and capability to be able to deal with double ended hybrid. It's just done differently. So the capability is there should you

find some surprise down the road. It is not like you have disabled a lot of equipment. And so, it's the totality of it.

COMMISSIONER McGAFFIGAN: I'm going to try to seize control again at some point. I recognize myself at this point. There has been a defacto 15 minute rule or more so I'll give myself -- are you both going to have further questions? So we just need to do me.

The issue that Commissioner Jaczko raised with Dr. Powers, the periodic safety reviews and the greater emphasis on severe accident management mitigation in Europe, how much of that is our backfit rule? And could you remind me and the rest of the Commission of the history of deciding to leave severe accident management guidelines which I think that decision is made in the late 80's, early 90's, to the industry as opposed to putting it into regulatory space where you said the Europeans are doing it.

Was it a backfit rule issue that drove the Commission or –

DR. POWERS: Clearly, it is exactly a backfit rule because you can't get a cost benefit out of this because the probabilities are low.

COMMISSIONER McGAFFIGAN: Again, trying to boil this down even for myself. In Europe through the PSR's and without a backfit rule, and maybe without even a substantial increase test in it, perhaps even without a lot of cost benefit analysis, they have chosen to incorporate the severe accident management things into their regulatory structure.

Here, the Commission at some point prior to my coming here and I think well prior, made a decision that we can't get the cost benefit to turn out well enough or at least, maybe it is the substantial increase test as opposed to the cost benefit test, so NEI or its predecessor initiative will be accepted in lieu of regulatory structure.

DR. POWERS: What can you do using available equipment and available resources. Whereas in Europe, there is more emphasis on doing more dramatic things, looking at the possibility of doing more dramatic things and it reflect itself in some of the designs that you see.

For instance, the new EPR reactor, had double containment, core catchers, impressive device.

COMMISSIONER McGAFFIGAN: Again, I'm always willing to have the staff come to the microphone if I'm doing a disservice to the Commission's history. And the reason I do some of this is that it isn't all written down very well unless you go back to the voting record on SECY, blankety blank, which the longer term staff have done, but I haven't.

I'm doing it partly to demonstrate to the two new Commissioners where the backfit rule is not my favorite rule which I have said a few times.

Okay, on the issue of risk-informing 50.46, Chart 18 I'm looking at this uncertainty band which is all notional. These are not

curves that exist but they are there to have us understand why you have to have an additional margin perhaps and this is not a calculated number.

One of the things, again, for our two new colleagues, I will say, is the 10 to minus 5 is a Commission decision, I think recommended by the staff. But different numbers could have been chosen.

And just as in pressurized thermal shock, the 10 to the minus 6 being chosen there. But these numbers are really policy numbers.

These are not numbers that -- and I'll just leave it at that. On pressurized thermal shock, the 10 to the minus 6 is a number that staff has chosen to do its analysis. And I think in some meetings some time in the last couple of years, when I see the results of 10 to the minus 8 range, I raised the question, if the results are 10 to minus 8, can't we at least go to 10 to minus 7 or something which I think still in the policy statement because we never fixed it for LERF? Why not be a little bit more conservative from the public's perspective because we are after all talking about vessel failure.

And you know, it may sound to my new colleagues like I'm saying, fit the criteria to the results. I'm not. I didn't mind the 10 to minus 6 as a staff peg.

It wasn't one that's been proved and gone through any Commission process. But now that we have the result that it is more like 10 to minus 8, should we take advantage of the result in our communications with the public and others. If we do this pressurized thermal shock rule, we have gone even an extra margin here because Reg Guide 1.174 was for normal licensing actions, and pressurized thermal shock is a pretty big licensing action so we put an extra margin in.

Do you have a comment on that whoever did pressurized thermal shock?

DR. SHACK: Well, we don't have an ACRS position on that obviously because we haven't discussed that. From my own personal point of view, no, I don't want to see reactor pressure vessels running out 300 years. Ten to the minus 6 would get me there.

COMMISSIONER McGAFFIGAN: Ten to the minus 6 allows them to operate for 300 years. What would 10 to the minus 7 get me? Would do 60?

DR. SHACK: No, 5 times 10 to the minus 8 will easily get you to 6O.

COMMISSIONER MCGAFFIGAN: If 5 times 10 to the minus 8 gets me to 60, I just raise the issue again for my two colleagues because this will come up more likely in your tenure than mine. Okay.

Dr. SHACK: Part of this will come down in a few years to whether one has an expectation. We have an expectation for advanced reactors of even greater margins of safety than we've already

provided. Whether we will have an expectation at the end of license renewal for existing reactors is something to be decided.

COMMISSIONER McGAFFIGAN: Dr. Apostolakis, you mentioned the importance of the Reg Guide to the 50.46 rulemaking, and mentioned this is a fairly profound change. You all want a very robust I'm sure, public comment process if we decide to go forward with this.

Should the Reg Guide if it is critical as I understand the current process, the Reg Guide doesn't exist at the moment. You all haven't been briefed on it. Items have been sort of been kicked into the -- when in doubt, if I were a staffer, my answer would be, Dr. Apostolakis that is going to be handled in the Reg Guide.

If the rule change itself, if the staff says and I have heard -- or the package I guess is with us -- but I have heard the staff talk about it, it is an enabling rule. I think one of you used the same term.

But how important is it that the Reg Guide, how we are going to actually implement the rule, be out there during the comment period because when we were doing 50.59 or some of our other rule changes, the Reg Guide was really part of the rule package, 50.65 A-4. Typically, the Reg Guide is part of the rule package or at least an initial Reg Guide may be flushed out more later. So I've asked a question, it is not rhetorical.

How important is it that the Reg Guide catch up with this process?

DR. APOSTOLAKIS: Well, I don't think personally, it is important to have the Reg Guide out there while the public is commenting on the draft rule, because the draft rule says that whenever there is doubt as to what to do, we'll apply the current approach which is very conservative. So the expectation is that the Reg Guide later will come in and relax some of these requirements for breaks beyond the TBS. But evaluating the draft rule itself, I don't think you need to see the Reg Guide.

What the committee said is the Reg Guide will be critical of the success of the application of the rule later.

COMMISSIONER McGAFFIGAN: Reg Guides, again, my recollection is they do go out for public comment. Reg Guides oftentimes follow the first applications which are sometimes done in pilots or whatever. I need to just look at the paper.

It just strikes me that the more I know about the intended implementation, the better off I'd be. And I don't know quite how to explain to -- Dr. Powers is a little optimistic about the French, I thought, at least as long as Adre Claude Lacoste remains head of DGSNR. If I want to explain what it is exactly that is likely to follow approval of the rule, the Reg Guide could be useful.

DR. APOSTOLAKIS: It could be.

COMMISSIONER McGAFFIGAN: I always ask questions that I don't get the answers that I wanted. But that's fine.

DR. WALLIS: I think we have said in our letters, the Reg

Guide is key to knowing what the implications of the rule are. We don't really know what the implications are until we see what you mean by mitigation.

COMMISSIONER McGAFFIGAN: Should that be part of the rulemaking process so that people understand what it is we are going to do.

Your answer is no, and you're not so sure. And Dr. Powers was -- I'm putting in perhaps the not so sure camp.

DR. POWERS: I don't think the Reg Guide is at all critical examining this particular issue.

COMMISSIONER MCGAFFIGAN: Wrong camp. Okay, I'm going to run out of time and I want to change course a little and ask you about whether you are up-to-date -- you all were among the advocates of the mitigating system performance index. And there was a recent meeting that was reported in the trade press that the hope was to implement the mitigating system performance index in January of next year. And the bug-a-boo of PRA quality, once again has reared its head.

And it isn't as clear. And I'm told by some industry officials they were shocked as to where their lowest common denominator was -- not exactly those words -- but it was a surprise to them as well since this was an NEI initiative, that there were some members whose PRA quality might not support a January, 2006 implementation date.

How am I to take all this? We've been at this for a while. PRA quality keeps coming up. We've got a road map of PRA quality will take whatever time it takes. But the MSPI, Mitigating Systems Performance Indicator, all you needed was a decent quality -- what you guys call it -- tier one internal events, PRA.

DR. APOSTOLAKIS: Level one.

COMMISSIONER McGAFFIGAN Level one internal events PRA. And I guess we are not there yet, at some sites. So I just ask the question.

DR. APOSTOLAKIS: I don't think we have been briefed on MSPI recently, so I don't know which meeting you are referring to.

COMMISSIONER McGAFFIGAN: March 14.

DR. APOSTOLAKIS: On the time schedule we are operating, this is a minute ago.

COMMISSIONER McGAFFIGAN: Again, it raises questions in my mind about how vigorously we can work towards some of these changes.

DR. POWERS: On the other hand, I think if you expect a uniformity of excellence throughout the industry.

COMMISSIONER McGAFFIGAN: I expect the uniformity and I was for MSPI because the industry folks who talked to me said that this is an enabling change. I think it's why you all may have supported MSPI because it will bring everybody up to a level, a basic level one internal events PRA that is pretty good. I hope it still does

and I still support it. But you know, I feel like the kid who keeps turning over rocks at times.

I think I have used my time and I have other questions. But do either of my other colleagues have a final question?

I didn't expect when I walked down here today to have the final word. But I want to re-echo that I really do appreciate what you all do. I think you do absolutely excellent work and appreciate the dissents as much as the body of the work.

And I think we all have to pay particular attention when there is fairly universal dissent as there was on GSI-191. The whole thrust of the letter is raising concerns. But we appreciate your work and I will continue to look forward to reading your work in my future wherever it takes me. Thank you very much.

DR. WALLIS: Thank you.

(End of Proceedings)