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UNITED STATES NUCLEAR REGULATORY COMMISSION
MEETING WITH THE ADVISORY COMMITTEE ON REACTOR
SAFEGUARDS (ACRS)

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THURSDAY

June 7, 2007

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The Commission convened at 1:30 p.m., Dale E. Klein, Chairman presiding.

NUCLEAR REGULATORY COMMISSION

DALE E. KLEIN, CHAIRMAN

EDWARD McGAFFIGAN, JR., COMMISSIONER

JEFFREY S. MERRIFIELD, COMMISSIONER

GREGORY B. JACZKO, COMMISSIONER

PETER B. LYONS, COMMISSIONER

1 ATTENDEES:

2 DR. WILLIAM SHACK, CHAIRMAN, ACRS

3 DR. DANA POWERS, ACRS

4 DR. THOMAS KRESS, ACRS

5 DR. GEORGE APOSTOLAKIS, ACRS

6 DR. MARIO BONACA, ACRS

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

CHAIRMAN KLEIN: Looking forward to hearing an update from all the good activities that ACRS has done since our October of '06 meeting and also your future activities. Before we really get into the details, there are two ACRS members that are going off their activities. Tom, we appreciate all that you have done.

DR. KRESS: My pleasure. Thank you.

CHAIRMAN KLEIN: We have your phone number so you haven't escaped. We know where to reach you. And Graham Wallace who is not here today is also going off. So thanks Tom for all your activities and like I said when we get in trouble we'll look you up.

DR. KRESS: I'll be handy.

CHAIRMAN KLEIN: Any comments before we start? Okay, Bill.

DR. SHACK: Before I start, we would like to thank Commissioner McGaffigan who stopped by this morning for a visit with the ACRS for his kind words. We've really enjoyed working with you over the years. We also want to express our best wishes to Commissioner Merrifield since this will be our last meeting with him as a member of the Commission before he leaves the Commission. We especially appreciate his interaction with us on the research report over the years and being heavily involved in that.

I'd like to just sort of briefly go over some of our accomplishments since

1 the last time we met with the Commission in October. We've issued 24 reports.
2 The one I'd probably like to spend a little bit of time on is our Draft Final Rule to
3 Risk Inform 50.46.

4 You've recently received a paper from the staff responding to the
5 recommendations in our report and again our report focused on the two critical
6 issues associated with 50.46a which is the process to monitor and control
7 changes in safety with the changes that are enabled by a change in the
8 transition break size and the provision of an adequate defense in depth for
9 breaks greater than the transition break size.

10 We recommended some changes in the basic monitoring and control
11 process for the risk process that we thought just made the proposed draft rule
12 more consistent with the existing guidance such as 1174. The most
13 contentious one is probably the defense in depth requirements. We look at
14 defense in depth associated with 50.46 not to control risk.

15 We've chosen the transition break size to make the risk of breaks
16 smaller than the transition break low. But to address uncertainty because
17 although we have an expert elicitation conducted by the Office of Research, I
18 think it does give us state of the art estimates of break frequencies for the large
19 breaks, there's still uncertainties associated with that choice of break size.

20 We made two specific recommendations to provide increased defense in
21 depth over the draft rule. One of those was to have prior review of the codes
22 used to analyze the breaks larger than the transition break reviewed and

1 approved by the staff rather than not.

2 And two, to use an application of the deterministic leak before break
3 requirements that we already impose when people want to remove dynamic
4 restraints from their piping system; pipe supports and that, make that at least
5 one of the requirements to ensure that your plant met the assumptions that
6 were built into the expert elicitation.

7 So for example, that would require that any hot leg welds with dissimilar
8 metal nickel alloy welds would have to be mitigated before you could apply
9 50.46a to your plant. We also suggested that the primary relaxation and the
10 requirements imposed on the equipment needed to mitigate breaks before the
11 TBS be based on the removal for the requirements for simultaneous loop and
12 worst single failure, not simply the frequency of beyond TBS breaks which is
13 assumed to be low but subject to uncertainty.

14 The staff paper rejected our recommendations on the use of approved
15 codes on the basis of risk significance. Again, we don't argue with them that
16 the calculated risk significance of these breaks is low. We're worried about
17 addressing the uncertainty associated with that break size.

18 They also rejected the recommendation that the demonstration of the
19 applicability of the elicitation results be the performance of the deterministic
20 leak before break analysis. In the staff approach then you have to do such
21 analysis to remove pipes support, but not to eliminate the current design basis
22 accidents.

1 One other element that we did discuss was the choice of the TBS for
2 both the BWRs and the PWRs. In previous letters, we've supported the staff's
3 choice of the transition break size as the largest attached piping. It's roughly in
4 accord with frequency estimates for PWRs and is kind of a logical place to put
5 the system. We all feel comfortable with the notion that frequency decreases
6 as pipe breaks size and so if you have a sudden transition between a pipe and
7 then a much larger pipe, it's a logical place to choose it.

8 It seems to lead to results that are overly restrictive for BWRs and we
9 suggested that reviewing that choice in terms of the frequency and the benefits
10 that might be accrued from a somewhat smaller break size. We don't feel that
11 that's inconsistent with the use of frequency as the primary basis for the choice
12 of the transition break size.

13 Overall, we feel that most of our recommendations require decisions
14 from the staff and the Commission and not additional research. They involve
15 judgments on a degree of defense and depth. It's difficult to address that in any
16 way except in informed judgment.

17 Moving on, one of the other reports we did was on Draft Guide 1145,
18 which was providing guidance for combined license applications for nuclear
19 power reactors. Our report on DG-1145 actually focused more on the
20 treatment of PRA in Part 52 where we really would have liked the PRA to be
21 submitted for approval with the plant. The Commission chose not to do that,
22 but we do appreciate the additional language that was added to ensure that we

1 would have living PRAs consistent with consensus standards and that's sort of
2 consistent with our view, often expressed view, that it's important to have
3 high-quality PRAs that reflect the actual plant. I think the added language in
4 Part 52 was very helpful that way.

5 Another good piece of work from the staff that we reviewed was
6 NUREG-1824 on the verification and validation of selected fire models for
7 nuclear plant applications. This was interesting not only because it was a good
8 piece of technical work, but it was a cooperative effort between the Office of
9 Research and EPRI and we think it will significantly improve the technical basis
10 supporting fire safety evaluations.

11 We also wrote a report on the TRACE thermal-hydraulic system analysis
12 code. We've had other reports reviewing TRACE and our most recent letter
13 was really supportive of the advanced capabilities of the code. It does
14 recognize that now we have this more capable code, we need to make the
15 effort to incorporate it into the regulatory process.

16 One example we had during our current meeting, the staff presented a
17 preliminary analysis of TRACE to stability analysis in BWRs and having this
18 capability that the staff can make independent confirmatory analysis of
19 important phenomena for EPU, confirms our expectation that TRACE can be
20 helpful in a broad range of confirmatory analysis. Next slide.

21 The most important element on this page is looking at the integrated
22 long-range research plan. The Commission recently directed the staff to

1 develop an integrated long-term regulatory research plan. We've also noted in
2 our recent biennial report on the research program the need for long-term
3 research not tied to near-term issues of the regulatory process.

4 The focus of the work proposed by the staff differed somewhat from our
5 focus on the modernization of the way the NRC conducts its regulatory and
6 safety mission, but we think the staff has made a good effort to look at some
7 long-range research that's needed and we look forward to working with them as
8 they further develop their research plan.

9 Dr. Bonaca will be describing our effort on license renewal which
10 remains an important part of our activities, although we seem to be coming to
11 the end of the current bow wave of license renewal applications. At least it's
12 sort of coincident timing with the arrival of COLAs.

13 We've been very concerned about future plant designs. As you know,
14 we've established design specific subcommittees and our subcommittees are
15 now set up so that the subcommittee that does the design certification will also
16 handle at least the first COLA so that we'll have experienced people moving
17 from design certification to COLA and carry that expertise and familiarity over.

18 As I've mentioned, we work to review the guidance for the SRP and Reg
19 Guides needed for the COLA preparation. We're busy working with other
20 activities on the ESBWR. Dr. Kress will discuss some of our efforts on the
21 technology neutral framework for licensing future plant designs. Next slide,
22 please.

1 Again, we'll still have many, many hours of a large portion of our effort
2 devoted to future reactor designs. We have the pre-application review of the
3 EPR coming up. We're making a change in the way we do the design
4 certification for the ESBWR where we've agreed with the staff to review the
5 SER on a chapter by chapter basis rather than it would have been easier for us
6 as an integrated whole. So again you can see how everything fits together.

7 It's important to try to help the staff maintain schedule and we've agreed
8 to do that by going to the chapter by chapter review. Again, we have early site
9 permits for Vogtle. Another issue involving operating plants is the dissimilar
10 metal welds where indications were found at Wolf Creek for circumferential
11 cracking which is really a quite different set of indications than we've typically
12 associated with dissimilar metal welds and somewhat unexpected based on the
13 residual stress pattern that we associate with such welds.

14 We support the staff and industry agreement on the resolution of these
15 weld issues which will allow the nine plants that haven't completed their
16 inspection and mitigation activities to do this in spring 2008, contingent on
17 some additional analysis results based on an industry - next slide - an industry
18 finite element analysis of an advanced sort that will provide a stronger basis for
19 the leak before break argument that we really do depend on when we're
20 dealing with known degradation systems. The licensees have committed to
21 enhance leakage detection as a compensatory measure in the meantime. And
22 again we think that's prudent to do.

1 It is unfortunate that we didn't get a sample from Wolf Creek before the
2 licensee decided to mitigate. Again, it's our only way of really ensuring that we
3 understand the degradation mechanisms that are going on and again our report
4 encouraged the industry to perform and asked the staff to encourage industry
5 to perform inspections before mitigation activities. We do plan to review the
6 results of the advanced finite element analysis when it becomes available.

7 Our ongoing and future activities - next slide, please - will obviously
8 involve advanced reactor design certifications. We're also in the midst of
9 reviewing a number of research projects for their quality to support the Office of
10 Research in response to the OMB requirement to evaluate the quality of the
11 research sponsored.

12 We had planned to take up the Commission paper on rulemaking on
13 50.46a, but we believe the Commission will be providing additional direction on
14 that, so there's really no need for us to plan to comment on that paper in July.
15 Next slide, please.

16 Digital instrumentation and control systems is a very important topic for
17 new reactors and back fitting of old reactors. Dr. Apostolakis will be attending
18 the July 8th meeting and he will be discussing some of our activities in that area
19 in a little bit more subsequent part of the thing.

20 Other import activities, again, we're still focusing on fire protection which
21 is especially in the current operating plans a major source of risk. High burn up
22 fuel and cladding issues. We're looking over some work that the Office of

1 Research has gone on high burn up cladding and some of their proposals for
2 ways to change the acceptance criteria for cladding to address these high burn
3 up issues.

4 Human reliability analysis is also another important topic that
5 Dr. Apostolakis will be addressing later in the presentation.

6 COMMISSIONER McGAFFIGAN: Can I just ask a clarifying
7 question on the high burn up fuel and cladding issues? Isn't there a 50.46b
8 draft rule floating around somewhere to that's relevant to that?

9 DR. SHACK: I don't believe there is a draft rule yet. There's
10 thoughts of a rule.

11 DR. POWERS: That's correct. Research has done some thinking
12 on the possibility of a rule and we've certainly recommended it in a letter to you
13 that we consider changing current 50.46 to a more technology neutral
14 framework so that we can accommodate new claddings that are out and are
15 coming out. It's a superior piece of research that RES has done on
16 understanding how these clads behave under design basis accident conditions.

17 DR. SHACK: But it hasn't progressed to rulemaking yet?

18 COMMISSIONER McGAFFIGAN: So we're handling it on an ad
19 hoc basis as people come in and want to use the new clads?

20 DR. POWERS: Right now the problem is the existing rule is
21 written specifically for Zirlo and Zircaloy so they have achieved something of an
22 exemption or deviation to use the more modern claddings. That is an irritation.

1 It's not a rule. What it does is deter using some of these clads that show
2 superior resistance to corrosion during normal operation and have good
3 behavior under accident conditions.

4 COMMISSIONER McGAFFIGAN: That doesn't sound good.

5 DR. POWERS: If you're going to change 50.46, you might as well
6 get both A and B at the same time. The staff has done a good piece of
7 research. They're not quite finished, but they've done enough so we
8 understand it well.

9 DR. SHACK: Next slide. Again, we'll be preparing a report this
10 year on the NRC Safety Research Program. It's our biennial report. We're
11 looking at that and we're still involved in the resolution of GSI-191 debris.
12 Again, the difficulties there in addressing the effects of chemical interactions on
13 the sump performance.

14 COMMISSIONER MERRIFIELD: Mr. Chairman, before Bill turns
15 off that page. This is old history to Ed and I and certainly the folks on the other
16 end of the table. The NRC Safety Research Program, the review of our
17 research programs is something that had been a longstanding requirement and
18 the Commission has asked ACRS to continue that effort.

19 One of the things that occurred when Dana Powers was chair of ACRS
20 is I think there was a refocus on that effort. Many times previous to that when
21 we asked ACRS to conduct that review or when they did conduct that review, it
22 looked at a lot of areas where there were gaps and that was very valuable

1 information for the Commission to receive.

2 One of the charges that we made, and I had highly encouraged this, is
3 that we also look at areas where we can sort of turn the tap off. I think what
4 ACRS has evolved to in this report is a more useful framework for us in a more
5 holistic way looking at our research programs to see where there are areas that
6 we have gaps and need to do more and where are there areas where we have
7 a good basis of knowledge where we can perhaps reduce or redirect some
8 moneys to more effectively utilize the research dollars we have.

9 With my departure, certainly someone will need to take the flag up as the
10 champion of that report and I certainly would encourage you and the other
11 members of the Commission to do that because I think it's an important tool, it's
12 an important effort that ACRS conducts for us. I wouldn't want to let that one
13 go by.

14 CHAIRMAN KLEIN: Having had been involved in research for
15 number of years and Pete as well, I'm surprised to hear you say that Dana
16 working at a National Lab would ever want to turn any research off.

17 COMMISSIONER MERRIFIELD: It's turning somebody else's
18 research off. That's not quite so hard.

19 DR. POWERS: I think we are acutely aware that there are more
20 demands for research information at the agency than the agency has resources
21 or perhaps the Nation has resources to satisfy.

22 So we are anxious and Commissioner Merrifield has been very helpful in

1 helping us and encouraging us to look in a fairly disciplined way on when
2 research had met the regulatory needs and when we could progress on to
3 address some of the issues that have been sitting on the back burner for a
4 while. It's been a delight, quite frankly, working with you on that.

5 COMMISSIONER MERRIFIELD: I concur; the same in the other
6 direction.

7 DR. SHACK: Next slide. Again, we are looking forward to working
8 with the staff on the state of the art reactor consequence analysis which we
9 hope to pick up again in the coming months. As I mentioned, we are preparing
10 another report on the technology neutral framework. Dr. Kress will be
11 discussing some of our previous reports, but we think we will have a report out
12 to you in July on the technology neutral framework.

13 And with that, I've sort of completed my overview. I'd like to ask
14 Dr. Kress to pick up the effort and discuss some of our efforts on the framework
15 for future plant licensing.

16 DR. KRESS: Thank you. We have been working for some time
17 with the staff while this has been a work in progress. It's a useful way to
18 interact with the staff because we are able to exchange views as things go
19 along and debate these difficult issues.

20 In general in this process, we think the staff is generally on the right
21 track. They're doing a good job with these difficult issues. We've given them a
22 lot of input, a lot of thoughts on how they should go and how they should revise

1 and modify, but we actually only had I think two formal letters to you.

2 One of them was in response to your SRM to us - next slide, please - in
3 which you asked us for our views on whether or not they ought to continue with
4 this general development of framework or would it be more useful to take a
5 specific type of reactor and do a specific framework for that.

6 In our letter of April 20th on this, we had some general comments which I
7 won't go into because we'll talk about those in the July letter, but we did say
8 that we felt the framework had progressed to a point where they really ought to
9 complete it before they try to apply it to a specific plant, to a specific new
10 design.

11 The reason for that being, of course, is that we think they'll need those
12 concepts when they get ready to develop a design specific framework. So they
13 might as well go ahead and complete the general framework and get it right
14 before they start with the specific application.

15 There didn't seem to us to be any urgent need at the moment for a
16 specific application, but when it comes time for that, we did recommend that
17 this application be for the PBMR. That's because the PBMR is so much
18 different from an LWR that it would be a good test and not only that the
19 required information that you'll need is pretty much available in the various
20 white papers they have submitted.

21 COMMISSIONER LYONS: Just to clarify; is your recommendation
22 specific to the pebble bed or specific to high-temperature gas reactors?

1 DR. KRESS: It could be either. The pebble bed is one type but it
2 has a bunch of white papers. It has a lot of the information that the staff will
3 need to apply this framework. That's one of the reasons we specifically called
4 pebble bed.

5 COMMISSIONER McGAFFIGAN: It also seems like it's making
6 about zero progress each month – in South Africa according to the trade press.
7 It's been suspended for quite some time now. Whereas the next generation
8 nuclear plant is getting very strong support from the House Appropriations
9 Committee and certain Senators and it looks like we owe a licensing framework
10 next year to the Congress.

11 DR. KRESS: That might be the one to choose then, given that.

12 COMMISSIONER MERRIFIELD: I would footnote, however, while
13 there have been some delays in South Africa, the Chinese have a very
14 aggressive pebble bed program that's not getting as much notoriety, but that
15 does seem to be continuing to move forward.

16 DR. KRESS: The other letter was in response to the question
17 whether or not the staff should proceed with some sort of rulemaking activities
18 as opposed to just developing the framework. We agreed, I think, with the staff
19 there didn't seem to be any urgent need to go to rulemaking, but all of the
20 plants coming up for licensing will be LWRs for COLs in the near future.

21 We agreed with the staff that they can defer that and concentrate more
22 on completing the framework and we did think it would help guide the next

1 generation nuclear plant if they completed it. While we think the framework is
2 in an advanced stage and is going in the right direction, before it can be
3 codified into rule we think it needs some modifications.

4 It's not quite ready for rulemaking yet, so this letter that Chairman Shack
5 suggested may be out in the July meeting will be our attempt to clarify the
6 ACRS position and actually spell out specifically what we think the
7 modifications or things that need improving in that framework. You might wait
8 with bated breath for that.

9 At this moment, I suspect there may be added comments.
10 Commissioner McGaffigan, I hope you're there to read them.

11 COMMISSIONER McGAFFIGAN: That's in reference to this
12 morning that I said I always enjoyed these various letters that had divided
13 comments.

14 DR. KRESS: This may very well be a two-handed letter, --, on the
15 one hand and on the other hand..

16 COMMISSIONER McGAFFIGAN: Not three-handed?

17 DR. KRESS: It will probably be three-handed.

18 DR. SHACK: We have a small pool as to how many added
19 comments there will be.

20 DR. KRESS: That's all I have.

21 DR. SHACK: The next person will be discussing our work on
22 Digital I&C activities and Dr. Apostolakis will be apprising us on that.

1 DR. APOSTOLAKIS: We received an SRM last November in
2 which we were directed to provide our views on the efforts by the staff to do
3 something about Digital I&C and also our views regarding backups to digital
4 systems. We had a meeting with the staff and they presented to us the new
5 management structure that involved senior managers to develop a plan, a
6 project plan to improve the deployment of digital I&C technology for new and
7 operating reactors.

8 Personally, I've been hearing about plans now for five or six years. I
9 hope this is the last time we're developing a plan and we start implementing
10 something. This is personal. not the ACRS view, but we do concur with the
11 staff's approach. We thought it was very nice. Then we made as usual a
12 number of recommendations about how to improve things.

13 The first and one of the most important recommendations is that we
14 should have an inventory and classification of digital systems that are being
15 used and may be used in the near future in nuclear reactors. This is extremely
16 important because most of the literature comes from the aerospace business,
17 where their systems are not necessarily the same as the ones we're using or
18 we plan to be using and there is a lot of confusion when it comes to discussing
19 methods that are appropriate for safety evaluation.

20 For example, a lot of our systems are simple actuation systems. When
21 you talk about an actuation system when somebody tells you what happened to
22 Ariane in Europe, you're talking about apples and oranges. We need this

1 classification to say, look, these are the categories of systems that we'll be
2 using and hopefully the next step will be to say for this class of systems these
3 are the appropriate methods, for this other class there's another set of
4 methods.

5 In order to do that, the second very important recommendation is to
6 collect the operating experience both in the nuclear industry which will not be
7 too large, but also other industries. The main idea being to try to understand
8 the failure modes because this is a major concern right now. You hear rumors
9 that software failed in different ways. They don't fail in continuous ways. You
10 changed the input a little bit and you don't know what you're going to get out.
11 So we have to understand what has happened in the past and then using that
12 as a basis to proceed.

13 So we believe that these two recommendations of classification,
14 characterization of digital systems and the understanding of failure modes plus
15 additional investigation to understand better the failure modes should be the
16 basis for proceeding with regulatory guidance at some point on defense in
17 depth and diversity.

18 You asked us directly what we thought about backup systems and we
19 feel this information is so important that since it's unavailable to us, we cannot
20 really tell you what we think about it. We just don't think about it. And on that
21 happy note, back to you Mr. Chairman.

22 COMMISSIONER McGAFFIGAN: Mr. Chairman, we are going to

1 have a meeting sometime - is it July - on Digital I&C. You may be the skunk at
2 the picnic. Last year, I remember at one of these early meetings we had I think
3 it was a fellow from EPR who was sort of demanding that we help them with
4 how digitized their control room could be. They were going to be buying
5 support things.

6 If this is where ACRS is and it reflects where the staff is, it's hard to see
7 how these new plants or even the existing plants build Digital I&C in, any time
8 soon.

9 DR. APOSTOLAKIS: There have been extensive tests and
10 reviews and analysis of various platforms that some companies are using. The
11 question in my mind comes when you get that and you want to convince
12 yourself that there is adequate protection and right now I think mostly it relies,
13 the way I understand it, on extensive tests and maybe other things, but I still
14 would like to see the two things that we are recommending and try to
15 understand better what is going on.

16 DR. SHACK: Our next topic will be the license renewal and
17 extended power uprates. Dr. Bonaca will be discussing our activities.

18 DR. BONACA: Good afternoon. In license renewal we performed
19 interim reviews of three applications at Vermont Yankee, Palisades and Oyster
20 Creek and two reviews of final applications on Palisades and Oyster Creek
21 since October 2006. We will perform an interim review of one application,
22 Fitzpatrick, and final review of two applications, Vermont Yankee and Pilgrim,

1 during the remainder of calendar year 2007.

2 We will perform three interim reviews and four final reviews in calendar
3 year 2008; Fitzpatrick, Susquehanna, Wolf Creek and Harris. You can see
4 there's still a significant number of plants coming through. Next slide.

5 For Palisade's license renewal we recommended continued operation of
6 Palisades during the entire period of extended operation contingent on the
7 resolution of three time-limited aging analysis issues associated with reactor
8 pressure vessel integrity. Reactor vessel at Palisades will exceed some of the
9 acceptance limits for fracture toughness during the period of extended
10 operation and specifically the upper shell energy criterion will be exceeded by
11 2021 and the PTS criterion will be exceeded by 2014 and also the pressure
12 temperature curves will have to be drawn by 2014.

13 The licensee has opted to manage aging during the period of extended
14 operation, which means essentially that they will, three years before they
15 exceed limits, they will submit analysis and whatever plant modification to
16 support analysis to the staff in order to re-qualify the vessel for continued
17 operation for the remainder of the period of continued operation. We felt that
18 this was an appropriate way of going about that. The licensee will explore
19 whatever ways it has to deal with this limitation.

20 COMMISSIONER McGAFFIGAN: Mr. Chairman, can I ask a
21 clarifying question? Isn't there supposed to be a pressurized thermal shock
22 rule? I remember you guys at the previous meeting praising the research effort

1 on that. Wouldn't the pressurized thermal shock rule sort of solve this by large
2 fractions?

3 DR. BONACA: Largely, yes. That was not stated by the licensee,
4 but I'm sure that's one of the options they are looking at very carefully. It
5 depends on when, of course, the new rule will be available.

6 COMMISSIONER McGAFFIGAN: Commissioner Merrifield has
7 pointed out that if the pressurized thermal shock rule goes through for many
8 plants. We may have a second license renewal. That's quite attractive.

9 DR. BONACA: It will provide significant margin, yes.

10 COMMISSIONER McGAFFIGAN: I hope we get it done by 2014.

11 DR. BONACA: 2011. Although they can opt, I think by 2011 they
12 have to lay out what the plan is to resolve the issues by 2014.

13 COMMISSIONER McGAFFIGAN: The plan is that we believe
14 NRC's research is very, very good and we'd like to use it. I suppose.

15 DR. BONACA: I would expect so, yes. Next slide. We reviewed
16 the Oyster Creek license renewal application. As you know, the external
17 surface of the drywell has experienced significant corrosion through the years.
18 The actions implemented by the licensee appear to have arrested the corrosion
19 and also confirmed comparability of the drywell. There were two types of
20 calculations both of them supported the comparability. The only difference was
21 how much margin is there.

22 We supported three license conditions for Oyster Creek. Two of them

1 we proposed the first two and the third one was proposed by the staff and we
2 support. The first one is identifying options to eliminate or reduce leakage in
3 the refueling cavity liner. This is really a recommendation we provided to
4 address root cause of the problem which is really the leakage that they are
5 experiencing rather than the mitigation of the consequences which they have
6 been focusing on. They volunteered, in fact, to perform this study.

7 The second is to perform three-dimensional finite element analysis of the
8 drywell shell with modern methods and again the objective of this is to confirm
9 margin. And finally, to increase the frequency of drywell inspection and monitor
10 two drywell trenches which have exposed rebar. The objective of this is to
11 manage aging during the period of extended operation.

12 Increased frequency would be appropriate in this sense and the
13 objective of course is to assure that the structural capability of the drywell will
14 be maintained through the period of extended operation. Next slide.

15 We reviewed one extended power uprate, the 5% power uprate
16 amendment for Browns Ferry Unit 1. We recommended approval of that. As
17 you know, these plants when they go through extended power uprate they're
18 asking for created back pressure or accident pressure and containment and on
19 our part the question is always whether in fact they have demonstrated that
20 they have sufficient back pressure to support the amount of credibility required.

21 We pointed out to Browns Ferry that for the 120% power uprate that we
22 will review later in the year, they may have to provide more complete

1 evaluations of two scenarios; one is the long-term LOCA. To demonstrate that
2 accident pressure exceeds the requested back pressure created with margin
3 after consideration of uncertainty. That's an important thing that we provide
4 them with credit that we provide that exists there.

5 For the Appendix R scenario, that turned out to be a more severe
6 scenario for this plant. They required credit for 62 hours, a significant amount
7 of credit and the concern that the scenario brought as a justification for credit
8 only in risk analysis. The risk analysis addressed the risk associated with this
9 scenario and stated that it was low; however, the risk analysis submitted
10 missed some important initiators of fire.

11 Specifically, for example, seismic induced fire which at this frequency
12 level is going to be a contributor. So we asked them if they would re-perform
13 this evaluation for the 120% power case, when they come up for that, including
14 all the initiators which are pertinent with this scenario.

15 Of course, for an alternative, they would still have for the Appendix R is
16 to protect the second train of RHR. That would give them all the credit they
17 would need. There would be no further need for providing credit. That's the
18 option that for example Vermont Yankee chose under Appendix R.

19 COMMISSIONER McGAFFIGAN: Second train of RHR – what
20 was your acronym?

21 DR. BONACA: RHR means Residual Heat Removal System.
22 They have four trains and only one right now is protected for Appendix R and

1 the other three are not. Next slide.

2 We plan to review the extended power uprates for Browns Ferry Units 1,
3 2, and 3 after receiving the complete safety evaluation reports later this year.
4 We'll also review in the fall the extended power uprates for Hope Creek and
5 Susquehanna. This completes my presentation.

6 DR. SHACK: The final presentation will be by Dr. Apostolakis on
7 Human Reliability Analysis Models.

8 DR. APOSTOLAKIS: At our last meeting with the Commission,
9 one of us was unable to control himself and expressed some views on human
10 reliability. Within days, we had an SRM directing us to work with the staff and
11 other stakeholders to evaluate existing HRA, human reliability analysis models,
12 in an effort to propose either a single model or a suite of models that could be
13 used in appropriate applications.

14 We met with the staff and we were informed that they are in the process
15 of producing a cooperative agreement or - I don't know what the technical term
16 is - a memorandum of understanding with EPRI to develop a plan - my favorite
17 word - to evaluate the human reliability models.

18 We thought that at a high level plan was reasonable, although we
19 emphasized that we would like to see a clear articulation of the goals of the
20 plan up front and we would like to see specific deadlines for intermediate
21 milestones as the plan progresses. The objective of this exercise in our view
22 should be to develop a common understanding of the relative importance of the

1 various factors that affect human performance and what ways are available to
2 incorporate those into the models.

3 That of course is a prerequisite for allowing the staff and us to develop a
4 guidance on which model should be used. The staff made a big deal out of this
5 HRA Empirical Study that they are organizing now to perform model to model
6 comparisons using the simulator in Halden, Norway. The ACRS views this
7 study only as one part of the broader effort to collect evidence regarding the
8 validity of HRA models.

9 We do believe that the study by itself will not be sufficient for us to
10 develop meaningful estimates of the probabilities of error. Another source of
11 information that would be relevant to this effort should be collected from
12 operating experience, especially the reports that the Augmented Inspection
13 Teams produced on past incidents. I have had opportunities to read several of
14 those. They're extremely detailed and extremely valuable.

15 Of course, they're not written for HRA purposes, but there is a lot of
16 information there that experienced people can utilize. So we plan to meet with
17 the staff periodically to be briefed on what they're doing, how things are
18 progressing and we hope that eventually we can have an appropriate suite of
19 models.

20 DR. SHACK: That completes our formal presentation.

21 CHAIRMAN KLEIN: Thank you very much for that update and
22 now comes time for the fun part; to get additional clarifying questions. As you

1 know, we get to rotate who starts, so I get to start today followed by
2 Commissioner McGaffigan and then the rest of the Commissioners.

3 Tom, when you followed up to Pete Lyons question on the framework for
4 gas reactors, if you do a pebble bed in a prismatic, would the fundamental
5 framework be that much different?

6 DR. KRESS: No. It would be very, very similar. It would be a
7 good test with either one of them.

8 CHAIRMAN KLEIN: On page 18, you talked a little bit about that
9 you thought that the framework was a good way, but then on the letter that you
10 all sent out on May 16th, there seem to be some questions about the risk
11 informed performance based part. Could you talk a little bit about the debate
12 that's going on in ACRS about the framework, risk informed and so forth?

13 DR. KRESS: We certainly don't have an ACRS position. I can
14 talk about some of the debate we've been having. We think that the framework
15 needed articulates our top level objectives first and then show how the specific
16 framework addresses top-level objectives. Part of the debate we've been
17 having is what should those top level objectives be.

18 One of them on the very top is we think this is a good chance to try to
19 put a regulation together that pretty much ensures that you meet the
20 quantitative health objectives of the safety goals. We recognize they are just a
21 goal and they're not a requirement, but we think you can craft the regulations in
22 such a way that it attempts to put together a design that would meet that.

1 Part of the debate we're having on that part of it is do you design a plant
2 so that that plant when put on a site meets the QHOs? Or should you
3 anticipate that there's going to be multiple modules if it's say a pebble bed or
4 it's a gas cooled or maybe multiple plants on different sites and maybe as it's
5 now progressing the new plants on old sites that already have plants there.

6 So the question is if one plant by itself meets the QHOs, then the site
7 won't need it. So the question is how do you provide design criteria so that you
8 meet QHOs and should it be each plant or should it be fore anticipating several
9 plants? And, of course, QHOs is a site characteristic and do you use a
10 representative site? So the debate goes on there.

11 The technology framework has put some emphasis on developing
12 licensing basis events, which in my mind are essentially the same thing as
13 design basis accidents. We generally think that's a good way to go because
14 you need something like that to give a designer something to design to and to
15 have a licensing basis.

16 Along with design basis accidents, you need figures of merit. We call
17 them that, that have to be met by the analysis tools that you have and so we've
18 had some debate on what those figures of merit ought to look like, what level
19 they ought to be cast at.

20 The staff has what they call a frequency consequence curve and they
21 choose these licensing basis events based on the PRA sequences that are
22 mostly dominant or at least give the most consequence. And so the question is

1 what sort of figures of merit do you have to preserve the concepts of margins
2 and defense in depth and conservative analysis. So our debate is focused
3 somewhat on that.

4 We also feel that it's not sufficient just to have design basis accidents
5 and figures of merit because in the present, current regulatory system that's
6 basically what we have and you end up with a fleet of plants that vary in their
7 safety in a sense. If we want to define safety as a CDF and alert as opposed to
8 a QHOs, they vary over a very relatively wide range.

9 We think that the framework also needs a summation of risk as a
10 requirement and the summation of risk, we think, in order for it to be technology
11 neutral, it has to be something like a complementary cumulative distribution
12 function which is the way to sum a risk. It's a true frequency consequence
13 curve.

14 We're having some debate, a great deal of debate, on what the "C", the
15 "consequence" ought to be in that frequency consequence curve. My own
16 personal opinion was that you have to cast this curve in such a way that you
17 could relate it to this CDF and LERF that we now have. Those have been
18 extremely useful concepts and they're design concepts. You can design a
19 plant for a given CDF and LERF. You know what safety level it's at and we use
20 it throughout the regulations in risk informing things. So if you could have a
21 CCDF curve that is equivalent to that --

22 COMMISSIONER McGAFFIGAN: CCDF, again, is

1 complementary --?

2 DR. KRESS: Complementary Cumulative Distribution Function.

3 It's a normal output of PRAs by the way. It's not anything that's going to require
4 a lot of changes to the PRA. It's something they produce already. So our
5 debate is about how to develop that curve and what level it should be cast at.
6 Should you develop that curve just like the licensing basis events so that you
7 meet the QHOs?

8 For example, the LERF we talk about has been ten to the minus five for
9 years. It is said to be a surrogate for the prompt fatality QHO for the current
10 LWR plants. Can we come up with a surrogate like that for the new plants and
11 rather than it be for one QHO, should we anticipate that there may be three,
12 four or five plants on a site, and have a site QHO or each plant may introduce
13 only some fraction of that.

14 This is the kind of debate we're having and by no means agree on how
15 to approach these things. I hope in the meetings today and July we can at
16 least have some concept of what the full committee feels and then maybe
17 additional comments that will give other opinions.

18 CHAIRMAN KLEIN: My guess is the risk informed performance
19 base will always be a work in progress.

20 DR. KRESS: It may very well be.

21 CHAIRMAN KLEIN: I'll come back with some more questions
22 later, but I'll turn to Commissioner McGaffigan now.

1 COMMISSIONER McGAFFIGAN: I think I'll just follow up. It's an
2 interesting line of questions. The last time we met or one of the times we met, I
3 called this the unified theory of everything. This has been looking at forever
4 and you seem to be making about the same degree progress as the physics
5 community and getting to that unified theory of everything. I'm perhaps more
6 practical, that's why the questions at the outset about why not focus on the
7 plant that may be built in Idaho that seems to have some support.

8 I understand from a paper we have in front of us at the moment on
9 GNEP that the staff is working on a licensing strategy for that facility and it's a
10 Part 50 licensing strategy which makes me a little worried since Part 50 has
11 calculably nothing in it on gas cooled reactors. It presumably is a strategy that
12 says we're going to use Part 50 where it's strategically appropriate and toss out
13 all the light water reactor stuff and we're going to substitute something. I'm
14 always interested in what the substitute something is. Not the theory of
15 everything, but the substitute.

16 If the Department of Energy is going to try to license a gas cooled
17 reactor in Idaho by 2021, then we probably should know by sometime early in
18 the next decade - no urgency right now - but sometime early in the next decade
19 what the design basis accidents are. We'll have to confront the issue that
20 we've dodged so far about what sort of containment you need, if any, and all
21 that.

22 I get a bigger charge out of trying to figure out that, what the Part 50

1 revised rule would be for gas reactors than figuring out some of the things
2 you're just talking about that could apply to everything. Then I still have to start
3 over and figure out what I'm going to do for the gas cooled reactor. I think in
4 trying to solve everything, my experience in life has been I end up not solving a
5 lot of things. I'd just be interested in your response to that, I guess. I do
6 appreciate your service. I appreciate your very, very long service as the
7 Chairman said and I think you've been one of the foremost advocates of risk
8 informed regulations during your tenure.

9 I think - what are Powers and I? Are we rationalists? Structuralists?
10 And you're the classic rationalist. That may be why I have a hard time. I'm
11 giving you a minute and 51 seconds in this round to sort of tell me why I'm
12 wrong.

13 DR. KRESS: Well, you're not exactly wrong.

14 COMMISSIONER MERRIFIELD: You know, I say that to Ed all
15 the time.

16 DR. KRESS: You know, if you view this technology neutral
17 framework in a rationalist way, what they're doing is trying to have a technically
18 based way to decide what ought to be basically your design basis accidents.
19 That's the first thing you have to do if you're going to use Part 50. You need
20 have a set of design basis accidents. They're trying to develop a rational way
21 to choose those using a PRA. So you do start from a PRA and that will be a
22 requirement number one.

1 You have to have a fairly good PRA which means you already have to
2 have a fairly decent design in mind before you start and which there will be, I'm
3 sure. That is the rational way to actually come up with design basis accidents
4 that to some extent are the design tool items and you want that design tool to
5 render your plant design to some level of what I would call a CDF and a LERF.
6 Well, instead of a CDF and a LERF, all we're talking about is a cumulative
7 complimentary distribution function. They're equivalent. They really are.
8 Where the "C" may be curies released or maybe dose at the site boundary, but
9 they're equivalent. You can relate one to the other.

10 COMMISSIONER McGAFFIGAN: So using gas cooled reactors
11 as the example, the general thought on gas reactors is that they're inherently
12 safer by a large margin.

13 DR. KRESS: No doubt about that.

14 COMMISSIONER McGAFFIGAN: How much of the theory do I
15 have to get to say I am so far ahead of these quantitative health objectives that
16 I don't have to worry about it and the only issue is do I pull in the emergency
17 planning requirements to a much shorter radius than we have for the light water
18 reactor.

19 The issue with the gas reactors is we have enormous margin and I'll shut
20 up so we can get on to the second round. I'm doing all this theory and then I've
21 got this practice where I start off knowing that I'm in pretty darn good shape.

22 DR. KRESS: Well, you have to convince people of that. In order

1 to do that, you have to have a set of accidents that you define and you have to
2 have a fission product release model and the appropriate database for that.

3 COMMISSIONER McGAFFIGAN: How does the technology
4 neutral approach get us there?

5 DR. KRESS: These are the things that you will have to do to
6 show that you'll meet the requirements in the technology neutral reactor. I have
7 no doubt that the gas cooled reactors won't come in well under the
8 requirements. The question is how much do you bother. We need to prove
9 that, I think.

10 COMMISSIONER McGAFFIGAN: I've used my time. There'll be
11 another round. We'll give you a chance, George, next time.

12 CHAIRMAN KLEIN: Commissioner Merrifield?

13 COMMISSIONER MERRIFIELD: Well, first, Mr. Chairman, I'd like
14 to start by saying it has been a pleasure over the years to engage with the
15 members of this particular body. On various occasions I'm sure Dana and Bill
16 and George can probably remember - Mario as well - remember meetings in
17 my office, actually probably meetings with every one of you in my office, we
18 giving you suggestions about various ways in which you can engage with the
19 Commission and communicate some of your results.

20 I want to compliment all of you. Obviously, you have extraordinary
21 backgrounds and bring tremendous things to the Commission. I think the work
22 you and your colleagues have done to try and translate that in a way which is

1 approachable for the not so technology sophisticated and also in a way that's
2 balanced and not overly, for lack of better word, unnerving sometimes I think is
3 helpful. I think the ACRS has made a lot progress in terms of how it presents
4 this data in these kinds of public forum, so I certainly want to give you my
5 compliments on that one.

6 Time has changed. I'm noting one thing I do feel more comfortable with
7 today is at least now I know how to pronounce "Apostolakis", which frankly was
8 a lot greater difficulty for me when I first got here. I say that with a smile
9 because George and I have a very good relationship. I'm happy for that.

10 I guess I'll pick up just to make sure we have some consistency on the
11 record. George, you wanted to add some comments in response to
12 Commissioner McGaffigan's last question. So I'll let you pick up there.

13 DR. APOSTOLAKIS: Thank you very much. I think there are a
14 few issues that need to be addressed before we say, "Gee, let's look at the gas
15 reactor and modify the existing Part 50 as appropriate." First of all, the
16 technology neutral framework is really a framework. It's not as regulatory
17 system. It sets up principles and one of the principles for example that you will
18 have to face with a gas reactor it seems to me is that of defense in depth. So it
19 attempts to give some guidance regarding prevention, mitigation and so on.

20 Here you have a reactor that is admittedly much safer. How do you
21 implement that principle? Do you go all the way to prevention? Do you want to
22 preserve something for mitigation; how much and so on? Then if you get

1 another type of reactor, then you'll have to start again from scratch, Part 50,
2 find the parts that don't apply, modify them. I think this framework will facilitate
3 that process. That's really what we'll do. It will facilitate it.

4 You will have a common metric, either the curies or the dose that the
5 staff is proposing to be able to compare also different types of reactors and
6 make sure that we're all on the same path. Otherwise, again, with the LWRs
7 we have a situation where we have a wide variability for that much frequency in
8 LERF and some of them are much safer than others. We will perpetuate that
9 situation in the future if we start modifying Part 50 for each technology type.

10 We will have reactors that will be much safer than other types and so on.
11 It's not a regulatory system. It's just a framework that tells you, if you will, how
12 you would change Part 50 to make it appropriate for another type of reactor.
13 So I think that's the main defense for it. There are many, many disagreements
14 among us as to what the licensing basis event should be and so on, but I'm
15 sure we'll see the light.

16 COMMISSIONER MERRIFIELD: I think for me that's helpful. I
17 guess the one thing I would say reflecting on the comments that both of you
18 have made is in the end it seems to me some of this has to be set up and
19 recognizing the very active and energetic debate that you're engaged in,
20 ultimately in the end, like any road map that a Commissioner would want to
21 have it's going to have options to it. There's more than one it way to get from
22 point A to Point B.

1 Ultimately, in the end while there are many obviously clear scientific
2 issues that are laid out, there are policy decisions that have an analog to many
3 of those. I think the Commission, part of the import of what you're going to
4 have to do is sort of lay those out if the Commission chooses to go this
5 direction on the road map, these are the outcomes. If the Commission chooses
6 to go that direction, these are the outcomes. In the end, that kind of document
7 that presents that would certainly seem to me be able to be reflective of some
8 of the differing positions that we've seen articulated previously.

9 There's some big issues. There's some big issues the Commission has
10 ahead of it and as we consider pebble bed reactors and some of the other gas
11 based technologies, there's some value judgments really and hard policy calls
12 that the Commission is going to have to make in terms of how far or how short
13 it wants to go in regulating those. But certainly your guidance in laying out
14 those options and laying out those different avenues to approach that road map
15 is going to be quite critical. Thank you, Mr. Chairman.

16 CHAIRMAN KLEIN: Commissioner Jaczko?

17 COMMISSIONER JACZKO: Perhaps I'm going to be unfair and
18 make a comment on the technology neutral framework and not ask a question,
19 so you won't have a chance to respond. I think it's an interesting discussion.

20 For me, I think probably the comment that George made is one of the
21 more interesting ones that I've heard which is that it's a framework and not a
22 regulatory system. I'm not necessarily convinced that that's the approach the

1 staff is taking right now. I think the approach that I've always felt that this was
2 more like was a regulatory system where we would have a fairly broad based
3 risk informed performance based regulatory system that was technology
4 neutral. Not just a framework to getting to the regulatory system.

5 I think viewed in the latter way it's something that I certainly am more
6 open to looking at. It gives you a way to pick what the regulatory system is,
7 what the design basis accidents are, what I think George or Tom you
8 mentioned would be a way to pick the things to change in Part 50, then I think
9 it's something that can be more useful.

10 But to some extent I think I'm a little bit more where Commissioner
11 McGaffigan is which is from a practical standpoint we need to put in place a
12 regulatory system and I think it would be difficult to get to a place where we
13 have a Part 50X that is truly technology neutral. I think that's never really going
14 to be an effective and efficient regulatory system to have.

15 As I said, if there's any real strong thoughts about that I'm happy to have
16 you respond. I wanted to turn to another issue, though, perhaps on another
17 area which may be somewhat related, Digital I&C.

18 The Committee has made some comments in a letter and expressed
19 some interest in getting some more information. One of the areas that I have
20 been wondering about with Digital I&C in particular as we move toward a more
21 risk informed performance based type of regulatory framework where we have
22 a lot more reliance on PRA is to what extent we have the ability to model Digital

1 I&C systems.

2 They are not flaws in Digital I&C systems that, I assume, are not
3 inherently probabilistic. If you have a software error, you have a software error
4 and that is not a probabilistic event. So how do you incorporate that into these
5 probabilistic models and can you combine those two systems? If any of you
6 have thoughts on that, I'd be interested in hearing.

7 DR. APOSTOLAKIS: Unfortunately, we don't have any methods
8 to do that. The reason is that the failure modes of digital software are what we
9 would call in the hardware space design and manufacturing errors. In
10 hardware space, we don't model design and manufacturing errors either. We're
11 assuming that the pump is good when it starts or the valve or whatever. This is
12 a tremendous problem. There's a whole literature out there where they take
13 digital software. They try to force the existing reliability models on them, but
14 they're really completely useless. So this is now the effort.

15 There are some people in fact that will say you'll never be able to do that
16 and you have to figure out another way of handling them, similar to what we
17 think about organizational issues, for example. There was an attempt years
18 ago to bring those into management and organization. Now most people say
19 maybe that's not a good idea. We'll do it outside. So we don't know,
20 Commissioner.

21 One of the projects in the plan is to look into how to bring Digital I&C into
22 PRA. There is some progress, I would say, but the fundamental problem of

1 design error has not been addressed. Not because they didn't try; it's really
2 very difficult. It's a different way of thinking. So we have to figure out another
3 way of handling them perhaps, but we'll see.

4 COMMISSIONER JACZKO: I think that's an interesting answer
5 and I'm almost reluctant to ask this. I'm wondering -- clearly we're moving to a
6 Digital I&C system and eventually it's going to happen. If we go back to some
7 of the comments about technology neutral framework and essentially what
8 we're looking at is fundamentally some kind of effectively a PRA based -- what
9 was it? The conditional - CCDF.

10 If that is inherently a probabilistic model, do we have a fundamental
11 problem then that we're going to be leaving out certain elements of plant
12 performance in getting to the QHOs and getting to that issue if we can't
13 inherently model the Digital I&C component?

14 DR. APOSTOLAKIS: You're right. Not everything will be there.
15 Again, the last major semi-almost-incident we had was due to a management
16 issue.

17 COMMISSIONER McGAFFIGAN: You're referring to
18 Davis-Besse?

19 DR. APOSTOLAKIS: Yes. These are not in the PRAs. We have
20 to do something about it. There is hope, though, and I'll tell you why. I think
21 the way the staff came up to handle management issues, which is a
22 performance based approach and so on, which was really something that

1 nobody had thought of several years ago gives me comfort that maybe we'll
2 come up with something like that to handle Digital I&C unless of course
3 somebody comes up with a brilliant idea and brings them into the PRA which I
4 have very serious doubts that this would ever happen. So in my view, most
5 likely they will have to be handled outside the CCDF.

6 DR. KRESS: There's always going to be parts of the PRA that are
7 incomplete. That's one reason we still advocate margins and defense in depth
8 and using conservative acceptance criteria.

9 DR. APOSTOLAKIS: The rationalists are very structured as to
10 what's appropriate.

11 DR. SHACK: It is, of course, always appropriate to be a
12 structuralist.

13 COMMISSIONER JACZKO: Thank you. I appreciate the
14 comments.

15 CHAIRMAN KLEIN: Commissioner Lyons? We did save some
16 questions for you.

17 COMMISSIONER LYONS: Maybe following up on the direction
18 Greg was going. I very much agree that Digital I&C is going to be a continuing
19 challenge, a very real challenge and offers substantial opportunities for
20 improved safety along with substantial challenges to maintain defense in depth.

21 I'm just curious if from the Committees point of view enough effort is
22 going into Digital I&C, both within the ACRS and within the staff.

1 DR. APOSTOLAKIS: What was the question? I'm sorry.

2 CHAIRMAN KLEIN: Is there enough effort going into Digital I&C?

3 COMMISSIONER LYONS: I'm sorry. I thought you were thinking.

4 DR. APOSTOLAKIS: What's enough? I don't know.

5 COMMISSIONER LYONS: I don't know and that's why I'm asking.

6 I think it's an extremely important area.

7 DR. APOSTOLAKIS: Commissioner, I think the most important
8 thing right now is for us as a community to understand the failure modes
9 because even if we want to handle I&C outside the CCDF – what does it mean
10 to handle? What does it mean to apply defense in depth? You have to
11 understand how the thing may fail.

12 I am very pessimistic right now that we will get probabilities at some
13 point, but I am optimistic that we will get a much better understanding and
14 methods for exploring the failure modes, which I think will be a major step
15 forward toward implementing defense in depth approaches and whatever else
16 we want to do.

17 Are we doing enough? I think there is progress. We can always do
18 more, even though I'm not from a national laboratory, I will always support more
19 research.

20 COMMISSIONER McGAFFIGAN: That was a low blow.

21 DR. APOSTOLAKIS: AS intended. It's a hard question to answer,
22 but I can't say that they're not doing enough because they don't have enough

1 resources. I can't say that. I think the effort, the challenge is really intellectual
2 at this point to make this breakthrough.

3 COMMISSIONER LYONS: How about from the perspective of the
4 ACRS. Again, for any of you, is the ACRS - should there be more effort within
5 the ACRS, additional expertise in this area or do think you're adequately staffed
6 in this area?

7 DR. APOSTOLAKIS: Can I answer that? We discussed this
8 many times. We have tried very hard to find both members and consultants.
9 We are very fortunate that one of our consultants right now is very experienced
10 and has been very helpful to us. The problem has been that if you find
11 somebody who is a true expert in safety of digital systems, that person either
12 works for the NRC already, so we can't hire them; or comes from a community
13 that for which nuclear is something foreign or they're not interested; or they're
14 awfully limited and as a member you would like somebody who would be willing
15 to approach broader issues at some point; but we're having great difficulty even
16 finding consultants who will appreciate the issues and be useful to us.

17 It's a very small community, the people who have worked on Digital I&C
18 and also know what a nuclear reactor is. It's the intersection of communities.
19 It's a very small set. We keep trying. We discussed it again this morning
20 during our free-for-all meeting and we hope that we will surprise you pleasantly
21 soon. I know it has been a concern of yours. It's not an easy thing to find
22 somebody.

1 COMMISSIONER LYONS: Well, it's a concern of mine because I
2 think it's going to be a major challenge for the industry and for the agency.
3 Perhaps in closing on this subject, ACRS has certainly involved foreign
4 expertise consultants in various ways in some of your studies. Have you
5 considered, given that there is considerably more work – there's certainly a lot
6 of work on Digital I&C outside of the U.S. and a number of examples where it
7 has been deployed. Have you talked about trying to tap into the international
8 knowledge base in any larger way through ACRS?

9 DR. APOSTOLAKIS: Yes. Well, first of all I did think it would be
10 very difficult to bring a foreign citizen, even a consultant.

11 COMMISSIONER LYONS: You certainly have them participate in
12 your meetings from time to time.

13 DR. APOSTOLAKIS: That's different.

14 COMMISSIONER McGAFFIGAN: Getting a blue badge is a
15 different issue.

16 DR. APOSTOLAKIS: You were saying about conferences and
17 meetings and interactions, that kind of thing. In various meetings, in fact, I
18 know some very good people in Germany who have been doing this. We might
19 pursue this and bring the guy here for a free meeting with us as an invited
20 expert if that's allowed, which I'm sure it is for a day or two, but he cannot be a
21 permanent consultant. Yes, that's something to explore, but it's not that we are
22 completely ignorant of what's going on there. Sometimes I get the feeling that

1 it's much more difficult to convince people here that something is safe than in
2 other places.

3 COMMISSIONER McGAFFIGAN: That may be a good idea.

4 DR. APOSTOLAKIS: I'm sure it is.

5 COMMISSIONER LYONS: I'll come back later.

6 CHAIRMAN KLEIN: I think this demonstrates one of the areas
7 that Commissioner Lyons has been looking at is do we need to put more
8 emphasis on Digital I&C research center and start getting more people trained
9 from the academic communities in terms of people that look at these activities.
10 So that's something that we kicked around ideas.

11 Clearly, Digital I&C is going to happen because that's where the makers
12 are going, the international communities are going that way, the Navy nuclear
13 program is going that way. I think there's a lot of examples we can learn from.

14 Mario, I have a question for you. We've got a good database on license
15 renewals and power uprates. What are the trends? Are we doing better?

16 DR. BONACA: Well, I think in the license renewal we've become
17 more efficient, of course. I think that the applications are quite complete. Many
18 of the older plants tend to go with exceptions because they already have
19 problems which have been proven for a long time. They propose them to the
20 staff. The staff evaluates and accepts them. But in general, I think the trend is
21 good.

22 We have seen some plants which are unusual, like Oyster Creek and

1 Palisades. In many cases, like for example, Vermont Yankee was just
2 reviewed this week. There are no issues. There are no open issues. What's
3 happening really is the industry by now is quite skilled in knowing what the
4 expectations of the NRC are and they have teams that go around, they come
5 and participate and they come very prepared for the follow-up. It's becoming
6 more of a routine activity.

7 In EPU's, it's a little more different. We're still on a learning curve and
8 there are still issues with the steam dryers that really have not been fully
9 addressed in some cases and there are issues to do with some of the
10 technology that goes behind. We've been reviewing this week a methodology
11 that GE has developed to allow more ability to the operators to operate at 120%
12 power essentially by changing flow conditions rather than rod insertions.

13 So they are presenting new technology. It's going to be challenging for
14 the staff for a period of time, it's going to be challenges for us because we're on
15 a learning curve.

16 CHAIRMAN KLEIN: Have you seen the quality of the applications
17 increase over the years that you watched them?

18 DR. BONACA: I think the applications are about the same. I think
19 what has helped us a lot has been the audits that the staff has been doing now.
20 They have audit teams that they hire. They send them out and they come up
21 with very detailed evaluations of the programs the utility is proposing. That's
22 very helpful.

1 The applications are pretty much consistent. They haven't improved any
2 more. I think that the period of time for review for the staff and our review has
3 gone to being as short as you can possibly be. I don't think we can improve on
4 that.

5 CHAIRMAN KLEIN: In my interactions with the international
6 community, a lot of concern is now being expressed by other countries because
7 they are now looking at license renewals as well. I'm sure we have some
8 lessons learned that we can share with our international partners in this area.

9 DR. BONACA: I think when I look globally at what we've seen in
10 the past few years, there is a lot of information being shared by the industry
11 because they are going through license renewal. That just has to be a plus
12 because experience is shared so much more frequently and totally than it used
13 to be 10 years ago. I think a lot of the merit is coming from license renewal. I
14 think this experience should be valuable to foreign companies that are planning
15 to go the same direction.

16 CHAIRMAN KLEIN: Thanks. Commissioner McGaffigan?

17 COMMISSIONER MCGAFFIGAN: One follow-up on the Digital
18 I&C discussion. It's the question we did ask in our last SRM that you couldn't
19 get to. It just strikes me having heard this discussion that the issue of backups
20 is going to be the central issue in deciding these things. You're not going to
21 convince me based on this discussion we just had that there isn't going to be
22 tremendous uncertainty and that you're going to need some sort of backup,

1 maybe modern, non-digital equipment. At least for some of these systems, we
2 can't take a chance.

3 But at some point, given that you feel you don't have the information at
4 this point to even discuss backups, at some point soon with the existing plants
5 and with the new plants, we're going to have to have that discussion as part of
6 a licensing process.

7 DR. APOSTOLAKIS: I think the classification of systems can be
8 done in two weeks; the failure modes in six months you're going to have a very
9 good report. That's my guess. We are not talking about a long-term research.
10 What does backup mean? You have to know what you're backing up.

11 COMMISSIONER McGAFFIGAN: I understand. I hope the staff
12 agrees with you on the two week and six month time lines.

13 DR. APOSTOLAKIS: That's not an ACRS position.

14 COMMISSIONER McGAFFIGAN: I'd like to see that too if that
15 was possible.

16 CHAIRMAN KLEIN: One of the clarifying issues that we learned
17 when we went to the Navy nuclear activities was that what they've done is
18 they've put some backup systems, separate independent systems at various
19 components, so they'll give you another signal that's not coupled with their
20 digital. There's ways that it can be done.

21 COMMISSIONER McGAFFIGAN: I'm sure that's the case, but it
22 would be nice for us to get on with figuring that out and having some sort of

1 systematic approach to approaching that.

2 I'm going back, I guess, to Tom and George. We're talking about how
3 easy it's likely to be - or I was talking and you weren't disagreeing - with regard
4 to high-temperature gas reactors in terms of you're pretty sure they are going to
5 be safer, there will be some issues – on the other end of the spectrum, our co-
6 located reprocessing sodium cooled fast reactors and fuel cycle facilities
7 handling and doing all sorts of fairly dangerous things. You put them in your
8 framework and instead of relaxing, we're going to be hardening Part 50.

9 DR. KRESS: I imagine you may be.

10 COMMISSIONER McGAFFIGAN: Will your framework help me
11 with that? I pretty much know if you count all those facilities together. You said
12 one of the issues you guys are arguing about is do you do a quantitative health
13 objective facility by facility or site by site.

14 If you have a lot of stuff on one site, each of which has some significant
15 danger associated with it or safety issues that have to be resolved, if you say
16 you have to use the cumulative approach, we're going to have to sum
17 everything up, siting these sites might be pretty hard.

18 DR. KRESS: Well, it may be, but I think that's the correct way to
19 go.

20 COMMISSIONER McGAFFIGAN: I've got two good experiments
21 going forward that the nation seems to be interested in; one is high-temperature
22 gas reactors and one is co-located facilities for closing the fuel cycle. The latter

1 is going to be the harder challenge. Does that help us? Do you think this
2 technology neutral framework, which I'm always calling the grand unified fuel
3 theory, will that really help us with the hard choices we're going to make on the
4 closed fuel cycle facility?

5 DR. KRESS: I certainly think it will.

6 COMMISSIONER McGAFFIGAN: I see Dana shaking his head.

7 DR. KRESS: Dana may have a different opinion about the safety
8 level of gas cooled reactors, but I certainly think it will. It gives you a systematic
9 look, pretty much like the hazards analysis does, except it tries to quantify
10 those. It gives you a systematic look at them and tries to quantify what the
11 consequences and the probabilities are. I don't know of any other way to say
12 you have a safe site without having safety criteria and having a way to quantify
13 that.

14 COMMISSIONER McGAFFIGAN: My question is I agree with all
15 that, but do I have to have the technology framework to –

16 DR. KRESS: I think so; unless it's an LWR, then I think you can
17 still go.

18 COMMISSIONER McGAFFIGAN: I've used up enough time,
19 although Dana has been absolutely quiet today.

20 DR. KRESS: He's one of the other hands that's going to have
21 added comments..

22 COMMISSIONER JACZKO: There's a perfect opportunity to add

1 something.

2 DR. POWERS: Well, it is fair to say that I disagree with Tom
3 almost categorically on this area.

4 DR. KRESS: Which is not unusual.

5 DR. POWERS: To come back to Commissioner McGaffigan's
6 comment, yes, I think you're going to have to reexamine your QHOs because I
7 think they lead to a conundrum that it is clearly better to locate a closed fuel
8 cycle system together to avoid the transportation issues that you would have if
9 you located them separately, yet your QHOs seem to preclude that. You
10 gentlemen are going to get the big bucks to figure that one out.

11 It's where your QHOs were never designed to handle those systems and
12 yet it is absolutely transparent. You do not want to have reprocessing facilities
13 in one state, actinide burners in another state, fuel fabrication in yet a third
14 state and transport the material around. The societal safety is just much worse
15 in that case verses collective. Yet you get this conundrum where the QHOs, as
16 Tom correctly says, is a site characteristic it just runs afoul of that. You will
17 have problems there.

18 You'll be either unable to find a site or unable to build a facility safe
19 enough that you can afford to handle all the materials. It's a conundrum you're
20 going to have to address.

21 COMMISSIONER McGAFFIGAN: I appreciate that comment.

22 Someday, some Commission is going to have to face these issues. I think the

1 way GNEP is going in Congress that day is not exactly imminent.

2 DR. KRESS: One concept I'd like to throw out in a rejoinder, here
3 is I guess is I view the QHO as an implied cost-benefit contract. You don't
4 actually go out and do a cost-benefit, but it's implied and they arrived at it by a
5 different path. But if it is a cost benefit, one might think about changing the
6 QHOs for something that has these multiple purposes on it because the benefit
7 is much better.

8 I don't think the QHOs necessarily are cast in concrete. My choice of
9 those is just for sites that have nuclear power plants. You may rethink what
10 your safety criteria are for these multiple purpose sites.

11 CHAIRMAN KLEIN: Commissioner Merrifield?

12 COMMISSIONER MERRIFIELD: This has been a very good
13 conversation. I think it's been well vetted, so I won't add to it. I want to make
14 one comment that I didn't make previously, but I think it's worth noting.

15 I think the Commission has spent a significant amount of time over the
16 last nine years looking at the composition of ACRS. I think we continue to
17 succeed in having an environment where there's an ability to have a diversity of
18 opinions.

19 One of those which I think we have done a better job at is making sure
20 we have individuals who have commercial operations experience. I think it's
21 very important as a Commissioner that obviously we need to have a good
22 grounding on the theoretical and good grounding on a variety of technologies. I

1 think it's vitally important that that be balanced within the context of the
2 evaluation of these issues by having individuals who have actually had to
3 operate nuclear power plants and I'm glad we've made a real effort to get more
4 of those folks on board and we have more in the pipeline, which is good.

5 With that, Mr. Chairman, I'm going to do something that I rarely, if ever,
6 done as a member of Commission and I'm going to waive the remainder of my
7 time. Thank you.

8 CHAIRMAN KLEIN: For a lawyer, that's amazing. Commissioner
9 Jaczko?

10 COMMISSIONER JACZKO: I guess I just have more of a general
11 question for a final question. It seems that the more I learn about PRA the
12 more I learn what PRA doesn't do.

13 COMMISSIONER McGAFFIGAN: That's about where I was about
14 eight years ago.

15 COMMISSIONER JACZKO: We all seem to be -- although with
16 Part 52 and with Commissioner McGaffigan's initiative we've outlined - and I
17 think Bill you commented on that -- to have requirements for living PRA for new
18 reactors, we still have 104 reactors in operation that potentially could see long
19 life ahead of them.

20 It's my understanding that we really still don't have good PRA and I
21 guess it's probably a question about what good PRA means. We could
22 probably have a pretty long discussion about that.

1 I'm wondering if you could just comment on where you see the state of
2 the art in PRA for the existing fleet and where we go in the future. I think we
3 are doing a good job in the fire protection area because of NFPA-805 and that
4 seems to be driving advancement and development of the PRA in that area, but
5 there are a lot of other initiating events, a lot of others aspects of PRA that may
6 be lacking. If you could maybe just comment; anybody who wants to on your
7 sense of that.

8 DR. APOSTOLAKIS: I think it's important not to oversell PRAs. I
9 think for LWRs, Level One that means core damage. I think we have a pretty
10 good PRA now that give you a good description of the ways accidents may
11 progress and damage the core. These accidents will involve natural
12 phenomenon and random failures of various equipment. They do not include
13 organizational issues. They do not include management issues and to the
14 extent that they are being used, they don't include Digital I&C.

15 The human error probability is, especially when it comes to recovery
16 actions during an accident, as I've said before, there are several models, most
17 likely they disagree in their numbers, but progress is being made there as well.
18 So there are certain areas that are larger uncertainties and things are not done
19 as well as we would like to like in human reliability. There are certain areas that
20 are completely out of the PRA and I don't think they will be included any time
21 soon.

22 As long as we are aware of these things, it seems to me that a

1 combination of defense in depth and risk informed insight is a proper way to go
2 and this is the way the Commission has been going now for nine years or so.

3 Now when it comes to new reactors, I think it will be useful to go back
4 and think of what happened to light water reactors when we started out and
5 what we have learned. How many times have we been surprised, for example,
6 that something happened that we never expected it to happen? Now you have
7 new designs.

8 People are optimistic because designers by their very nature are
9 optimistic. They're not out to make things that fail. They're out to make things
10 that work and produce power. It's not a malicious kind of thing. That's their
11 nature. Then you have analysts.

12 In fact, it's very interesting - in the old days we had methods for
13 identifying the initiating events. Now for light water reactors nobody's going to
14 do that now. We have standard lists, procedure guides and so on. Then we
15 talk about new reactors. We have to go back and start thinking. You have to
16 go back and rethink the issue of initiators.

17 COMMISSIONER JACZKO: By new, are you referring to passive
18 designs or are we talking about next generation?

19 DR. APOSTOLAKIS: I don't know what may happen. I have a
20 good list for PWRs, a good list of LWRs and the standard advice is start with
21 those and look at your own plant if there is something special that you want to
22 include. That's fine. If I'm talking about a gas reactor or I'm talking about a

1 liquid metal reactor. How can I make sure that my list of initiating events is
2 fairly complete?

3 Looking back at the history, we realize that we were surprised a few
4 times. It stands to reason that we will be surprised again if we ever build any of
5 those things. So using PRA to summarize; for LWRs, Level One and maybe
6 Level Two; Level Three we haven't really done much. But for Level One I'm
7 pretty confident that we will not be surprised again anytime soon.

8 Davis-Besse was not a surprise. A lot of people were saying that; that
9 something like that would happen. But for the new reactors, the new type
10 reactors, I think we should be very cautious because surprises will be there.
11 It's human nature. You can't figure out everything, especially the initiators.
12 That's the way I see it.

13 COMMISSIONER JACZKO: Does anybody else want to
14 comment? Thank you.

15 CHAIRMAN KLEIN: Commissioner Lyons?

16 COMMISSIONER LYONS: I have one fairly specific question on
17 the human reliability portion of the presentation and it was reference to using
18 the capabilities of the Halden facility to evaluate different models. I had the
19 opportunity to visit the Halden facility.

20 I was extraordinarily impressed with it, but I was also slightly concerned
21 because at least when I visited, I asked the question whether the human
22 reliability studies at Halden had ever been conducted with crews trained in the

1 U.S. I was told that Halden only had used Swedish, Finnish and perhaps a few
2 German crews. That doesn't mean that I wasn't very impressed with the
3 Halden facility, it also increased my interest in having facilities in this country
4 where such work could be done, but I just wonder if that point - if that raises
5 any concerns with your comments to use Halden in terms of evaluation models.
6 I'm just not sure that models necessarily cross cultural and training differences.

7 DR. APOSTOLAKIS: We specifically asked that question when
8 the staff told us they would carry out this new study in Halden and I believe the
9 answer was that yes, there would be American crews. Either they already had
10 a commitment or they were about to get a commitment from American utilities
11 to send Americans to participate in the exercise. It was left at that. We are
12 fully aware of this issue. This was the answer from the staff.

13 COMMISSIONER LYONS: I would feel a whole lot better if that
14 statement is correct and if we're going to base data from Halden on crews with
15 our cultural and training backgrounds.

16 DR. APOSTOLAKIS: I think Dr. Powers has a question there.
17 What was it?

18 DR. POWERS: What do you learn from a Norwegian reactor, run
19 by Finnish crews, using French procedures?

20 COMMISSIONER LYONS: That's another way of stating my
21 question.

22 DR. POWERS: You still have the problem, the unfamiliarity and

1 whatnot of the environment and things like that. We have a wealth of data from
2 our simulators that we just have not mined effectively and I think that's part and
3 parcel of the future plants is to use the wealth of data that we have and to
4 explore these models. It doesn't get us out of the problem that PRA does not
5 now have good ways of handling errors of commission and a list of other things
6 that I'll add to your list on things that doesn't happen.

7 And augment what George said about PRA to say that I suspect it will
8 not surprise me if one of the conclusions that comes from our research report is
9 that we're concerned about the stagnation of development and methods within
10 the agency in the area of PRA.

11 COMMISSIONER McGAFFIGAN: It's good to have these structuralists
12 around, Mr. Chairman. I hope some of these new folks we're bringing on in
13 PRA expertise have structuralist tendencies.

14 DR. POWERS: They're rationalist, every one of them.

15 CHAIRMAN KLEIN: I assume you're saying "structuralist" and not
16 "obstructionists".

17 COMMISSIONER McGAFFIGAN: Structuralists are good people.
18 I think I'm one, they've told me years ago I was a structuralist.

19 DR. POWERS: I knew I liked you for some reason.

20 COMMISSIONER LYONS: Thank you.

21 CHAIRMAN KLEIN: Thank you very much for a very good
22 presentation and a lively discussion. We certainly thank you for your

1 independent advice and counsel. It helps us in our deliberations. We certainly
2 expect our workload to increase, which means your workload will increase as
3 well with a lot of things on our plate. Again, thank you for what you do for the
4 Commission.

5 On behalf of the Commission, thanks for what you do. Tom, thanks
6 again for your service as well. I think Commissioner McGaffigan might have
7 some comments.

8 COMMISSIONER McGAFFIGAN: I second your comments
9 particularly with regard to Tom. When did you arrive?

10 DR. KRESS: 1991.

11 COMMISSIONER McGAFFIGAN: 1991. So you easily beat my
12 tenure on the Commission. The purpose of me asking for the floor at this point
13 is to recognize that this is Jeff Merrifield's final public meeting in this room. Jeff
14 and I have been together for over 8 ½ years on the Commission, even
15 counting the times when we were off waiting for the Senate to act on various
16 nominations and whatever. It's been a great service to work with Jeff.

17 He will end up, I think, the sixth longest serving Commissioner in NRC's
18 history. We ended up having a time here where we had the first, the third, the
19 sixth and the seventh all at one time. We were the people who greeted Dick
20 Meserve when he showed up and said goodbye to Dick Meserve as he left.

21 It's been a tremendous honor to serve with Jeff and I think we have a
22 record of accomplishment partly because of that continuity that we had among

1 all those long serving Commissioners.

2 I also want to recognize Larry Chandler. Larry is about to retire. This is
3 his last meeting down here representing Karen Cyr. He's about to retire with 37
4 years of Federal service, 35 of them here with us; the last 18 as the Associate
5 General Counsel for hearings. Last eight. I've got the wrong date.

6 He could have retired a long time ago. I've always been joking he could
7 have retired in 2001. I prayed that he would not do the calculation as to how
8 much money he makes when he comes to the office. He's a truly dedicated
9 public servant and we're going to miss you as well. With that, Mr. Chairman, I'll
10 turn it over to my colleagues.

11 CHAIRMAN KLEIN: Thank you. Jeff?

12 COMMISSIONER MERRIFIELD: Well, I'd just like to thank you for
13 those kind words. We've had a lot of fun the last 8 ½ years and we've
14 accomplished a lot. This is not the same agency that we inherited when we got
15 here and I think the work that the Commission has done, the work that our
16 senior staff has accomplished and in the end the hard work that has been
17 engendered by all of our staff has put this Commission in the best place its
18 been in perhaps in the entirety of its history.

19 Obviously, our three newest members inherit a Commission that is
20 strong, is vibrant, is ready and is well prepared for the challenge that it will see
21 in the future. I feel very good about what we've done and I feel very good
22 about the relationship that you and I have had over these years.

1 I would also want to join you in congratulating Larry. Larry has provided
2 great counsel to me on a variety of occasions in the past and he is a dedicated
3 servant. Like you, I would reflect Larry, maybe because I'm an attorney and I
4 have a little better appreciation of this, Larry could have earned lots and lots of
5 money on the outside. Maybe he will when he nonetheless leaves. It's a pretty
6 good time for attorneys leaving the Commission. I certainly wish him well. He's
7 been great for us.

8 CHAIRMAN KLEIN: Thanks.

9 COMMISSIONER JACZKO: I certainly want to echo the
10 comments about Larry. I haven't had as many opportunities to interact with
11 Larry, but I think when it comes to attorneys, that's always a good thing. Not
12 because it's bad to interact with attorneys, but usually because you interact with
13 attorneys in bad situations. Let me clarify that somewhat.

14 COMMISSIONER MERRIFIELD: Present company at the table
15 excluded.

16 COMMISSIONER JACZKO: Right. And then of course, I would
17 like to say a few words about Jeff. As I remarked earlier, he was one of the first
18 people who I met with before I actually came to the Commission after I'd been
19 confirmed. He gave me some good advice then and it was I think the start of
20 what I hope is as productive of a relationship for you as it's been for me to
21 serve with you. It's not been certainly the length of time that Ed has served
22 with you, but I certainly have enjoyed working with you for a little over two

1 years.

2 I think it's pretty clear the contributions that you and Ed have made to
3 the agency and you certainly have a lot to look forward to as to embark on your
4 next career. I think wherever you go, you certainly will be a tremendous asset
5 to whatever your next endeavor is. I appreciate your service and have enjoyed
6 working with you.

7 CHAIRMAN KLEIN: Pete?

8 COMMISSIONER LYONS: I certainly want to echo the comments
9 both from Ed and Greg and also from Jeff with regard to Larry. We're certainly
10 seeing the departure of two very dedicated public servants. I tremendously
11 appreciate the contributions that both of you have made.

12 Jeff, I've looked to you for advice in many areas and as we have more
13 opportunities to discuss and roast you, I'll go into more of some of those areas.
14 But in any case, I really appreciate the service from both of you and wishing
15 you all the very best.

16 CHAIRMAN KLEIN: In summary, I'd like to thank Jeff and Larry
17 for their public service and the only question Larry, is that you didn't start here
18 right away. You took a slight detour in your public service before you started.

19 MR. CHANDLER: Just a brief period for two years.

20 CHAIRMAN KLEIN: Thanks again for what all of you have done
21 for the NRC and best wishes in your next careers, whatever that may be.

22 Meeting is adjourned.