inspector to a senior, and then they'll move to another facility, but seven years is the maximum, and that's written in our policy.

CHAIRMAN CONWAY: Thank you. Dr. Hackett.

DR. HACKETT: Thank you, Mr. Chairman. I have a different challenge today, which is to try and help walk you through a story that's very important to us in the nuclear industry. In general, it dovetails with what Russ and Cindy had been talking about. The thing I'll add on this slide is that during the timeframe from May to October 2002, I was Assistant Team Leader for the NRC's Davis-Besse Lessons Learned Task Force. That's the role in which I'll be presenting this information to you. As you've been doing, I think I found that these work most effectively when there is back and forth exchange and dialogue. I think that would be the best way to proceed.

For those who don't know about this, in February 2000, we discovered a corrosion cavity, and I have some graphics here to walk you through, on the Davis-Besse reactor vessel head during inspections for vessel head penetration cracking. These are the penetrations that come through for the control rod drives. They are Inconel and the vessel head is a carbon steel.

The extent of the corrosive attack was unprecedented. This was from a concentrated boric acid solution, but we still don't know exactly the particulars. It was a combination of leakage through the penetration of the primary coolant system and also most likely leakage from above in terms of some of the seals on the control rod drive assemblies themselves.

It set up a situation on top of the head that ended up in a very aggressive attack on the head, that as you can see on the slide here, degraded over six inches of carbon steel all the way down to the internal stainless steel cladding liner, which was all that remained as the pressure boundary over the degraded area. This was absolutely a function for which the stainless steel cladding was not at all designed. I think this has been characterized in the press as a "near miss" for the industry and for us, not a place we ever want to see ourselves go back to again.

I like to use props, so I brought one along. I don't know if this will be too heavy to pass around. I brought along a metallurgical section here, too, the Midland reactor vessel that shows some of the features that I'm talking about. I can hold it for the camera here too and I'll pass this around. I've marked the six-inch point on here to show exactly how much steel you are talking about degrading.

Also this shows some details of the through-wall weld and also the stainless steel cladding. You can pass that around. It is a bit on the heavy side. That was discomforting, on the order of a nine-inch wall. When we talk about conservatism, there's definitely some there.

In reaction to this, the NRC chartered a Lessons Learned Task Force, as I mentioned, in May 2002, and it was really aimed at answering the questions of: "Why was this event not prevented? How could this have happened?"

I'll talk you through some of the specifics. This came out a little bit scrunched up into PowerPoint here, but a typical pressurized water reactor. In the case that they specified, we are looking at the B&W [Babcock & Wilcox] design that illustrates some of the features I was mentioning earlier. On the top there, of course, you have the control rod drive assemblies and the penetrations that go into the top of the reactor vessel head are in this area here. That's where I'll be focusing.

This shows it to you a little bit better.

This area right [here] is where the degradation cavity was on the Davis-Besse head. As I mentioned, pretty much along with the laser pointer here from the top right here all the way down to this inside piece was degraded over the area about the size of a football. It's been characterized as that most often in the media. Again, that was a combination of leakage through this penetration here, which was nozzle number three, which was due to stress corrosion cracking in the Inconel penetration and also leakage from the seals, above which had accumulated a crust of boric acid underneath this insulation.

Some other features I can mention, it's obviously a difficult area to inspect. There is a very high radiation area. Also, this has an access structure on it which has access holes in it. But to get in there and do a thorough inspection of this region on a B&W design is difficult. It's far more difficult on some of the other designs, unfortunately. B&W is actually one of the easier ones.

This is some detail of the penetration. The leakage that I'm talking about came through [the] wall on this material here, which is the Inconel. The cracks go through - in some cases there's both - what we call the "J-groove welds" down here, which are an austenitic weld metal that joins the Inconel to the carbon steel. They also go through the actual wall of the Inconel housing itself. Then what you set up apparently - we'll never know this for sure given the way things played out - a condition in this area here that was very conducive to accelerated attack of the carbon steel that was further complicated by a crust of boric acid and corrosion product that remained on top of the head.

DR. MANSFIELD: So you were indicating that the leaks and initial corrosion could have been from inside out.

DR. HACKETT: That's correct. What you'll see and what I'll talk to you about is that the state of the head up here over a fairly long period from probably about 1996 to 2002 was in a pretty bad state of maintenance. That is something that not only the licensee missed, was not focused on, nor was the NRC.

CHAIRMAN CONWAY: Wouldn't that have shown up in a refueling during that period of time?

DR. HACKETT: Absolutely. There were two refuels during that period of time during which the head was "inspected." Obviously those inspections were completely inadequate to have detected this phenomenon. That's part of what I'll go into.

The last piece, this shows the schematic. Then we'll see the actual photo. This shows the cavity. You can see from this penetration here, number three, the entire piece of the head through this region is gone all the way down to the cladding.

Actually something quite spectacular to me was when I figured this out at the time that the cladding was able to serve the function of the pressure coolant boundary as well as it did. It is not at all designed for that. It's about three-tenths of an inch of stainless steel weld.

Our research analysis actually showed that it would have held more than double the pressure of the reactor coolant boundary over that area. Obviously that would not have lasted forever. The debate rages as to how much longer you would have had, but it was probably on the order of months to a year before it would progress to the point that you might have lost that interface.

DR. MANSFIELD: So the span would grow.

DR. HACKETT: Right, exactly. The problem is trying to get into a debate with corrosion experts around the world of exactly how fast that would have progressed.

DR. MANSFIELD: But there wasn't any

degradation of the properties of the stainless.

DR. HACKETT: No.

DR. MANSFIELD: So a properly designed discontinuous support of a thin stainless steel vessel might be able to serve as a pressure vessel.

DR. HACKETT: That's correct.

CHAIRMAN CONWAY: You said there are differences, disagreement, among the so-called experts, but you bounded it presumably so the most conservative if you will --

DR. HACKETT: Exactly. That's what we tried to do in our bounding. We always are nervous when we use the word "bounding," because as soon as we issue that from your mouth it's challenged or it's proven to be wrong. We thought the bounding estimate would be on the order of six months that the attack could progress that fast and spread out over a wide enough area that you might actually cause a breach. So again, as I said at the opening, far closer than we ever wanted to be.

This is actually what it looked like. Probably not the best picture, but here, this is the top of the reactor vessel head around the side of the cavity. This dimension from here down to there is the six inches or actually I think it's about six and a half inches. Then what you're looking at right there is the stainless steel cladding, looking down from the top of the reactor vessel head end. Again far worse.

DR. MANSFIELD: How was the cladding fastened? Was it fastened to the inside?

DR. HACKETT: It's metallurgically bonded to the inside of the reactor vessel head through welding. It's a strip clad process that's put down. So that's the particulars. This is showing some pretty significant evidence here. These are the access holes that I was talking about, and you can see that in this case the refuel outage in 2000, which was two years before this was discovered, showed significant evidence of boric acid and corrosion deposit streaming down through these access holes. The unfortunate situation is that the head was left in this state for a significant period of time. Our best guess is four to six years.

DR. MANSFIELD: Would the access that is possible allow you to have used something like a borescope or some sort of remote television thing?

DR. HACKETT: Absolutely. Again, this is very similar. I read at least excerpts or parts of the Columbia Accident Board Report. There are a lot of similarities here. We had two major causes, technical and organizational. The technical one, I'd like to talk about. It's the easy part.

I don't want to underplay that, but I am a metallurgist by training, and we can fix things like that. We think we know how to fix stress corrosion cracking occasionally. We've been working on that at least most of my career. But those are the easier parts. The organizational elements, I think, are the greater challenge.

But in terms of the technical piece here, the parts that we had some difficulties with - or let me back up and say that this piece here, the technical piece, for those of you who are familiar with the Columbia Accident Investigation Board Report, this would be our foam strikes. This was going on.

Our engineers were even in some cases aware of it and were numb to it because of my second bullet here, a mindset that boric acid on the reactor vessel head, was not considered to be highly corrosive. The heads are hot and dry. "You don't have a corrosion cell set up there," was the mindset. You're just not going to get this phenomenon.

So there was an awareness of it, but there was also this mindset that it's not going to be this type of problem. Even if it ever got to this level, our inspection effort would catch it. You would have to have egregious leakage to result in this kind of attack, and our inspection effort would catch that type of thing. When, in fact, this happened with a very low leakage over a very long period of time, and we missed it.

The previous NRC assessments in this area were axial cracking in reactor vessel heads penetrations, Inconel penetrations. They were not considered to be an immediate safety concern, circa the mid-1990s. The French had a very opposite reaction to this in their program when they saw this. They were the first ones to see this stress corrosion cracking phenomenon in the Inconel. They reacted very much more aggressively than the NRC did almost 13 years ago now with an event that happened with their Buget plant.

The other thing that happened for us is we didn't make this linkage. Because of this -- I also have a fracture mechanics background. We're very concerned with cracks and the extent of cracks and the severity. That would have considered leak-before-break.

The Inconel is a forgiving material. You had axial cracks. It's not terribly safety significant from a fracture mechanics standpoint. I think it's fair to say the linkage was not made between the cracking in the vessel head penetrations and the boric acid attack even though there was ample evidence available to contradict that which was out there in the literature when the team looked through this.

CHAIRMAN CONWAY: Go ahead.

MR. FORTENBERRY: Dr. Hackett, quickly. These are all listed under technical. I would argue with you on that because of a couple of things I want to ask about.

DR. HACKETT: Good point.

MR. FORTENBERRY: One of them is something that we heard from the NR folks which is interesting, and that is waivers to requirements are essentially anathema in the organization, and you describe a situation where you had some cracking that clearly wasn't within the specifications of that component.

DR. HACKETT: Right.

MR. FORTENBERRY: You'd say limits can take just so much. You essentially accepted the condition as opposed to saying, "Unacceptable, it doesn't meet the requirements." You basically entertained a waiver that allowed the cracking and the bit of leaking, and here's where you come to based on something. I know in the Lessons Learned from your task force there was some discussion. I was a little bit confused or foggy about what they were saying, but they seemed to imply that this mindset was based on some risk-informed approach that said, "What is the probability - I guess is the right way to say it - of this amount of leakage leading to an unacceptable event?" Again, a decision was reached that said, "This is not one of those paramount high significance issues. We can afford to not focus on it."

Of course, the utility followed logic. You saw the streaming. You showed boric acid coming out, but again that's not the focus of, let's say, the regulatory [agency] imposing itself. That's why I argued that these are in fact the organizational part, which is not the focus of our session today, and trying to understand how you avoid things like this and, again, not trying to blame, to criticize.

But it is interesting to compare what I heard this morning, which would have said, "We don't know what the effect of these cracks would be really, and some people could argue that it's okay, and some people might say that it's not. We can do a probabilistic assessment to say it's so much, but we're better off staying with doing it right, for example, and not allowing any cracks." Of course, that would have eliminated all the stuff.

DR. HACKETT: These are good comments. I did say technical here but I think there are all organizational and cultural aspects mixed in here. You hit on a very key point. In all honesty, the boric acid inspections in the plants by this point in time would not have been considered terribly risk-significant. Obviously that's the wrong answer.

But if you were looking at this on a risk cut, you are probably not going to get there with the NRC-mandated boric acid inspections. In fact, one of the findings of the team was that the boric acid inspection procedure was eliminated in the year 2000 based on exactly that. It wasn't making the cut.

DR. MANSFIELD: So this isn't a way of dealing with the problem by defining it as not important. I'm struck with something our Naval Reactor colleagues told me, "If anything happens that's not submarine-sound, you never ignore it." Does that accurately put what you told me one time? You don't define it out of existence. If anything looks like a non-reactor look, then [don't] ignore it. Is that the lesson I should take?

DR. HACKETT: I agree. That's very fair. The next piece tried to focus in more on the organizational pieces. Our team concluded that the event was preventable. There are three major contributing elements. The first one goes to failure to review, assess, and follow up on relevant operating experience. There's a wealth of experience in this area as it turns out.

It's sad to look back at that kind of thing, just like with Columbia, and find out that there was actually a history of boric acid attack events, none even approaching the severity, but that showed the potential for this type of thing to happen. There were numerous NRC communications. We communicate with our licensees through our generic communication process. We had issued numerous generic communications on the issues of stress corrosion cracking and boric acid. What we were failing to do was to integrate that all properly.

Then there was the very much stark contrast with the French experience, where they did operate as the Technical Director mentioned. They took a position very early on. They were not going to tolerate any cracking in these penetrations. They proceeded down a path that ultimately led to replacement of the majority of the heads on the French commercial fleet, which is coincidentally now where a lot of the U.S. fleet is going, but much earlier in the process.

CHAIRMAN CONWAY: The second bullet there with the, "NRC, the licensee, and industry failed to adequately review...": was this pretty well known out among the industry, among the other pressurized water reactor operators? Was INPO cut in on this do you think?

DR. HACKETT: They were, in fact, and I think they've done their own critique of their situation. I'm not familiar with the particulars. The information was all there. When we go into well known, I guess that goes to obviously it wasn't well known enough by the right people, but the information was all there, unfortunately.

The second piece goes to the licensee's performance. They, in our opinion, failed to assure that their plant safety issues would receive the appropriate attention. As Cindy mentioned in her presentation, that for the NRC is the first line. We're assuming that the licensees are doing their job. Their performance and safety focus is their primary function. Our inspection program and our regulatory program is a check on what they are doing. They obviously, FENOC [FirstEnergy Nuclear Operating Company] in this case, the licensee, has owned up in their own self-critique that they had what they called the "production" rather than the safety focus. They were trying to keep the plant running. They were not focused on safety.

The last piece is what I'll spend the most time talking about today regarding the NRC. We really failed to integrate a lot of information that was available if you looked in the right places into appropriate assessments of their safety performance. This is probably over at least a five or six year period that this was occurring.

DR. MANSFIELD: I'm guessing now that you would not have failed if your inspectors were instructed to take note of anything that looked different in appearance, which means they have to know what different means.

DR. HACKETT: Right.

DR. MANSFIELD: So they would have to have a fleet-wide picture of what reactor vessel heads should look like.

DR. HACKETT: Another good point. Yes, that's true. One of the findings we also made -- and

I think it was referenced previously to -- a questioning attitude. One of the findings on the team was that we did not see as much of a questioning attitude on the part of our own inspectors, certainly not on the part of the licensee in running these types of things down. It does go that there are some very specialized expertise obviously that would be required here, but there were some pretty egregious signs of things going wrong inside this containment, including multiple failures of the containment air coolers that were fouled with corrosion product that was ferric oxide or ferrous oxide.

It was obvious that it was some carbon steel corroding to a fairly large degree in the containment, but the questioning attitude went towards, "They weren't pursuing that." Instead, they were changing out the containment air cooler filter elements more frequently.

CHAIRMAN CONWAY: Does this utility have a safety committee that was outside of the production part of the operation?

DR. HACKETT: They do, in fact, as do many of the licensees. They also did not pick up this.

CHAIRMAN CONWAY: That's what I was going to ask. Did this question ever come up in their committee meetings?

DR. HACKETT: Not that I'm aware of, certainly not in advance.

MS. CARPENTER: We also recognize that the inspectors were aware that they were changing out the filters. They were doing maintenance, maintenance that was usually every couple of years; they were doing it routinely, and I guess they got into a groupthink and that happens. You asked about the rotation of the inspectors.

CHAIRMAN CONWAY: Yes.

MS. CARPENTER: That's one of the reasons that our inspectors do rotate out. It's one of the reasons we have region-based inspectors go out to the site, which is to maintain that questioning attitude of, "This just doesn't look right" rather than just taking on face value if the licensee says, "This is what it is." Suddenly, we were all going in that direction.

It's continued to emphasize in ROP. You have to question all the time: "This just doesn't make sense." It was more of an unusual maintenance situation and now it was being done routinely. Why did it change? That is one of the valuable lessons for us.

DR. MANSFIELD: And my previous comment about the value you would have had if you had a questioning attitude toward the visual appearance of it extends, of course, to anything that's out of its envelope, like the filter and things like that, which is operating in a way that wasn't designed into it. I'm kind of surprised that the owner wouldn't dig into that right away the way you would if your car starts doing something outside of its envelope.

DR. HACKETT: Exactly. That's a good analogy. The last piece I was going to mention here goes towards the resources and staffing. If there were more time, I could touch on a lot more things. Part of the discussion previously went towards continuity. Unfortunately on our part, we had nine program managers for Davis-Besse over a ten year period. It's unacceptable.

We should have more continuity than that in our project management effort. We had significant changeovers as Cindy mentioned in the inspectors who were onsite. So we had a definite lack of continuity. We had a NRC Region III which oversees the plants in that vicinity very challenged during that time with a number of former watch list plants. Davis-Besse was, actually ironic to look back now, considered the top performer in the region before this event. So there definitely were some resources and staffing and continuity issues going on.

DR. MATTHEWS: This may be a good time to ask a question I had, and it refers back to your talk. The question is: how are you going to change your inspection and oversight program? I'm sure you're going to look at boric acid corrosion. That part's easy. But it's the cultural issues, the organizational issues, the safety culture issues, the human factors issues which are a lot more difficult to measure and predict the next type of problem. I was curious. Are you going to change anything in that area as a result of this, and what would they be?

MS. CARPENTER: Yes, sir. We are. Part of that is a constant reminder of "Lessons Past, Lessons Learned" to our inspectors. We have new staff come in, and with the new staff, the corporate memory disappears. It's a matter of trying to remind the staff continuously that their job is that questioning attitude. That's why they're out there.

The other thing is, Ed talked about operating experience. We were receiving that information. It was within the agency, but it was in various parts of the agency. No one took that piece of that and put it into the inspection program. So part of it also is building into the inspection program some of these lessons learned, going back and looking at some of these safety issues that were out there, some of the generic communications that we've issued. It's to put them into a database so that the inspectors can see that.

When an inspector picks up an inspection procedure and is going to go out and look at boric acid control, some of that operating experience that was out there is there for them to look at. It's to remind them that this was an event that happened a long time ago. Here's what's been happening out there. So part of it is better training of our inspectors, building it into the inspection program, and keeping our technical staffs.

I think Ed will touch on this. We have a task force looking at: how do we do a better job of integrating operating experience, and how do we make sure that our licensees are doing the same thing? How do we make sure that they are asking those questions and that they are following up?

We're changing our corrective action procedures to say, "Is the licensee making modifications? Are they deferring modifications so that they can come back on line faster? Look at those deferred modifications. Pick those out. Pick up some of those old operating experiences. What are they doing with those?" So these are different pieces that we are incorporating into it. There were a lot of great lessons learned out of this, and we're building it into the programs.

DR. HACKETT: On the next slide, I think in the interest of time I would go towards the bottom actually. In case anyone wants a more detailed treatment of this, the Lessons Learned Task Force Report addresses the area shown on the slide. It was completed almost a year ago now, and it is available on our website. I don't know what the download would take. It probably would be a little while. It's 96 pages I believe. There's a lot of detail in there, some of which I'll touch on in the next slides here.

Broadly speaking, these are some of the areas we've been talking about. To jump way ahead, here is where we made recommendation, not surprisingly, in the area of inspection guidance from things as simple as Dr. Matthews mentioned and straightforward, as boric acid inspections and fixing that. Those inspections were dropped from the ROP. They are now back in obviously.

But more specifically, it goes towards the pieces Cindy was touching on: the lack of the questioning attitude, and reinforcing that through training and sessions like this with the NRC staff, which we've done many of; including this team had training sessions basically with the entire NRC Headquarters staff in all four regions with the idea of trying to tell the story and internalize and institutionalize these lessons learned as part of a good learning organization.

MS. CARPENTER: Part of that is also each of these were being put into the licensee's corrective action program. We're going to ask our inspectors to review corrective action reports and look for trends now. "Do you see that the same corrective action, the same problem, is coming up and the licensee is not fixing it?" That's the trend piece of it that we're going to build into the corrective action procedure to have them think more about that, to pull some of those out when they do the corrective action inspections every year, pull a sample of those out and take a look at those and see why aren't they fixing them, or is there something more that we see here.

DR. MATTHEWS: Let me ask, not to put too fine a point on this, but, okay, your inspector is out there, and he sees boric acid. You know what to do. The action is straightforward. Now he goes out there and he sees a lack of questioning attitude. What do you do with that?

DR. HACKETT: What we get to in the discussions is sort of back to when Mr. Reagan was President, the "Trust but verify." There is one I can share with you on this. It is our inspectors did question the maintenance of the head during this period, but where they didn't go as far as maybe we'd like to see them go, they would ask a question about the head, for instance.

As a specific example, "Was the inspection completed in 1998?" They would get the response of "Yes, the head was inspected." "What were your findings?" "Well, there was some boric acid there, but nothing that we haven't seen before. Not a big deal." That's as far as we pulled the thread.

Instead, maybe what we should have had was, "Where's the bore scope video from that inspection? I'd like to get a look at that and just let me conclude for myself what kind of state the head was in." Frankly, had they done that, already by 1998, that head was in a horrible state of corrosion and corrosion product, and we didn't do that. It wasn't offered up by the licensee either, but we didn't pull the thread. So that's the kind of example.

Cindy mentioned operating experiences as a big part of this effort. We spawned yet another task force that's looking at operating experience. A couple of items on that: we used to have an office at the NRC that was called the Office for Analysis and Evaluation of Operational Data. That office was disbanded in 1999, and it was our sort of centralized clearinghouse for assessment of operating experience.

Certainly what we found is that the NRC assessment of operating experience is a lesser function today than it was back then. That didn't help. It's not a cause and effect thing, but it certainly didn't operate in the right direction.

We mentioned consensus standards earlier. The ASME code in this case, which had inspection requirements for observation of the head that were -- we find in hindsight now -- completely inadequate. They call for what ASME calls a VT-3, which is a visual observation of the area basically so that you could just say that you laid eyes on it, and you saw it. It does not require removal of the insulation.

When you look at the B&W design or some of the Westinghouse designs, there would be no way to see this corrosion given that kind of inspection procedure. ASME is correcting that now. We've corrected it through generic communications, but at the time, that was a serious inadequacy.

DR. MANSFIELD: This question just shows my ignorance of the ASME code. Is there no provision in the ASME code for inspections when direct visual inspections are impossible because of insulation or coverings or things like that? Aren't there prescribed equivalent methods?

DR. HACKETT: There are. In fact, in this particular area, given the mindset that prevailed, it was not subject to those inspections, unfortunately. It was relegated to what they call VT-3. Obviously it's not anymore, but that was a serious shortcoming for the ASME Code.

Leakage monitoring requirements and methods on our part and the licensee were: we have a lot of the recommendations of the report. Go to this area because there was a very small amount of leakage over a long period of time, and it was very difficult to discriminate where that leakage was coming from, whether it was actually reactor coolant pressure boundary, which it ultimately was found to be, versus it was just seal leakage from above. So there was a tolerance on our part and on the licensee's part for what we thought to be seal leakage that was not considered terribly safety significant. So we are looking very hard at those.

I'll jump to the bottom one. Our executive director asked us to take also just a quick look as far as our team went on previous lessons learned reviews. We've done these before. Are we learning lessons? Are there similar themes that we're seeing here with Davis-Besse that came up with our previous one, Indian Point, when they had their tube rupture in the year 2000?

We found that there were some things that were common elements among all lessons learned. We hadn't brought all that together, all of which went towards follow-up on some of these activities that the NRC, I think, would characterize itself as an organization that reacts very well to these things. I think we did a very good job to reacting to this event, but we were not proactive, and we also had found that there were cases where we just didn't follow up adequately, which was one of the team's findings, particularly with regard to long-standing hardware-type problems.

It just turns out that there are 51 recommendations in the report. I just brought along a few here to share with you. I think the first one goes towards one of the pieces Cindy was referring to. We issue generic communications a lot in reaction to things that we find through inspection efforts or sometimes proactively if we anticipate that there might be a problem.

What we find is those generic communications generally achieve what we're wanting to do at the time. One of the things we're finding is that we do not do a good enough job in following up on a generic communication that is say in this case, 13 years old. We had a boric acid communication that went out in 1988, and there were some initial follow-up inspections and a lot of intense activity, but two, five, ten years later, you are probably going to be dealing with an NRC staff that's not even very familiar with that generic communication. We have not followed up on it.

DR. MANSFIELD: Was that warning specific to rapid corrosion?

DR. HACKETT: That was not specific necessarily to the rapid corrosion, but it did go to boric acid inspections and requiring those for the plants. We did not pay enough attention to that over time.

MS. CARPENTER: That's one place where the ROP needs to incorporate the lessons learned to occasionally go back and look at some of these issues that the staff has done a generic communication on and say, "Again, pull that generic communication out. What is the licensee [doing]? What did they say they were going to do? Are they still doing that? What are they doing today?" That is an area that the inspection program is following up on.

MR. FORTENBERRY: Is there an element of technical competency here in terms of understanding the interaction with the boric acid leakage and doing or performing the required or, looking back, the desired R&D [research and development] type activity to understand this, which would have then, of course, fed into some of these other actions? I don't see anything that speaks to that.

DR. HACKETT: There are. I apologize for that. To have gone through all these would have taken too long, but yes, absolutely. We have pieces that go to that.

MR. FORTENBERRY: Clearly, this wasn't an obvious issue. We are still debating about the specifics of it.

CHAIRMAN CONWAY: Kent, you'd better talk more into the mike if you want people to hear what you are saying.

MR. FORTENBERRY: I'm sorry. Clearly, this wasn't that straightforward. But going back to a topic that we've talked about a few times now, and that's the simple technical authority that the NR folks talked about and whatnot: can you parallel that in terms of how this problem was dealt with? I'm talking about back a long time ago when the issue first came up, and the issue was dealt with in terms of what do we need to do about it, and do we need to rip off all the insulation and go look at it? Was it a central authority that made that decision?

DR. HACKETT: At least part of my answer, I guess, is fact. Part of it would be opinion. We do not have that same type of structure. I think that's obvious that the NRC is a much more diverse and frankly bureaucratic structure than I'm sure Naval Reactors is. There are challenges inherent to that that we deal with.

In answer to your question, I'll back up to the technical competence. I think my answer, my opinion, is no. I don't think there were technical competence problems on the part of the NRC staff or, frankly, on the part of the licensee. Our team's findings were that there were people in place who were technically competent enough to have been aware of this and to have pursued it.

What we failed to do, in a single word that always comes back to me, is "integrate" the information. In looking back in time, I was in a different job at that time. I was one of the metallurgists that was involved in reviewing this situation.

To give you a good example, we were somewhat compartmentalized. I was in the assessment area that did the structural integrity review. So I was presented with, "You have some cracks in these Inconel housings and they are not through wall. There is some partial depth, and you're the fracture mechanics people. What does that mean to the safety of this structure?" The answer was that it doesn't really mean a whole lot to the safety of that structure. It's in pretty good shape even if you leave the cracks there. You watch them. You monitor them with some advanced inspection techniques, but it's okay to leave them there.

That was decoupled in our organization

from the folks who were looking at the potential for boric acid attack. So that linkage was never made. That's a weakness that we're trying to address through some of the action plans that are in process right now. The proof will be in how well the NRC deals with this again, or better yet, in the Naval Reactors slide that showed obviously the better part, which is to sweat the details and focus on the small problems so you never get to something like this. That's where we want to be. I don't think we are there yet. I think we have some work to do, and that's part of what we're dealing with here.

MR. FORTENBERRY: Thanks.

DR. HACKETT: I'll just focus on the last one on here because this was a particularly tricky item for us. The reactor vessel was assumed in our probabilistic assessments not to fail. It's inviolate or sacrosanct. So we found ourselves really lacking in this area of analysis methods to assess the risks associated with passive component degradation. This was not something that we were focused on.

Cindy and Russ talked about the Significance Determination Process. It made that significance, the determination of that which is obviously, in a layman's sense, that this was a very significant thing. It was very difficult to deal with analytically because we did not have models that addressed this type of thing before.

DR. MANSFIELD: So you could get a PDF [probability density function], say, of probability of release as a function of volume and time for boric acid, but you didn't have a mechanism for turning that into probability of failure for the pressure vessel.

DR. HACKETT: That's correct. In this case, that was unanticipated. I guess I'll just move towards summing up here. We heard this throughout the presentations this morning. I had occasion as part of this analysis to review some books by a professor, Henry Petroski. I think he's at NC State. He's written a book on preventing structural failures.

What you see are these common elements, a lot of common elements between our effort and the Columbia Accident Investigation Board, for instance. A lot of it goes to communications and organization. These were some failings for us in terms of communicating up the chain what was going on at the site, at the plant, and through our inspections and the inspection effort itself, as I mentioned earlier, without a questioning attitude.

Also, the engineering design, in this

case: What saved the day? Well, my hat's off to the designers, because you had six and a half inches of steel and it took six and a half inches of steel and the stainless steel liner still held. Not a place you want to be, but engineering design plays a key role in this. I think the nuclear industry is very fortunate to have that kind of backstop to this.

Then it goes to the operating experience piece. The last part is the timely dissemination of data and information. We did not do a good enough job of that in our effort internally at the NRC. The last slide.

DR. MANSFIELD: Excuse me. Could I ask a Naval Reactor's representative if those four points sound familiar, and would they add anything to that list?

MR. KAUFFMAN: Yes, they are familiar. I already talked about the importance of communicating problems to all the involved individuals and then taking timely action to resolve them. Conservatism in design, I talked about, "You get what you inspect, not what you expect." Those are key elements. There are a lot of other things that you could add, but this is a pretty good overview. I think if you are going to take away four top level things to keep in mind, this is a good list.

DR. MANSFIELD: Because we eventually want to consider a list like this for the Department of Energy sites as well.

DR. HACKETT: My very last slide just goes towards a couple of pieces that are somewhat unique, at least to the NRC, and some are not. The fact that the technical elements as I mentioned earlier are really only part of the story. Not to underplay it, but they are the parts that are easier to fix.

In our case, we had some real challenges in our regulatory framework in issues and then some policy issues. A good example of one to share with the Board here is we do not regulate safety culture. The NRC Commission has taken up that debate. In the past, they have decided that we don't have the appropriate wherewithal to measure safety culture. I think it's fair to say the Commission is now reevaluating that approach.

Also, we're going to be seeing a new composition of our Commission. It's ever a dynamic situation, but everywhere we did what we would call in this case the "Lessons Learned Task Force," a deep vertical slice on a particular issue. Everywhere we touched we saw safety cultural issues at this licensee that were disturbing. We do not regulate that. I think there's an overlap there with NASA's situation and the Columbia Board.

We have obviously the nature of the public interface for us. It's probably also very different from Naval Reactors. It's critical for us. We ever operate in a fishbowl, and we are accountable to the public in a very telling way. I think we think that's the way it should be. We report to the public. We're chartered to protect the public health and safety, but it makes the job very difficult to communicate this type of thing effectively the elements that Cindy mentioned as our strategic goals. Communication, we already talked about.

Even the study for me after this team was the importance of risk and communicating risk. I said actual and perceived. Perceived becomes actual. If we're talking to people, and we did, who live in the vicinity of this plant out in Ohio, their perceived risk is the risk. We have to be able to articulate that. It's a real challenge for us to do that in the most open and scrutable way. These are just some other elements and additional lessons for us as an organization that we're working our way through, too. That concludes my remarks.

CHAIRMAN CONWAY: Thank you. A.J.

VICE CHAIRMAN EGGENBERGER: I have no questions.

DR. MANSFIELD: This was very valuable. Thank you.

CHAIRMAN CONWAY: It was very helpful to us. I appreciate the time you've given us this morning. Thank you very much.

MS. CARPENTER: Thank you.

CHAIRMAN CONWAY: Now, as we indicated in our previous announcements, we always invite members of the public and representatives of the public to testify. I've been informed that Mr. Richard Miller, Government Accountability Project [GAP], would like to speak this morning. Is he present? Mr. Miller, welcome.

MR. MILLER: Good morning, Mr. Chairman and members of the Board. My name is Richard Miller and I thank you for carving me into your schedule today. I hope I can emulate the crispness of the briefing that you've received from your previous speakers. It's often the case that you come to speak to advise people on your views and you learn more from coming to the meetings than you ever think you could possibly convey.