can turn it over, but --

MR. WALLIS: It has been extruded from a hole.

MR. ALLEY: Yeah, and we've seen that at several different locations or different utilities that had experienced this spaghetti string looking deposit that's coming from the annulus area.

Again, we wanted to communicate that to the industry. The first time somebody saw it and referred to it, everybody was wanting to know what's spaghetti strings. So we put these in a visual guidance again and showed pictures of that.

MR. ROSEN: That's the first picture of that I've ever seen. Is it rare?

MR. ALLEY: I won't say it's rare. It's not as common as the popcorn type deposits, but there have been, you know, more than one occurrence of this.

MR. WALLIS: You're probably got macaroni and all kinds of things.

MR. ALLEY: Yeah, we've got all kinds of names for things.

So we do have a document that we -- and a CD and a videotape -- that has gone out to the industry. People review that before their inspectors go in to do visual inspections of the head.

MR. WALLIS: Well, you're saying that this is the sign of a leak. Now, you're implying that anything that comes out of the leak and solidifies will be stay there and won't get blown away. Suppose you have a leak that's tossing out particles or boric acid but they're not sticking. You wouldn't see that, would you?

MR. ALLEY: Well, you'll see other signs of boron deposits on the head.

MR. WALLIS: You would? I don't know. I don't know. I can imagine a hole which is simply spewing out bullets instead of spaghetti.

MR. ALLEY: We certainly haven't seen any of that, nor have we seen that in the NDE results that indicate that we have nozzles that are acting like that, that we don't have visual evidence of.

MR. WALLIS: Well, I know, but you see the point. I mean, we don't really know all of the possibilities when you get a leak in the form of the solidified or otherwise boric acid is coming out.

MR. ALLEY: And we recognize that. That's why this document has been revised twice now, because we continue to learn. As we do inspections, we continue to learn and want to communicate that to the industry.

MR. SHACK: but you've got a lot more volume now. Did you find anything in your volumetric inspections this spring that would indicate a through wall crack that you didn't see visually?

MR. ALLEY: I don't understand your question.

MR. SHACK: You did a lot of volumetric inspections in the spring inspections. Did you find any through wall cracks that did not produce a visual indication?

MR. ALLEY: No. We have some that are being debated, but again, NDE is not exact science. So it's debatable as to whether or not the crack went right up to the edge or actually went through wall and we're still having some of those debates.

I can only think of one case where that's really being debated. Can you think of another?

MR. MATHEWS: Well, the other situation is the one that just doesn't leak, like North Anna, the Stealth crack.

MR. ALLEY: Right.

MR. MATHEWS: And you know, you can find it with NDE/UT, but if it doesn't penetrate the annulus, you won't have a leak.

MR. ROSEN: Right. It hasn't gone through the surface.

MR. MATHEWS: Right.

MR. ROSEN: So there's no leak path to the surface.

MR. MATHEWS: Yeah, exactly. So it takes some other technique besides visual to find it, and that's why we're saying that we've got to go back and look at the basis for 75.

MR. ALLEY: And to skip from the visual document, the approach that MRT has taken to demonstrations, we work very close with the reactor vessel head working group. That group defines to the NDE committee relevant flaw mechanisms, the SEC or BWSCC, fatigue, whatever those mechanisms might be. They communicate that to the inspections committee. They define the inspection locations in volumes, are interested in weld metal tubes, define the range of flaws that they wish to address in the mock-ups.

The inspection working group works on the approach that we will take to demonstration and we'll go into some details on that. Mock-up design and procurement, we'll go into some additional details on that.

Specification for the flaws in the mock-ups, the realism of the flaws in the mock-ups --

MR. WALLIS: Are you going to be trying to duplicate spaghetti and popcorn in these experiments?

MR. ALLEY: We have skipped here to the volumetric stuff. So now we're talking about the flaws as they appear in the nozzles and the tube and the weld. This is for ultrasonic purpose and eddy current purposes now for a visual.

MR. WALLIS: Okay. So you're still on cracks then.

MR. ALLEY: We're on cracks.

And then we developed a demonstration protocol of the schedules to work with the various vendors. There was a Tiger team that was put together of key individuals from both the working head group and the inspection group.

MR. WALLIS: Do these give false indications sometimes?

MR. ALLEY: Certainly.

MR. WALLIS: How do you sort that out?

MR. ALLEY: It's a very difficult task.

MR. WALLIS: It could be that many of these flaws which were reported earlier this morning are simply false indication.

MR. ALLEY: Well, typically in an NDE you would like to have more than one piece of information that you rely on when you're going to make conclusions with your NDE for that reason. We don't always have that luxury, but we certainly look for that.

You like to see the visual signs of leakage on the head supported by volumetric examination that finds flaws. You feel very confident about those results.

If you only have one NDE discipline, then your confidence in a result can tend to be --

MR. WALLIS: So you really want to detect them before they leak, don't you?

MR. ALLEY: That would be the preference, yes. Again, you like to have eddy current results and ultrasonic results. You like to have overlaying results because there is the potential for false calls, and it's not necessarily a small potential.

So the Tiger team got together, which was key individuals from the head working group and the inspection working group to design the next generation of mock-ups, and again, we'll get into some more details on that.

If we look at the demonstration process, there's several characteristics of these demonstrations that have been consistent ever since the 9701 response. One of those is tha these are blind mock-ups. The inspection vendors are asked to examine these mock-ups without knowing the location, size, and orientation of the flaws. We demonstrate the procedure so that it's application of the procedure. We make sure that the procedure is followed and it contains the essential variables.

We try to demonstrate the best available techniques. As we mentioned earlier, this is an evolving inspection, and it is changing with every outage season actually.

The ASME codes should drive out the technique and personnel qualifications. This is not a qualification process. We are not out there trying to qualify vendors, and as I'll mention later, nor do we have an acceptance criteria. Those are left up to code committees.

We're trying to demonstrate the state of the art with regards to inspections. We're trying to define the limits of the inspections, but we're not trying to qualify the person at all.

MR. WALLIS: Do you have some specifications for the sensitivity of these detection techniques?

MR. ALLEY: We don't specify sensitivity levels. The vendors work with their test pieces and mock-ups to understand the sensitivities. What we do is report back to the utilities and the end users of this technology what these techniques are capable of delivering.

We tried not to design the test. We leave that to the vendors. What we're trying to do is define the boundaries of the test.

MR. WALLIS: So you report to them that they failed to detect ten percent of the flaws. They don't really know whether this is the fault of the way the personnel did the test or the sensitivity of their device or something else.

MR. ALLEY: Well, again, what we do is we look at their procedure and make sure they followed the procedure. The calls that are made on whether a flaw is real or false or the size or the depth or the length is spelled out in the procedures. We do monitor that process to make sure that the procedures and the calls are done in accordance with the process that they've outlined, and again, we've defined the boundaries of that process and the results.

MR. WALLIS: So you're talking about -- I'm a little bit puzzled. This procedure demonstration, there are no acceptance criteria.

MR. ALLEY: That's correct.

MR. WALLIS: And you don't qualify the people or the technique

MR. ALLEY: That's correct.

MR. WALLIS: At what point does the industry take responsibility?

MR. ALLEY: Well, the ASME code committees need to drive that out. What we're, again, trying to do, and these procedures are evolving. They're quite a bit different today than they were two years ago.

We're trying to define the boundaries of the procedure, and these demonstrations are set up to do that. The acceptance of that procedure for use on these heads is utility specific, and we'll get into a little more details with regards to that as far as the information utilities are provided here.

CO-CHAIRMAN FORD: So when the order goes out to inspect, for instance, as it just has or for the fall outages, who sets the criteria for the people and the technique?

MR. ALLEY: It's normally worded that the techniques will be demonstrated through the MRP protocol.

CO-CHAIRMAN FORD: So you do set the acceptance criteria.

MR. ALLEY: Well, the acceptance criteria is that the boundaries have been defined, but not what those boundaries are. We don't say that you've got to have a minimum detection limit of ten percent through the wall. We don't get to that.

What we're saying is that you have to define what your boundaries are as part of this process. You need to understand we've got maybe four players in this ball game. So there's not a lot of vendors that are out there going through this protocol.

CO-CHAIRMAN FORD: So there's no acceptance criteria of the crack depth, seven inches plus or minus, that has been done by a qualified person.

MR. ALLEY: No, sir.

CO-CHAIRMAN FORD: And there's no information on the probability of detection.

MR. ALLEY: No, sir. Again, we were trying to set the boundaries of this exam. We did have a discussion, which we'll talk about perhaps in a minute, with the Tiger team about probability of detection. That actually requires a different set of mock-ups with different flaw orientations and different numbers of flaws and sizes of flaws.

Again, we're pushing the boundaries of

these inspections right now just trying to define the limits.

CO-CHAIRMAN FORD: So when are you going through your decision path that you showed on the evaluating cracking and then applying eventually Reg. Guide 1.174?

There's no uncertainties at all then.

MR. ALLEY: Normally what's looked at is the minimum detection limit, and we detected that 100 percent of the time, but what we didn't do is go back and repeat that exam ten, 15, 20 times to make sure that it's detected every single time. Again, that's where you start shifting protocols when you start addressing the POD.

We're trying to set the boundaries of the examination now. It may be later that we do address POD, but to try to do all of that at one time and develop the techniques did not seem to be a very good goal.

So when we report, we would report minimum detectability. Then normally the inspection committee and these people looking at assessment would assume that false highs or however they want to do that, and the statisticians can draw some POD from the flaws that we've got here, although it may have a fairly wide variance.

MR. SHACK: In MRP 75 you assumed a failure to not detect at like .08. Does that number --

MR. MATHEWS: I thought it was much higher than --

MR. SHACK: Much higher than that?

MR. MATHEWS: Yeah. I thought the volumetric failure to detect was much higher than that. I'd have to pull the document and look.

The visual was -- I know on the visual it was like only a 60 percent probability of detection, and then if you missed it the next time, it was like 20 percent of that. So you only had like a 12 percent probability of picking it up a second outage.

On the volumetric, he had put in some kind of POD curve based on vessel stuff, but I thought it was more than an eight percent. It might have been eight percent. I'm not sure. I'd have to pull that out for the peak. I mean, that was just an assumption.

CO-CHAIRMAN FORD: Alan, when you get up later tomorrow, I guess, will you be addressing these issues?

MR. HISER: These issues, can you

enumerate what "these issues" --

CO-CHAIRMAN FORD: Well, the issues that I just brought up, the question of what acceptance criteria is that the NRC is expecting.

MR. HISER: Well, we have reviewed the demonstrations that the various vendors have been able to perform. We have reviewed the MRP documents that specify what the performance was, and we have found those to be acceptable to providing, you know, the reasonable assurance kind of level of inspection.

CO-CHAIRMAN FORD: Okay.

MR. HISER: So bottom line, we found the inspections and the way they've been able to demonstrate those to be to be acceptable.

MR. ALLEY: We know the ASME is working on this, and that's usually an organization that drives out in the industry the personnel qualifications and accepted standards for things. So we're looking to the ASME to drive that out if it's going to happen.

Again, what we're trying to do is define the boundaries of the exams.

MR. HISER: And at this point the NRC has found those boundaries to be acceptable. The problem is the ASME code is not able to turn as quickly as the industry is and we're able to do.

CO-CHAIRMAN FORD: So do we keep pointing in the other direction as to it's the NRC, no, it's the MRP, no, it's the industry, no, it's ASME?

MR. HISER: Well, I think the MRP provides a report card on what the vendors are able to do, and we find that the grades so far have provided acceptable inspections.

CO-CHAIRMAN FORD: Okay.

MR. HISER: Ultimately the ASME codes should be the ones that should become a more automated process within the ASME code, but we're not there yet.

CO-CHAIRMAN FORD: Okay. Thank you.

MR. ALLEY: Okay. To carry on, the demonstration process, the protocol that was developed, the vendors collected data on the mock-ups and reported the findings. We evaluate the measure versus the true values of the flaws.

The detection of the number of flaws versus total flaws; the location with respect to pressure boundaries. Sizing results are documented. False call performance is documented.

The NDE center documents the essential variables. Again, we talked about this in the procedure. There's things in the procedure, the way you set your sensitivities, the transducers that are being used, angles, frequencies, those are essential variables as defined by ASME and some other areas. Those essential variables are documented as part of the procedure review.

We verify that the vendors are actually using the procedures and the essential variables that were reported in the procedures.

MR. WALLIS: I have no idea about this process. Is this a process where the technician manipulates a lot of things, and he flips on a screen and has to interpret them, or is there a computer that analyzes all kind of stuff and gives him an image of what the flaws look like in some way?

MR. ALLEY: Probably more the first point, as in they see, as you see, blips on the screen. That's all computer enhanced and all of that, but they have to -- in their procedure, they have to spell out their decision making process, and it has to be consistent. It has to be applicable to A inspector or B inspector or C inspector. They have to follow the procedure.

So the procedure will say: if you see a blip in this location and it has this orientation and this definition to it, you call it a crack or you call it a false call.

Those are the essential variables in the analysis part of the procedure.

MR. WALLIS: -- ultimate judgment of the person.

MR. ALLEY: Well, in the application of the procedure it's not as much personal judgment as it is the application of the procedure. The procedure spells out the decision making. We try to keep it immune from this black box, and we don't look in it and pull an answer out.

The procedure has to spell out the logic that you follow to get to that answer, and that has to be consistent form one person to the next. Theoretically that procedure should be able to be followed by any inspector and they would get the same answer consistently.

It's the same basic protocol that's followed with the ASME Section 11, Appendix 8 PDI process. You demonstrate the procedures. You demonstrate the adequacy of the procedures to do it. You take out as much of the human error or human judgment part of this as you possibly can.

And then to summarize, the results are given to the utilities.

MR. POWERS: Well, I guess I'm -- why the emphasis on getting the human judgment out? There are only four vendors that are doing this. One guy is just really good. He looks at and is communicative about what he sees.

MR. ALLEY: Well, you'll certainly find utilities expressing an interest to have one inspector or one person on their site versus another. So it gets to be a word of mouth idea, but what we're trying to demonstrate here is the capabilities of the equipment and the capabilities of the procedures, not the capabilities of the individual.

If the procedures and the equipment are capable of detecting and locating sizing and detecting these flaws, then we have demonstrated that we have adequate techniques to do that.

The next part of that may go into the personnel qualification piece of this, how someone applies the procedure, but right now we're trying to demonstrate the capabilities of the procedures and the techniques.

MR. HISER: Dr. Ford, just one other point. Where the NRC gets involved in this, for in-plant implementation of inspections we have a temporary instruction that's used by either the residents or regional staff to oversee and evaluate the implementation of the inspections. They go back and verify that the essential variables that are used at the plant are consistent with what the vendor demonstrated.

So there is that level of review and evaluation as well that the NRC does on these inspections.

CO-CHAIRMAN FORD: I was hoping to see a plot of actual crack depth and location versus measured crack depth and location.

MR. ALLEY: I have some results to share with you, but we don't have that plot. That's the POD data you're actually looking for.

CO-CHAIRMAN FORD: But such plots do exist.

MR. ALLEY: They exist with some techniques and some processes. That's true. That was not the goal of this process, to define a bounds of probability of detection as indicated in a least squares fit and all of that. That was not the goal of this demonstration process.

CO-CHAIRMAN FORD: Well, reassure me that, for instance, if someone goes in and looks at North Anna or any reactor and they size a crack, what makes me think that I should believe that?

MR. ALLEY: They have demonstrated on these mock-ups that their sizing has a certain error associated with it. We have enough different size flaws in there to say that they found this flaw and that they size it X. We have data to support the fact that they had the capabilities to do that.

What we don't have is the error defined associated with that.

CO-CHAIRMAN FORD: Okay. So one of the four teams goes in and does such a measurement.

MR. ALLEY: Un-huh.

CO-CHAIRMAN FORD: And it agrees to within a certain tolerance of the actual --

MR. ALLEY: Well, that's some --

CO-CHAIRMAN FORD: -- and then they're okay.

MR. ALLEY: That's some of what we're hoping to drive out when we cut up these North Anna pieces. I mean, ideally you'd like to have the destructive analysis to go along with the NDE findings. This environment is very tough to do that, and so we don't have that analysis, and that's what we're hoping to get out of the North Anna heads.

We are asking all of the vendors to go

through and reexamine the North Anna nozzles prior to sectioning so that we will now be able to get a better feel for what we're actually seeing versus what we're actually detecting, and it may be that we evolve to this point you're talking about now.

Right now we're pushing the boundaries of the capabilities of the vendors to even get sound energy in these things and get data out. So we're trying to define those boundaries.

CO-CHAIRMAN FORD: Okay.

MR. ALLEY: I mean, you're talking probably a more mature program here versus one that's still evolving.

MR. WALLIS: Doesn't it really depend on how you're acoustically coupled to the thing you're looking at?

MR. ALLEY: Certainly, and that's one of the things that the demonstration has done, and this has been a very valuable experience for everyone involved in this. And I've got some pictures later on that will show you we simulated the nozzles through the heads with the J groove welds that cause distortion on these nozzles. They're not perfectly round on the ID, and what we saw many of the vendors do as part of this process, they were at one time scanning in the circumferential direction in what's called a raster scan. They would scan the increment and scan the increment, and what we saw was the way they were losing coupling when they would go over some distortion in the weld.

Now most of the vendors are scanning in the up and down direction. Okay? So those are the things that were driving through as a result of this demonstration process. This is not only to demonstrate the techniques. It's to improve the techniques, and we've got some things I'll talk about later on that we're doing to even further that some more.

As we mentioned before, it's a very complicated weld examination volume. It's very, very difficult to inspect the weld metal itself. It's very, very difficult to inspect through the tube into the weld metal.

They're asymmetrical welds, which adds the whole geometry factor to it. So it's just not a very easy environment to inspect.

There's a whole host of different probes and carriages and schemes of which you can go about inspecting. There's open tube probes. This is when the internals are pulled from the drives and you have an open diameter tube that you can now inspect. When you have that luxury, you can now deploy a big scanner that's got multiple probes and multiple transducers and eddy current probes and all of that stuff on one scanner and actually go in and interrogate the volume.

In service we typically use blade probes, and a blade probe is like a probe on a Venetian blind. We have to get in between the other components in there, and some of these areas I think Al will talk about tomorrow. I think some of these relief requests have to do with restricted areas. Things are not perfectly concentric. So there's the thermal sleeves and the lead screws and the stuff will push to one side or the other and you jam blade probes and these types of issues we're having to deal with in actually implementing these things in the field.

MR. ROSEN: Isn't it another confusion factor that each nozzle is different in terms of where it is on the circumference? The degree of ovality is changing --

MR. ALLEY: That is certainly an issue.

MR. ROSEN: -- as you go from the center to the outside periphery.

MR. ALLEY: Yes, and then one of the things that we also wanted to demonstrate here is the ability to map the weld because you've got to know where you are on that weld itself. And, again, they're asymmetrical.

There are some that are on the higher slope, lower sides, and of course, the one on number one nozzle is pretty concentric. So all of those variables make this somewhat difficult.

And probes are designed to accomplish specific objectives. The specific volumes, flaw orientations, detection techniques. There's quarter traps, tip diffractions. There's just a number of different schemes that we can use to interrogate this volume.

MR. WALLIS: All of these are qualitative arguments. I'd like to go back a bit before. I used to have some sort of a quantitative demonstration of what's actually being measured versus what's there. What are the sources of error, and so on?

That could probably be put into one or two slides.

MR. ALLEY: I've got some summary slides to show you some typical results. We can certainly compare the true versus the indicated size on a given flaw, but again, what we don't have, in a statistical word, you'd like to run that a number of times to be able to see what that error band is.

We know that the vendors have oversized or under sized flaws. We have information and data to support that, but in reality the way you apply this, too, is typically this is a detection. If you detect these flaws in these nozzles, most utilities are going to invoke a repair immediately. So it's almost a detection game.

Whether you size or under size or oversize a flaw to a relative degree doesn't really matter in reality. We repair them.

MR. MATHEWS: There have been a few that have been left in service for one cycle, but believe me, the UT data get scrutinized to the hilt to come up with is it okay to leave this flaw in service for a cycle. Is it going to grow through wall or grow 75 percent through wall?

And the NRC is buying off on that.

CO-CHAIRMAN FORD: So the ASME 11 book are relying under the flaw -- it doesn't exist.

MR. ALLEY: The only place we have a --

CO-CHAIRMAN FORD: If you find a flaw, you replace.

MR. ALLEY: The only place we have a --

MR. MATHEWS: I said some have been left

in service. Very shallow ID flaws may be left in service for a period of time.

MR. WALLIS: Okay.

MR. SHACK: The next, shallow axials?

MR. MATHEWS: Yeah, I don't believe there's any that have been left in service.

MR. ALLEY: Yeah, shallow axial flaws which were typical of what we saw back in the 9701. There is some analysis to allow you reasonable times to reinspect those flaws, but once you get on the OD of the tube and then the weld metal of the tube, detection really is what you're trying to accomplish.

Okay. More than one probe, as mentioned before, can be used to examine a volume, particularly when we're dealing with blade probes. It's a decision to make with regard to which blade probe you want to deploy in trading off the sensitivity of one blade probe versus another.

CO-CHAIRMAN FORD: Just to go back to Graham's point, if you have such a presentation at the full committee meeting in a couple of weeks' time rather than all of these word slides, a graph of real versus observed or observed versus actual --

MR. ALLEY: Okay.

CO-CHAIRMAN FORD: -- it would be very

helpful.

MR. ALLEY: Okay. Let's regress just slightly and talk a little bit more about the 2001 demo process. Again, we were looking for the safety significant flaws in the two base metals.

The mock-ups consisted of two different mock-up blocks or samples. One was the stub-in pieces off the Oconee penetration tubes, and I've got a picture to show you there.

The concept behind that was to demonstrate that the ultrasonic techniques were capable of detecting a cracked HIP, and this was a real PWSCC. So you actually did -- the vendors did hand scanning on this block to show that they could detect the cracked HIPs, which is the primary mode that we're using for detection.

We had a good range of flaw sizes in the Oconee pieces which you'll observe in just a minute. Then we had a full scale mock-up, and that full scale mock-up contained EDM notches, which are not particularly challenging in the NDE world.

At the same time, this is where we started taking into account distortion issues, access to the nozzle, scanning rates, patterns, those sorts of mechanical devices probably as much as ultrasonic devices were demoed as part of that.

MR. SHACK: Now, these EDM notches, did you try to squeeze them down, tighten them up at all?

MR. ALLEY: This was the first round. So these were EDM notches, and we did use squeeze notches on the second round, which I'll discuss that in just a few moments.

We had flaws located relative to the weld. We had some cluster tight flaws, notches. In this case we call them flaws, but notches. We had triple point indications or notches in the triple point area. Again, I've already mentioned we used EDM notches, and the initial demo here was blind, but immediately after the vendor turned over the results, we unfolded the scales on the keys to the blocks. We were able to now negotiate with the vendor with regards to what they detected and what they found, a very helpful exercise in developing the techniques.

MR. POWERS: I don't understand what you mean, "negotiate." I mean you either found something or you didn't.

MR. ALLEY: Well, you can try smaller probe size. You can try a different frequency. Why don't you do this? Why don't you do that? Trying to work with the vendors at this point in time, showing them what they missed and trying to explain to them why they missed it.

This first round of demos we started in the fall of 2001, actually went on for about six months. We envisioned first that we would have these blocks and we'd run these in a week, and I think the NRC actually was invited on many of these demos and came down and witnessed, and you stood around a lot because the vendor would go in and do some of the inspection work and then have to go back and tweak a probe.

So this process went on and on and on. This block was shipped all over the country; these blocks were, trying to get the techniques developed.

So when I said "negotiate," that's what we were trying to do, is basically push the technology and the development of the technology. It was a learning experience.

Okay. The next slide will show you the Oconee in-stub pieces. This was the ends of the tubes that were removed at Oconee as part of the repair process. You can see the flaws that were contained on these tubes, ID and OD flaws.

MR. WALLIS: Now, I can see a whole lot of sort of vein like things. Those are all flaws?

MR. ALLEY: That's PT results from --

MR. WALLIS: Anything there which doesn't look like a homogeneous substance is a flaw?

MR. ALLEY: All the bleed-out there that we see in the dye penetrant. This was a dye penetrant picture of the stub-in pieces only, Oconee unit. Those are all --

MR. WALLIS: It's riddled with flaws.

MR. ALLEY: Yes, it is.

MR. WALLIS: And you're looking for one flaw?

MR. ALLEY: Well, we picked out flaws that were oriented at 45 degrees, the ID flaws and the OD flaws, and we asked the vendors to take their probes and manually manipulate their probes on the surface to see that they could detect the tips of these flaws. That was part of --

MR. WALLIS: --looking for rivers from a satellite. I mean, you can see them, but if they're small enough you won't see them.

MR. ALLEY: True.

MR. WALLIS: So there must be something that you can specify about the resolution or the sensitivity or something. Isn't that a requirement?

MR. ALLEY: It's looking at --

MR. WALLIS: You don't have any specifications; is that right?

MR. ALLEY: It's looking for the tips. I mean, they needed to demonstrate that their techniques were capable of finding the tips, and it wasn't always done.

Excuse me?

MR. WALLIS: Atomic size tip?

MR. ALLEY: No, we picked out a flaw in here, the 45 degree off-axis flaws to demonstrate that they're capable of doing that. Again, this wasn't to define minimum detectabilities. This was to show that they're getting sound energy to the cracked tip and they're able to see resident energy off of that tip.

MR. WALLIS: It just sounds so qualitative.

MR. ALLEY: This was the first cut through these demos. So if they can't find crack tips, they're not going to perform on any demonstration. So the idea here was you find the crack tips first. Then we'll go to the next round. So this was kind of a screening process. It actually worked very well for that.

MR. MATHEWS: And most of those -- is this the same? Well, these are two different -- most of those that all those flaws on the OD, most of them were not through wall by any stretch.

MR. ALLEY: No.

MR. MATHEWS: Marked through wall flaws of various depths, and they picked out one or some.

MR. ALLEY: The off-axis flaws is one we were very interested in.

MR. MATHEWS: Yeah.

MR. SHACK: You should have been around in the days before they looked for the crack tip reflection if you really wanted to see a qualitative argument.

(Laughter.)

MR. ALLEY: The only thing in NDE worse than finding something is finding nothing.

MR. SHACK: Amplitude drop and all of those exciting parameters.

MR. ALLEY: Yeah. Then the next slide just shows the full scale mock-up that was constructed. Again, this had EDM notches in it, but you can see here that we tried to emulate some of what we had seen in the field. Here are some cross-hatches with a circumferential flaw on the 45 degree slope, and the inspection vendor has some difficulty not in detecting that, but in trying to resolve the axial flaws from circumferential flaw.

We had another circumferential flaw over flaw number three there. It's a bit challenging. It's got little cross-hatches on it as well. Again, for the speed of trying to get this done for the fall inspections, these were just all of the EDM notches that we put in place.

You can see a picture of that block over on the side there, and you see that that's full scale.

MR. WALLIS: So these flaws, these are not -- it can't be like the real flaw.

MR. ALLEY: These are notches.

MR. WALLIS: And they're much more microscopic than the real flaws, aren't they?

MR. MATHEWS: Yes.

MR. ALLEY: Yeah.

MR. MATHEWS: The goal was to demonstrate the ability to detect the tip of a PWSCC flaw on a real PWSCC flaw. That was the goal with the two stub pieces from Oconee that had PWSCC flaws in them.

Then using that technique in a mock-up with notches, the purpose of the notch -- mock-up with notches was to demonstrate the ability to deliver sound to the location, with the presumption, if you will, that if you get the sound there and you can see the tip, then it will work.

MR. ALLEY: Yeah, the notices were not challenging, but again, it was somewhat challenging to pick out the axials versus circumferentials when you have all of these axials lined up with a circumferential flaw cutting through it. That was a bit challenging.

And we had WesDyne, Framatome, and Technatome actually participated in these mock-ups. We also had eddy current mock-up which I didn't show here. it was an eddy current mock-up with a J groove weld that just had three flaws located in it. So we had some ability to do the eddy current.

The results were distributed by the MRP. Vendors were capable of detecting the crack tips on the Oconee tube ends after enhancing their procedures. So to me that was the successful part of this demo. The vendors came in at first and tried to find crack tips on those tube pieces and couldn't find them. So we changed the procedures and the techniques associated with that until they were able to find them.

Then you go to the full-scale mock-ups. that was a very valuable experience.

Vendors were able to detect the flaws in the full scale mock-ups. As I said, those notches are not very challenging.

Again, I had already mentioned that we did multiple demos. This process went on for a very long time. We changed inspection requirements.

CO-CHAIRMAN FORD: Just to go back, you said you changed the criteria and then they found it.

MR. ALLEY: We changed probes, changed -- I don't recall specifically what we changed now, but the probes and the depth of focus of the probes and the frequencies and the technique that was used, those were changed as part of this demo process.

When the vendors first came in and scanned the blocks manually, they couldn't see the crack tips.

CO-CHAIRMAN FORD: Right.

MR. ALLEY: So they throw that technique away and got another technique and came out and started doing that.

CO-CHAIRMAN FORD: You didn't make it easier for them to find it. They had to go away and sort it out for themselves?

MR. ALLEY: Yeah, we were able -- "we," EPRI was pretty instrumental, I think, in giving them some guidance in what they needed to do to do that.

CO-CHAIRMAN FORD: Okay.

MR. ALLEY: So the EPRI NDE center is kind of managing this system for us.

CO-CHAIRMAN FORD: So you educated them of it and --

MR. ALLEY: Used the 45 degree shear wave (phonetic), you know, that kind of thing.

The results were demonstrated periodically as we had a chance to update this or something new happened in the demonstration process. We updated the industry on where we were.

The next slide is just a table that shows typical results. The vendors still treat this as fairly much proprietary as far as what angles and what probes and what frequencies they're doing. There's certainly a commercial aspect to them having developed most of these techniques.

Again, the goal of MRP was not to develop these techniques. The vendors needed to develop that.

Just to give you a feel for the types of results that we were able to get, you can see a number of different techniques or flaw sizes that were used across the top. The A, B, C, D, E, F, which is scaled on the right-hand side, shows you the orientation of those flaws, the techniques and whether they were detected and whether they were sized successfully.

These are the kind of tables that went out along with additional information to the industry for all of the vendors that went through the examination.

So that was the first round of demos done very hurriedly and done with notches and what we could get our hands on very quickly.

MR. SHACK: Were the Framatome people using the same techniques that they used on the French reactors? I mean, were they --

MR. ALLEY: Well --

MR. SHACK: They run with cracks.

MR. ALLEY: The initial approach that Framatome used at Oconee, for instance, when we found Oconee 1 with some issues, they deployed the techniques that were developed as part of 9701: eddy current ID, rotating probe, and went in and did that. And the performance of that was not anywhere near what it is today. So those techniques have changed.

Now, the eddy current techniques are still the same, but the ultrasonic techniques have changed quite a bit in the last two years.

Again, what the French were looking at was eddy current detection and then a very shallow focused ID flaw for sizing, and it was backed into sizing. If you didn't see it, you would assume it was the minimum detection limits of the probe. So that kind of broad brushed approach to the 9701 was very successful in that program, but in this program since the flaws are oriented from the OD and coming in, that approach was not as successful. So we had to change.

Now, for the 2002 demos, we replaced the EDM notices with CIP flaws, which is cold isostatic pressure. We actually EDM the flaws in place and then put it in autoclave and slam the flaws shut and make a very tight flaw.

We were able to have depth sizing, length sizing, and location with respect to the weld. We had an increase population of flaws, many more flaws in the blocks. We had blocks manufactured to have flaws in the attachment welds. We had wanted to identify flaws that reached the triple point, and the triple point is the point where you have the two materials, the weld metal and the buttering, all meeting at that one point up there, which is the spot at which you have to get across the triple point in order to leak into the annulus.

So, again, there's several different schemes about how you might go about addressing this problem. One is if I don't see any indications to the triple point, then I don't have leakage. If I don't have leakage, I can't have circumferential flaws.

So there's a logic approach for a while. We wanted to get some information on that.

The effects of cluster flaws we know is part of the 9701, that many of these nozzles contain crazed type IDs, shallow clusters. So what would happen if we had a flaw line beneath that? So we wanted to include that in the next round of demos.

So the Tiger team, to go back to that real quickly, the Tiger team did design the next round of mock-ups. These were the goals of the mock-ups.

We wanted to maintain a blind. We wanted to demonstrate the sizing capabilities. We wanted to maintain a full scale mock-up. We wanted to establish inspection thresholds. What's the minimum detectability?

Again, we talked about the POD. That was not part of the goal of this process. We wanted to provide practice blocks, and we wanted to include the craze cracking.

So those were the high level goals that we approached going into the next round of demos.

The mock-up flaws must be representative and appropriate for the NDE methods to be demonstrated. For UT we needed specular reflection off the flaws. We needed tipped fraction responses and corner trap responses. So we needed to make sure those were included in there.

For eddy current, we needed a realistic electromagnetic properties and crack widths.

The goals as realistic reproduction of key detection and sizing variables. So any differences were monitored and considered during the demonstration process. Again, numerous NDE methods were being applied, a number of different probe frequencies and schemes were being applied.

The CIP flaws we considered. The Tiger team considered all different flaw making techniques.

MR. ROSEN: What's sift?

MR. ALLEY: CIP, cold isostatic pressure. We basically put it in an autoclave and just put so much pressure in there that we're able to slam these notches shut and get a very tight flaw.

We reviewed all of the different flaw making techniques, fatigue cracks, thermal fatigue cracks, mica disks, EDM notches, CIP flaws, HIP flaws, which is hot isostatic pressure, and we settled in on the CIP as being a good approximate for the eddy current. They are very tight and no unrealistic electromagnetic features. They didn't give us false calls, in other words. They were appropriate for UT. They gave good tip responses, which again tip response is the primary detection mode now.

The reason that we use CIP rather than a true SCC flaw is because we can control the dimensions of that. We machine the notch in it. We know how deep it is, how long it is, and the orientation of it before we put it in an autoclave to slam it shut, and that way we've got good sizing ability to know what it is.

If it's a true SCC flaw, we really, because of the sonic uncertainties, you don't understand what the true bounds are. So that was one of the primary goals.

MR. POWERS: But the trouble is now you don't know anything about the detection of true flaws.

MR. ALLEY: Well, the true flaws, as I mentioned before, they meander, and they sort of break up and scatter and work their way through the material. So there's some ultrasonic uncertainties associated with that.

In defining the boundaries of the exam, we wanted to make sure that we eliminate those uncertainties.

MR. POWERS: I understand that, but the

result is that the skeptic says, "Great. This is an inapplicable."

MR. ALLEY: It's inapplicable?

MR. POWERS: Doesn't have anything to do with reality.

MR. ALLEY: Because the true flaw may not be truly represented?

MR. POWERS: Doesn't look like that at all. It meanders and goes around, gets diffused, and there are a lot of things that fool the detector.

MR. ALLEY: That's why we're very interested in the North Anna results. The only way to truly understand detection versus true in real life is to cut flaws up, and that's what we're going to accomplish with the North Anna. We should be able to answer that question better for you once we have sectioned the North Anna components and can compare the true ultrasonic responses to the true --

MR. POWERS: And the scenario --

MR. MATHEWS: We simulate some of that though. We did try to simulate some of the branching, et cetera, by intersecting multiple flaws in the EDM before they were squeezed, et cetera.

MR. ALLEY: That's correct.

MR. MATHEWS: Some of that was captured in the way some of these flaws were manufactured, and plus what do you call it? The irregularity of the flaw face, I think, was tried to be captured in some of the flaws or maybe all of them.

So they do the best they can to create a flaw that will represent what's in the field.

MR. POWERS: And then the question is whether that best you can is good enough. Now, the problem we have with the North Anna is here's one that's unusual, unique, and whatnot. So you get done with that, what do you have?

MR. ALLEY: You've got several different orders of uncertainty, and one is uncertainty in the technique itself, which is where we need to have clearly defined rules for how we can define that, which is what the CIP flaws accomplish.

The other is the physical boundaries of the technique itself, and that's what you're asking. What are the physical boundaries when physics starts to distort the answer?

And, again, the only way I know to accomplish that is to cut samples up. This protocol here is not designed to answer the physical boundaries. When we start pushing the physics beyond its abilities, we can't define that in this protocol here.

Does that answer your question? You still look confused.

Do I continue?

CO-CHAIRMAN FORD: Please.

MR. ALLEY: Again, what Larry mentioned was we actually went in and machined the notches so they would have some faceting to them, again, to try to emulate a flaw that would tend to meander through a material.

We did have branching in several of the flaws. We also found out from studies that when the notched tip collapses, it actually forms a little Y where the material collapses, and it gives us two real good branches there to get tip refractions off of. So those flaws worked very well for that.

We did use accelerated corrosion cracks. We had some mock-ups that we used, weld metal to accelerate the cracks. We used this mostly with the eddy current, which I'll get into in a minute when we show you the eddy current blocks.

We were able to use the SCC flaws for eddy current because eddy current, you have almost no depth information on eddy currents. So the actual depth of flaw is not as important in that.

Again, just to kind of go through what the Tiger team had --

MR. POWERS: How did you make your accelerated flaws?

MR. ALLEY: Weld metal in the tube that's then put in an autoclave. So the weld metal has a lot of residual stress, and you put it in the autoclave and then put it in the environment. It got slow to start, and then it went pretty well. So we got a little behind on that process.

I'll show you a picture of one of those in a minute.

CO-CHAIRMAN FORD: I'd like to finish by about five to one, 11 minutes to one.

MR. ALLEY: Okay.

MR. WALLIS: Mr. Chairman, are we doing now what we would normally do after lunch on the program or do we have something after lunch as well? Are we doing Part 5 now or four or what?

CO-CHAIRMAN FORD: We did Part 5.

MR. WALLIS: We did Part 5. So we're doing this afternoon's session now.

CO-CHAIRMAN FORD: Yes.

MR. ROSEN: Why are we doing the afternoon session now? I thought we would go to lunch. I thought we were going to go to noon when you took the poll at 11:30.

CO-CHAIRMAN FORD: Well, I know that. that's why I asked the question. Do you want to have lunch at half past 11 or --

PARTICIPANTS: Or not at all.

(Laughter.)

MR. MATHEWS: He didn't phrase it that way.

PARTICIPANT: This is the way it's working out.

CO-CHAIRMAN FORD: Could I suggest Jack reminds me that you might have problem getting lunch in the cafeteria?

PARTICIPANT: Yeah, if you wait long enough they all go home.

CO-CHAIRMAN FORD: Sine you're just starting the 2002 topic, maybe this is a good time to break if that's okay with you.

MR. ALLEY: Very good, yeah.

CO-CHAIRMAN FORD: And then let's go into recess now until half past one, and then we'll start up again at half past one.

(Whereupon, at 12:28 p.m., the meeting was recessed for lunch, to reconvene at 1:30 p.m., the same day.)

A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

(1:33 p.m.)

CO-CHAIRMAN FORD: Okay. We're back in session.

You're all well fed. Mike says I'd better keep you awake now.

Okay. Tom.

MR. ALLEY: Okay. Where I am is 2002 mock-ups. The next slide, I think. Let me get the video here and where I am on the same page.

Okay. Yeah, what the Tiger team has decided to do in the 2002 mock-ups is have axial circumferential and off-axis tube flaws. Now, I use "flaws" to describe notches before, but these are actually the CIP flaws.

We had approximately 20 flaws, up to 100 percent in depth, ranging in length from 1/100,000 to three inches. We had cluster flaws in the tube, 25 flaws up to 20 percent deep, 1/100,000 to 1/250,000; axial circumferential flaws in the attachment welds. We located them at the well head and weld to tube interface, and flaws approaching and through the triple point. So, again, it was one of the inspection philosophies here was being able to look at that triple point. So we wanted to be able to define the capability to do that.

The next slide is just a graphical presentation, and this is typical because, again, these blocks are steel blond (phonetic). So we did hand this out to the inspection vendors and had time to show a representation of the flaws and the locations and what we're trying to accomplish.

This isn't the actual drawing of the block, and it shows the orientation across the weld. You can see the little clustered flaws, 14 and 15 up on the right-hand side. That was to look at the detectability through the craze crack along the ID that we saw on the left-hand side. You could see some cross-sectional views of flaws that would be in a circumferential direction and in the axial direction.

I'll have a few more details on this as we go along.

The J groove welds, this is a similar view for what was proposed to build and construct in the J groove itself. You could see flaws along the lower part of the weld, through the weld, axial --

MR. ROSEN: It would help me if you could point out as you're going along what you're talking about.

MR. ALLEY: Okay. We've got defects that

would essentially be in the circumferential location even though it's on an off axis. You just talk a lot about the off axis, but it's following the weld root area.

We've got the axial flaws that would go down through the weld approaching the triple point. We've got flaws up through the triple point. These are in the weld metal.

MR. WALLIS: How do you make those flaws?

MR. ALLEY: Those flaws in the weld metal were made by notches, and then collapsed.

MR. WALLIS: Notches and then you squeeze it all together again?

MR. ALLEY: Yeah.

MR. ROSEN: Can you put the red dot on the triple point?

MR. ALLEY: The triple point would be right here.

MR. ROSEN: Right there.

MR. ALLEY: So, again, you're thinking this is probably on the ID. This is on the OD of the weld. So it's a --

PARTICIPANT: OD of the tube.

MR. ALLEY: I mean the OD of the tube, even though it looks like the ID. Exactly, you've opened up what's called a C scan view. So we've got a variety of flaws proposed in here.

The next slide is just a copy of what we call the J block, which is, again, the tube weld -- I mean the tube defects that we put in here and the location. You can see the full scale mock-up here on the side, and we actually suspend it off the floor. So we have to manipulate the equipment underneath it and then access up to the bottom of the tube and scan the tube.

These defects are in the tube themselves. So you'll see OD circumferential, ID circumferential. We see the axial flaws here, both OD and ID. This particular block was manufactured as a piece and then welded in place. We were able to --

MR. WALLIS: Excuse me. These flaws are straight, aren't they? They're relatively simple geometry?

MR. ALLEY: Well, we talked about before we've fastened them as much as we can. You have to machine the notch in, and then we can collapse them. So there aren't absolutely straight specular reflectors. They've got some twisting and turning to them. We've tried to emulate branching in some of them. They're just graphically shown here as being straight to show the orientation.

And then it's very important to us that we did some work to show that the tip, as I mentioned before, when it collapses it actually forms a little Y. As all of that material collapses, it's very important because the vendors rely on cracked tip detection as a means for detection and sizing the flaw. So now we have a couple of tips up here that we can now detect with tip responses. If it was just a specular reflector, we wouldn't get a very good tip response off of that.

So that's the ones that are in the tube material themselves. The next slide, again, shows the K mock-up, we call it. This was the one with the weld metal defects that are located here, and then we've got these defects are shown growing this way You' can't really see it in this slide, but they're shown growing circumferentially around the nozzle and up through the weld.

So there are actually two blocks there for that, and those, again, were ship flaws.

We did UT tests on the inside of the tube to try to detect these. Again, we're interested in seeing how far in the weld metal we can see things, and we did eddy current inspections from the wetted surface to see the interface of these flaws to where they interface to wetted surfaces.

MR. ROSEN: How do you put the pressure on the outside of this thing to close the --

MR. ALLEY: It's done in autoclave.

MR. ROSEN: You make this whole part and put it in the autoclave?

MR. ALLEY: Well, there's kind of a -- usually we end up having to crop it off here and crop it off somewhere else and weld it together and reassemble it. We make sure that the area that contains the effects here is what goes through the treatment, and then we'll manufacture that in place. We can't put that whole block in.

So it can cause us some sonic concerns out here and some sonic concerns down here, but that's not the area of interest for us.

MR. ROSEN: So you put it in the autoclave and you take the autoclave up to a couple thousand psi

MR. ALLEY: Yeah, I forgot.

MR. MATHEWS: Forty-five thousand.

MR. ALLEY: I've forgotten what the pressure is, but it's --

MR. POWERS: Are you doing your own or are you having somebody do it for you?