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NUCLEAR REGULATORY COMMISSION

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BRIEFING ON STATUS OF REACTOR PRESSURE

VESSELS IN COMMERCIAL NUCLEAR POWER PLANTS

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PUBLIC MEETING

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United State Nuclear Regulatory

Commission

One White Flint North

Rockville, Maryland

Wednesday, December 7, 1994

The Commission met in open session, pursuant to notice, at 2:00 p.m., Kenneth C. Rogers, Commissioner, presiding.

COMMISSIONERS PRESENT:

KENNETH C. ROGERS, Commissioner

E. GAIL de PLANQUE, Commissioner

STAFF SEATED AT THE COMMISSION TABLE:

KAREN D. CYR, General Counsel

JOHN C. HOYLE, Acting Secretary

JAMES TAYLOR, Executive Director for Operations

WILLIAM RUSSELL, Director, NRR

BRIAN SHERON, Director, Division of Engineering, NRR

ASHOK THADANI, Associate Director for Inspection and Technical Assessment, NRR

JACK STROSNIDER, Chief, Materials and Chemical Engineering Branch, NRR

MICHAEL MAYFIELD, Chief, Materials Engineering Branch, RES

P R O C E E D I N G S

[2:00 p.m.]

COMMISSIONER ROGERS: Good afternoon, ladies and gentlemen. Chairman Selin was called away this morning and has asked me to chair the meeting. Unfortunately, he won't be able to be here.

We're pleased to welcome members of the staff to brief the Commission on the status of reactor pressure vessels in commercial nuclear power plants. The NRC requirements for reactor pressure vessel integrity are set forth in part in Appendix G, fracture toughness requirements, of Part 50 in Title X of the Code of Federal Regulations. In addition, 10 CFR Part 50.61 sets forth the requirements for fracture toughness requirements for protection against pressurized thermal shock events.

On March 6th, 1992, the staff issued Generic Letter 92-01, Revision 1, Reactor Vessel Structural Integrity, requesting licensees to submit information demonstrating compliance with these requirements at their plants. As part of the review of licensee's responses to this generic letter, the staff has assessed the upper shelf energies, transition temperatures and reference temperatures for pressurized thermal shock. The staff has also developed a computerized reactor vessel integrity database. This database will be made available for public access early

1995.

In today's briefing, the staff will discuss the findings from this assessment. In particular, the staff will discuss in detail its assessment of the Palisades Nuclear Plant.

Commissioner de Planque, do you have any --

Mr. Taylor?

MR. TAYLOR: Good afternoon. With me at the table are Brian Sheron, Ashok Thadani, Bill Russell, Jack Strosnider from NRR, all from NRR, and Mike Mayfield from the Office of Research.

As you mentioned, Commissioner Rogers, there will be an update of Palisades. The paper on this subject, which was dated October 28th, there have been later developments with regard to Palisades and the staff will try to bring you up to date at the very close of the presentation with a number of slides talking about Palisades.

With that, I'll ask Jack Strosnider to continue the formal briefing.

MR. STROSNIDER: Thank you and good afternoon.

If I could have the first viewgraph.

[Slide.]

MR. STROSNIDER: As indicated, the purpose of this afternoon's presentation is to provide you a report on the status of reactor pressure vessels in the United States.

During the past two years, the staff has assessed, as you stated, the addition of all the commercial nuclear power plants in the United States, in particular with regard to the upper shelf energy requirements in Appendix G and with regard to the pressurized thermal shock criteria in the regulations.

We had two primary objectives in our program. The first was to establish a baseline condition of all the reactor pressure vessels with regard to upper shelf and pressurized thermal shock. The second part of the program was put that baseline into a form where we could use it for a continuous assessment of reactor pressure vessels. I think one of the important concepts that we want to get across in today's presentation is that this is a continual effort. We cannot assess the condition of the reactor vessels and put it on the shelf and forget about it because there are new data and changes that need to be monitored and assessed with time.

Before I got into the actual results, scope and results of the program, I'd like to review some basic concepts with regard to reactor pressure vessel instruction and material properties which I think will help in understanding some of the material that follows.

[Slide.]

MR. STROSNIDER: In the next viewgraph, we have figures which show the two typical configurations of reactor pressure vessels in U.S. plants. In the upper left configuration, the beltline area is fabricated from plates which were rolled and then welded together into rings. The rings are then welded one on top of the other to form the beltline region. So, in that configuration, there are vertical welds in each of the courses in the beltline, plus the circumferential welds. These are typical of some of the earlier vessels that were fabricated and there's about 90 of the plants in the United States that have that configuration.

In the lower right-hand corner of this figure you see the configuration of some more recently fabricated vessels in which the rings were forged in one piece. So, there's no vertical seams. Eliminating those vertical seam welds has an advantage because the vertical welds see a higher stress in the reactor vessel then the circumferential welds.

On the next viewgraph, the property of most interest or the characteristic of most interest in the reactor vessel steels is the fracture toughness or resistance of the material through propagation of a preexisting defect. This property increases with temperature. That is the material typically has greater resistance to fracture at higher temperatures and it decreases with the radiation.

There are several types of tests, material tests, that can be conducted to assess the fracture resistance of material. We have some specimens here today, some test specimens which were provided through the courtesy of the Research Office, which I think might be of interest. The most simple sort of test that's run is referred to as a drop weight test. This specimen in the front is a drop weight specimen. The way it's tested is to support it with the -- there's a weld across the face of it with a notch in it. Then it is supported on two supports like this and a weight is dropped on top of it. The idea is to test specimens like this beginning at a low temperature and then increasing to higher temperatures to determine what kind of failure you get.

This specimen was tested at a low temperature and -- I'm sorry, I've got the wrong one. This was tested at a low temperature. The darkened area is the amount that the starter notch crack propagated when the weight was dropped on it. If the crack propagates all the way across the face of the specimen, it's considered a failure. As you go to higher temperatures, the crack will propagate a shorter distance and if you look at this specimen you can see the tinted area. The crack did not propagate all the way across the face. This would be considered a nonfailure.

So, the way the test is used then is to begin at a low temperature, increase the temperature ten degrees at a time typically until you find two no failures. You subtract ten degrees from that and that's referred to as the nil ductility transition temperature. It's some indication of where the material goes from a brittle behavior to a more ductile behavior.

Another test that's used to characterize the fracture resistance is a charpy test. It's a smaller specimen. This is the charpy specimen here. It has a notch in it and it is mounted on an anvil and hit with a pendulum to break it. What's done then is you measure the amount of energy that's required to fail the specimen. If you start at a low temperature and then move to higher temperatures, it will require more and more energy to fail the specimen as its behavior becomes more ductile.

On this display which we put together, you can see starting a low temperature and if I can move that. Sorry. If you start at the lower left-hand side of that, in what we refer to as the lower shelf, you can see a very shiny granular sort of surface which reflects a brittle behavior. As you move to higher temperatures, as indicated on the ordinate, the amount of energy required to fail the specimen increases. You can also look at the failure face there and you can see that there are greater shear lips on the sides and that the specimen looks less granular or shiny until you finally reach a plateau or upper shelf area where there are some very large shear lips and the material behaved in a very ductile manner.

Those are some of the specimens that are used. The charpy specimens, as I'll indicate later, are the specimens that are included in the surveillance capsules in the reactor vessel.

[Slide.]

MR. STROSNIDER: The next viewgraph is a figure similar to what you were just looking at. It shows the energy associated with breaking a charpy specimen as a function of temperature. As I've indicated, as you go to higher temperatures, it requires greater energy. There's three regions of the curve. If we start at the lower left, we refer to as the lower shelf. Then you go through a transition region as the material becomes more and more ductile or as it demonstrates more resistance to fracture, until finally you reach this plateau or upper shelf value. The upper shelf value can typically range on the order of 75 to 125 foot pounds for a material that's not radiated. This is when the vessel is first put into service.

The interest in that upper shelf energy is that it determines what sort of margins you have during normal operating conditions. In fact, we've indicated on the temperature scale 550 degrees. When the vessel is first put into service at normal operating temperature, you're typically several hundreds onto the upper shelf. So, there's a large margin for transience in the reactors such that as the temperature drops you remain on the upper shelf and you have a high toughness. The idea in limiting the shift, which I'll talk about later with radiation, is to make sure you have enough margin from normal operating conditions and to account for transients that might occur.

COMMISSIONER ROGERS: A little error in the labeling, I notice.

DOCTOR THADANI: Yes. Yes, there is. You're right.

COMMISSIONER ROGERS: That has to be redone, I guess.

MR. STROSNIDER: I'm sorry, I didn't see it. Which --

COMMISSIONER ROGERS: Well, you've either got one irradiated and one unirradiated curve --

DOCTOR THADANI: Yes.

COMMISSIONER ROGERS: -- or you've got one curve with half of each.

DOCTOR THADANI: You're correct. That is incorrect.

MR. STROSNIDER: Yes. And, in fact, it's --

COMMISSIONER ROGERS: The first one should be unirradiated and the second --

MR. STROSNIDER: The first one should be unirradiated. I apologize. Okay. And that actually is what I wanted to point out next. The curve on the left is the unirradiated curve and you can see -- we discussed how it changes with temperature, but you can also see that it changes with irradiation. It changes in two ways. First, the upper shelf energy decreases and it can drop as much as 40 percent depending upon the level effluence and the copper. It's also sensitive to the copper content of the material. The curve also shifts to the right, meaning that you have to go to a higher and higher temperature to achieve the same resistance to fracture as you irradiate the material. This shift in temperature could be as much as several hundred degrees, depending again upon the effluence, the copper and also the nickel. So, the chemistry does influence how sensitive this change is.

One other thing I wanted to point out on this drawing is the reference temperature. The reference temperature is determined using these specimens that we just discussed. With the drop weight test, you determine where you get the transition from brittle to ductile behavior. Then you have to, in accordance with code procedures, you have to show that you have 50 foot pounds of energy on the charpy curve at 60 degrees above that transition temperature. That's a little complicated, but the idea is that you're coming up with a reference temperature that marks the transition between brittle and ductile behavior. That's an index that we use to reference to the resistance to fracture and we want to maintain that reference temperature at low enough a value so that we have margins again to account for pressurized thermal shock type transients.

COMMISSIONER ROGERS: Could you say just a little bit more about that? I've never been entirely clear on how you use these curves in terms of actual operation of the reactor. Normal operation would be at about 550 degrees fahrenheit.

MR. STROSNIDER: That's right.

COMMISSIONER ROGERS: And so you'd like this -- you want this big upper shelf plateau to extend as far to the left to as low a temperature as you can so you can accommodate a wider swing as a result of transients. Now, what's the relevance of the reference temperature though because you're not operating down near there? So, what is the significance of that in terms of a regulatory approach here?

MR. STROSNIDER: The reference temperature is a temperature that's fairly easily measured using these types of specimens.

COMMISSIONER ROGERS: Yes.

MR. STROSNIDER: And you can measure the change in it.' In fact, the assumption here is that this charpy curve, the full curve is going to shift to higher temperatures in basically the same shape. So, by using --

COMMISSIONER ROGERS: So you're saying that the lower portion gets preserved under irradiation, but it's the upper portion which is more affected? Is that what you're saying?

MR. RUSSELL: The whole curve shifts.

COMMISSIONER ROGERS: No, no, no. But the shape of it. In other words, that it shifts, but as you can see here you're beginning to lose a sharp knee as a result of irradiation. I imagine that's a fairly generic characterization and that you start off with a fairly sharp break and then you come up to the knee and you get the upper shelf defined. As you irradiate the material, that knee begins to get less and less sharply defined and then begins to bend over. But the significance of the reference temperature you're saying is that somehow that lower portion of the curve, its general shape seems to be preserved more than the upper part and just shifts as a result of irradiation? Is that what you're saying?

MR. STROSNIDER: The general shape of the curve, and it's going to vary from material to material. Some of them, the knee will be less sharp than in others, depending basically on the materials. It's a statistical sort of phenomena, but the general shape of the curve remains the same and it shifts to higher temperatures. The reference temperature basically just uses an index to get to a fracture toughness value to see how much it's changing.

COMMISSIONER ROGERS: Just the toughness.

MR. STROSNIDER: Yes. And, in fact, what you do is after establishing the reference temperature, you measure the shift in these charpy curves at the 30 foot pound level and that's the change in reference temperature. The reference temperature for pressurized thermal shock is the conservative estimate of this reference temperature and that's what's limited. So that you know that if you don't allow this curve to shift too far to the right, that as you pointed out you have margin on the upper shelf to account for transients.

The value that actually goes into a pressurized thermal shock analysis is a more sophisticated test. I didn't have one of those specimens here. This reference temperature basically indexes you to do that more sophisticated fracture mechanics test, the stress intensity factor test.

COMMISSIONER ROGERS: Okay.

MR. STROSNIDER: Did that clarify it somewhat, I hope?

COMMISSIONER ROGERS: Yes. Somewhat, yes.

MR. STROSNIDER: All right. So, the nice thing about the charpy specimens though and indexing the fracture toughness to the charpy specimen is that these are convenient to put in a surveillance capsule. The drop weight specimens, as you can see, are quite large and the room in the surveillance capsules is at a premium. So, the idea was to have an analysis that could be indexed to these small specimens.

[Slide.]

MR. STROSNIDER: That leads onto the next viewgraph with regard to the surveillance program. Appendix H of the regulations require that each plant have a surveillance program. There are surveillance capsules located between the reactor core and the wall of the reactor vessel that include these type of specimens, also some tensile specimens and materials for measuring dosimetry. These specimens are withdrawn periodically in the life of the plant and they're tested and a new charpy curve is developed and the shift is measured as a function of radiation.

COMMISSIONER ROGERS: That period, is that determined by the integrated fluence or is that by the calendar? How often --

MR. STROSNIDER: It varies from plant to plant and I think it's more dependent on the fluence and the different types of reactors have different lead factors. The specimens, because they're closer to the core than the reactor vessel wall, they see effluence value earlier than the wall does. The lead factors in some plants can be as high as seven or eight, meaning that the specimens see seven or eight times the fluence of the reactor, that the reactor vessel walls actually see. In some cases, it's two or even between one and two. So, depending upon -- and there wouldn't be a whole lot of point if you had a lead factor of eight of leaving that in to close to end of life. So, those specimens would be withdrawn earlier in the life of the plant. For those plants that have lower lead factors, the withdrawal schedule would be spread out more through the life of the plant. So, it is plant-specific, depending upon the actual configuration of the reactor and the core.

COMMISSIONER de PLANQUE: What kind of supply of these samples are we talking about in the plants and are we in danger of using up too many of them?

MR. STROSNIDER: Well, I was going to comment on this later when we look at the responses to Generic Letter 92-01. The regulations refer to an ASTM standard that talks about the number and types of specimens in the withdrawal schedule. All the plants satisfied those requirements. That is, they satisfied the requirements of this standard at the time they were put into service. At the time, however, that these vessels were manufactured and the surveillance programs were put together, people didn't really understand the influence of chemistry, in particular copper. So, they didn't necessarily pick the most limiting material to put in the surveillance program. So, on that hand it would be nice --

COMMISSIONER ROGERS: They didn't pick the weld materials.

MR. STROSNIDER: Right. I mean there are some weld materials in there, but as I indicated some reactor beltlines may have seven welds in them. Depending upon which wire was used to make that weld, it could have a different copper content.

So, to get back to your question, it might be nice to have some -- it would have been nice to have some materials in these surveillance programs that aren't in the programs unfortunately. But what's done is when the specimens are removed and tested, this is all put into a database and there's a regulatory guide which has been put together, regulatory guide 199, to predict the shift. It's a function of the fluence value, but also the copper and the nickel. There's quite a bit of data in that database now. We're on the second revision of the regulatory guide has been issued and I think probably -- well, the vast majority of the data that's going to come out surveillance programs is in that. There will be more data as some of the later in life capsules are pulled.

So, we have a fairly good sized database now and I think it will be settling down in terms of the statistical evaluations because there's a lot more data in it now than there was before. But there will still be some more added.

With regard to are we worried about running out of it, we have what's in the program and that's what we'll use and I think by putting this into this sort of statistical evaluation and using the right margins, we can use it to predict the shifts for even the materials that aren't in the surveillance program.

There's a penalty that goes along with that though because you typically are going to have to use some conservative estimates to bound the statistical scale.

MR. RUSSELL: I might point out that there are some facilities that are looking at potentially installing specimens now and putting them in locations where they would have higher irradiation and that this may become more common as people look to extend the life of the plants for another 20 years of operation. So, that's one issue.

The other is whether the database that we have is representative of all the types of materials. There may be some where there is a limited set for some particular weld types.

MR. STROSNIDER: This discussion leads to the last bullet on the viewgraph, which mentions the integrated surveillance programs. This is basically a pooling of data. As I indicated, a particular plant may not have the weld of greatest interest in its surveillance program, but that weld may be included in someone else's surveillance program, at least the weld that was made with the same weld wire and the same weld flux by the same process. So, the data are pooled and people are, in some cases, relying on surveillance data from other people's plants. This is allowed by the regulations so long as you demonstrate that it's being irradiated in a similar manner and temperature and that the data are really similar.

COMMISSIONER ROGERS: Just on that question of being irradiated in a similar manner, to what extent does a knowledge of the energy spectrum, neutron energy spectrum play a role here? I know you've got to be above about an meV to begin to get important structural effects, I guess, coming in here. But what about the spectrum, the energy spectrum above an meV? How important is that?

MR. STROSNIDER: It is an issue. I can't tell you exactly the sensitivity to it, but it is an issue that we address when we look at these integrated programs to make sure that the energy spectrums are comparable. Depending upon again the type of reactor and the core configuration, how close it is to all those, they can be different and they have to demonstrate that the fluence flux, the energy spectrums are comparable and that you wouldn't be seeing big differences because of that. So, it is sensitive to that. It is part of our review.

COMMISSIONER ROGERS: Okay.

MR. STROSNIDER: The other message you might get looking at this surveillance program is that it's a major bookkeeping effort. If you consider over 100 reactor pressure vessels, many of them having seven beltline welds and you have to keep track of chemical composition, fluence, the initial material properties, the shift of each one of these welds and in some cases those data are inferred from surveillance programs in other reactors, it is a very massive bookkeeping effort and to try to assess all this information. It did take quite a bit of resources by the industry and the staff in the last two years to perform the assessment that was performed.

COMMISSIONER ROGERS: How much international exchange of information is this in this area?

MR. STROSNIDER: There is exchange. People are aware, of course, of what we have in our regulatory guide. We are aware of the information they have with regard to irradiation embrittlement. There's some complications in merging the data because some of the foreign steels are different. They have different chemistries and it's not clear that you can put them in the same database and treat them as the same population. But we do track what's going on, particularly through the research office, looking at what information is available.

Would you add anything to that?

MR. MAYFIELD: No, not really.

MR. RUSSELL: There is one issue that you ought to be aware of that I'm proposing to make an issue with NEI and with some individual utilities. That is that some of this data is treated as proprietary and not all the utilities that have the same type of welds have access to all of the data that's representative of those welds. We'll talk about this later. When you're doing best estimates of what the copper or the nickel content is in a particular weld, it's important from a safety standpoint to know what is the total population, that is the N value, what is the mean and what is the sigma associated with those and that's the type of information that because these are irradiated specimens they're expensive to develop, to break, collect, that there has been not much sharing of data in that context. There are a few that have integrated programs. There are others that do not have integrated programs where each utility is basically fending for itself with whatever data they can get. We've found cases where the staff has had more information about welds in a particular utility's vessel than that utility had. That, in my view, is not a satisfactory situation and we're looking at trying to get to the point where the database itself has the actual results of the weld specimen information, what were the shifts, et cetera, so that it's not just point estimates but actually includes the number and the statistics associated with it so that this can be aggregated and treated in a more reasonable manner. That has been an issue that's been under discussion with NEI, with the owners, and there is one owner's group that is currently holding out.

COMMISSIONER ROGERS: You mean they don't want to participate?

MR. RUSSELL: They don't want to release the proprietary data.

COMMISSIONER de PLANQUE: To what extent have we been able to or could we make use of materials in decommissioned plants?

MR. RUSSELL: Jim and I talked about that just before lunch.

MR. TAYLOR: I didn't plant that question, but go ahead.

COMMISSIONER de PLANQUE: You didn't tell me to ask it.

MR. RUSSELL: It would be expensive to gather the information. It would involve taking boat samples and then machining those samples such that you could do some testing and you could certainly address the issues of chemistry. That would be much easier. It would be difficult to get a sample out of a vessel for a vessel that's going to continue to be used that will be large enough for charpy specimens. You could sample to get the actual chemistry data in a vessel. But I think that the cost would be quite high and you would get only a few data points. A much more efficient way of doing it would be to put specimens in which are representative or more representative of weld materials and do irradiation, whether it's in a test reactor or in another like reactor. You're much better off, I think, if you use a commercial reactor so that the neutron spectra, et cetera, are similar so that the dosimetry, the spectra and everything, so that you're minimizing the potential for error. If you use a harsher spectrum in a test reactor with an accelerated irradiation, you may be actually having some effects that you can't identify.

So, I personally believe that we'd be better off getting more samples out of surveillance programs with the option of putting more in, recognizing you're going potentially longer in vessel life for some of these plants with extensions than to go to the high costs of taking them out of existing vessels.

MR. TAYLOR: We're looking at it.

MR. RUSSELL: But we are looking at it. Thus far when it's come up to industry, industry has not been interested in doing that. There are big costs.

COMMISSIONER de PLANQUE: I know the issue came up when I was visiting Fort St. Vrain and you have all these materials going to the waste facility and you say, "Isn't there some useful life for these materials, for at least looking at materials properties?" I realize that reactor is a totally different can of worms, but there are others.

MR. TAYLOR: There are others and we're looking at that subject.

COMMISSIONER de PLANQUE: Is the one thing you lose with contemporary plants in putting in new samples is the aging effect that you might be able to recover somehow with the others?

MR. TAYLOR: Yes. We're not ready to tell you what we want to do.

COMMISSIONER de PLANQUE: Okay.

MR. TAYLOR: But we've been talking about that subject.

DOCTOR THADANI: Yes.

MR. TAYLOR: We'll come back and tell you what we think we might do.

[Slide.]

MR. STROSNIDER: The next viewgraph deals with the upper shelf energy issue again. The main purpose of this viewgraph is to point out what it is in the regulations with regard to upper shelf energy criteria.

10 CFR 50, Appendix G establishes a criteria that you should have no less than 50 foot pounds upper shelf energy unless you've performed an equivalent margin analyses. The upper shelf energy can, in fact, be allowed to fall below 50 foot pounds if you do this sort of analysis. This is a more sophisticated fracture mechanics analysis. The methodology or the technology was developed in the late '70s and early '80s. There's been some experimental work to demonstrate it and it is now codified. That is it's in the ASME code, there's a code case, and we also have a draft regulatory guide which indicates how to do that analysis. As I get into the overall program, I'll be pointing out that there are a number of licensees now that have performed this sort of analysis to demonstrate that they will have adequate upper shelf energy through the end of the current license.

COMMISSIONER ROGERS: Well now, in satisfying 10

CFR Part 50 using an equivalent margins analysis, do our regulations actually refer to specific sections of the ASME code in carrying out those marginal analyses?

MR. STROSNIDER: I don't know if the revised one does, but the --

MR. MAYFIELD: No. The regulation sends you back to Section 3 of the ASME code to determine what the margins are in Section 3, but then it's silent on any kind of code analysis to determine equivalency. That's what the current ASME code is addressing and that's what our draft reg. guides --

COMMISSIONER ROGERS: Are they still working on that or is that --

MR. MAYFIELD: No, sir. There is a code appendix to Section 11, Appendix K, that addresses most of the analysis you need to do that. The draft guide we have out that we're nearly ready to put in final finishes the job by picking up what's in Appendix K and adding to it guidance on how to select transients for consideration and material properties that should be used in the analysis.

MR. STROSNIDER: The one additional thing that the regulation does require though is that the equivalent margin analysis be reviewed and approved by the NRC, by the director of NRR. We have, in fact, reviewed and written safety evaluation reports for those plants that are utilizing this approach.

COMMISSIONER ROGERS: Well, it just occurred to me that if we could refer to a specific ASME code that is appropriate for this, not just one that we pick off the shelf as we did in a couple cases in the past, it might be a good thing for us to try to do so that it gives additional stature to our own requirements. Not that they don't have stature, but there is -- when there's an ASME code on something, it's gone through a very rigorous process, peer review process of its own, to get established and it would be comforting, I think, to be able to refer to that when the 50 foot pound criteria is not met. It seemed to me that when we were thrashing around a year or so ago with this business with the Yankee-Rowe pressure vessel and we were talking about other ways in which a licensee might demonstrate compliance, it sounded to a layman perhaps as if we were kind of picking things out of the air, that they could do some kind of an analysis of some type that might satisfy us. But if we had a specific reference to an ASME code and said, "That's an acceptable alternative to the 50 foot pounds if the 50 foot pounds is not satisfied," it would seem to me that gives a little bit better comfort level of the general public that we're not adjusting our requirements to allow somebody to get through a screen of 50 foot pounds just because we would like them to continue operating when they don't meet the 50 foot pounds test.

I'd like to see us be able to, wherever we can, include in our regulations references to established ASME or other professional society codes.

MR. STROSNIDER: I understand and that is a reference which could be made easily at this point. There has been, as I indicated, a lot of work that went into experimentally demonstrating fracture mechanics methods and materials data that are used in this analysis. It went through peer review and has been accepted by the code. Our Research Office performed independent work in this area too. So, it is a reference that we could provide in the next revision.

COMMISSIONER ROGERS: Well, I would like to suggest that you try to do that as much as you can.

MR. MAYFIELD: The tie will perhaps not be as a direct as you're suggesting, but there will be a tie through -- we'll endorse the -- it's called Appendix K in Section 11. We will endorse that through 50.55(a), through the normal updating process. And the reg. guide, when it's put out in final, explicitly states that the Appendix K method is acceptable. It unfortunately doesn't go on to address -- the code doesn't address how to pick transients and they deliberately did not include methods for determining material properties, leaving that to the individual licensee.

MR. RUSSELL: It's almost like you've got a process for concluding that the left-hand side of the equation is equivalent, but you've not defined all of the stuff that has to go into the right-hand side from the transients, et cetera. So, it's not going to be a complete closure, but it's clearly improved over what it was when we last talked, which at that time we had a draft that we had a letter from the code on saying that it was working its way through the process. We did follow that on those plants and that's basically what has been used.

COMMISSIONER ROGERS: Good.

[Slide.]

MR. STROSNIDER: On the next viewgraph I'd like to review the criteria that are in the regulations with regard to the reference temperature for pressurized thermal shock. As we discussed earlier, the idea here is that you want to limit the temperature shift in the fracture toughness curve. In practice, you have to first have the initial reference temperature, add to that a shift in the reference temperature, and then there is a margin term which is added which is to account for statistical variability and material properties, measurements of chemistry, fluence calculations and those variables that go into the equation.

COMMISSIONER ROGERS: But is there a prescription for determining that margin term?

MR. STROSNIDER: Yes.

COMMISSIONER ROGERS: There is?

MR. STROSNIDER: Yes, and it's dependent upon -- if you're using generic data, the margin term is somewhat larger than if you have plant-specific data. It's basically looking at the standard deviations. It's a two sigma value on the deviations associated with the initial reference temperature in the shift.

So, when you've done that calculation, you then have criteria in the regulations, in 10 CFR 50.61 which indicate that this criteria of 270 degrees fahrenheit for axial welds or plates. Again, the axial welds have a higher stress on them. So, the temperature criteria is set somewhat lower. For circumferential welds, the criteria is set at 300.

When a plant is projected to reach that criteria, they're supposed to then perform additional analyses to determine whether the plant could continue to operate beyond that temperature. Actually, the regulations would require that you start that analysis three years or submit that evaluation three years before you're projected to reach the criteria.

As we mentioned earlier, after Yankee-Rowe actually, the staff issued Generic Letter 92-01. That was in March of 1992. The questions that the industry was asked to respond to, two principal questions in that letter were, one, do they have a surveillance program for their reactor which satisfies Appendix H. As I indicated earlier, all the plants do, in fact, have a program that satisfies the regulations.

The second question was what are the status of their reactors with regard to upper shelf energy. We have -- actually, in February of 1993, we sent up a preliminary assessment of our review of the responses. We completed the responses now. That's what I'm going to go into. We have assessed now the upper shelf energy for all the commercial nuclear power plants in the U.S. We also included in our evaluation the reference temperature for pressurized thermal shock. It was not a specific question in 92-01, but we had enough data in response to the generic letter that we went ahead and performed those assessments.

With regard to the upper shelf energy evaluations, if you recall SECY-93-048 which was sent up in 1993 with our preliminary assessment, we indicated that in response to the letter all the licensees indicated that they had greater than 50 foot pounds upper shelf energy. However, based on the staff's evaluation, we said that actually there were some plants which could be below 50 foot pounds, 15 plants that could be below 50 foot pounds at this time and another three that could be below 50 foot pounds before end of life. So, there was some discrepancy there.

The reason for that is that the staff's evaluation was based on Regulatory Guide 199 which is, as I indicated, looks at basically a two sigma upper bound on what the drop in upper shelf energy could be. Licensees, on the other hand, might have had plant-specific data that they wanted to rely on to demonstrate that they still had greater than 50 foot pounds. So, it's basically the difference between a conservative generic analysis and a plant-specific analysis. So, that was one of the things we had to deal with. What we concluded was that although some of the plant-specific data could indicate greater than 50 foot pounds, that it was in some cases a very small amount of data and we didn't feel that you could have a lot of confidence based on that few data points.

So, rather than debate that issue, we suggested to the industry that they might want to consider performing equivalent margin analyses in those cases. In fact, that's what happened. We had good cooperation through NUMARC at the time, NEI now in coordinating the owners' groups and they did perform the equivalent margin analyses such that for plants where we had some debate about whether they above or below 50 foot pounds, we could refer to the equivalent margin analysis to say it's really not an issue. In fact, when you go through these analyses, again it depends on the type of plant because that dictates what type of transients you have to analyze. But you can demonstrate that for some plants you can go down to 40 foot pounds or below and still demonstrate the margins of safety that are required by the ASME code.

So, the industry performed those analyses. We reviewed those. We wrote safety evaluation reports, as I indicated earlier. In addition, we requested the Office of Research to take an independent look at this and they did perform some generic analyses looking at a generic reactor pressure vessel for several different types, again to look at different transients representing different vendors. So, that was documented in NUREG/CR-6023 and it confirmed that, in fact, you can demonstrate that you can go below 50 foot pounds and still have the sort of margins that it requires. So, we have independent confirmation.

The conclusion of all that work is that all plants should have adequate upper shelf energy through the end of their current operating license.

As I indicated, we also assessed the reference temperature for pressurized thermal shock. We looked at all the domestic commercial PWRs. We identified two plants that could potentially exceed the RT-PTS screening criteria before end of life. Those were Palisades and I'm going to talk a little bit more about Palisades later in the presentation.

The paper which we sent up to you in October indicated that Palisades could reach the screening criteria in the year 2004. Their current end of license is 2007. We also indicated in that letter that the date could change. As I've been trying to point out throughout the presentation, depending upon new surveillance data, new test results, depending upon what licensees do with regard to their flux management, how they manage their fuel or putting in poison assemblies, for example, these numbers can change. We expect that they will.

We did get some new information from Palisades. They went to their retired steam generators to get some additional data because they had similar welds and we'll talk about that later.

The other plant was Beaver Valley Unit 1, which was predicated to reach the criteria in the year 2012 versus their end of license in 2016. They are currently assessing various forms of flux reduction. So, those numbers could change.

The distribution of the remaining plants is shown in the table. We indicate here there are four plants which would be within ten degrees of the screening criteria at end of life. This is based on projecting their end of life fluence values and another seven plants within 11 to 30 degrees. Again, this is all based on currently docketed information and the current calculations for projecting fluence. As I said several times, it could change depending upon what people do with the fluence or on additional surveillance data.

COMMISSIONER de PLANQUE: You've looked at all of these with respect to end of life, but what about the license renewal question? How much of a --

MR. STROSNIDER: The question -- a lot of people expressed interest in that. We chose to assess at this point the end of life because that's the data that we had available. Projecting beyond that is really going to depend a great deal on how the licensees operate their plant, particularly with regard to flux reduction. So, it would be difficult for us to say how far beyond end of life they could go.

COMMISSIONER ROGERS: License.

MR. STROSNIDER: End of license, excuse me. Yes, right, how far beyond end of license they could go. We just felt that was too difficult or too uncertain a thing for us to assess at this time. So, we looked at the end of license.

COMMISSIONER de PLANQUE: But in some cases the end of license is much closer in time than in other cases.

MR. STROSNIDER: Yes. Well, I think --

COMMISSIONER de PLANQUE: So, we're talking about the ability to project to a delta T. I understand you're saying it depends a lot on the plant conditions.

MR. STROSNIDER: Right. One thing you can do is we have -- and I'll discuss this later, we have all the information, all the data that goes into the calculations in a database. A lot of it was summarized in the NUREG report that we sent up. You actually can look through that and get a fairly good idea of which plants are going to be close to the screening criteria at end of life and which plants have a lot of margin. So, you can, at least qualitatively, look at which plants are probably going to be in better shape as far as looking at license extension.

MR. RUSSELL: There's one other phenomena, Jack, that you probably ought to explain and that is the shift in RT-PTS as a function of irradiation. It's not uniform with time. As you get to higher levels of neutron fluence, incrementally the amount of shift is smaller. So, the issues, I think, are going to be ones more of weld chemistry and knowledge of what is existing in the welds even for the longer lived ones. That is you don't stay on the steeply increasing portion of the curve very long. If that were the case, you would want to do things very early on to manage it, but it does change as a function of irradiation. I think we showed you some of those curves when we were talking about Yankee-Rowe.

COMMISSIONER ROGERS: Yes.

MR. RUSSELL: But for vessels that have already incurred a lot of irradiation damage, the shift is already fairly well established. So, then the issue becomes one of any uncertainty associated with chemistry of the weld.

DOCTOR THADANI: I think surveillance data, as you get more information, becomes a pretty important factor too. So, that would be a consideration, it seems to me.

MR. STROSNIDER: It is an important point that most of the radiation damage is done early in life and action to reduce the fluence early in life is the most effective. Once the fluence is accumulated, then it is very sensitive to looking at the chemistry. You'll see that, I think, when we talk about Palisades.

[Slide.]

MR. STROSNIDER: I wanted to put this on a separate viewgraph, this comment on the next viewgraph, that the RT-PTS values will change. I started off the presentation by indicating that this is a continuous process. One of our major efforts was to try to put together a system so that we could continue to monitor the condition of the reactor vessels.

[Slide.]

MR. STROSNIDER: On the next viewgraph it discusses some of the characteristics of the reactor vessel integrity database that we are putting together. This is a computerized database. It has more data in it than was transferred to you in the NUREG report. In fact, it has for every material in a reactor pressure vessel, that is if it has six or seven welds, we have the data that's available for those six or seven welds and the plates or forgings. So, what came up in the NUREG report was basically a summary of the limiting material, but in fact we are tracking in this database all the material that's in the reactor vessel.

The database also includes all the chemistry values, initial RT-NDT values, upper shelf values, et cetera, that go into the calculations of RT-PTS or upper shelf. It also indicates whether people are relying on an equivalent margin analysis or whether, in fact, there are sufficient data to demonstrate that they have greater than 50 foot pounds.

Again, this database, it's intended to be a licensing database. It's not really meant for the purpose of research. There are other databases with surveillance data for that purpose, but this is a licensing database which indicates what data went into the various calculations. So, it's based on docketed information.

One of the issues that Mr. Russell brought up is the proprietary. It is our intent that the database will have the information in it, the licensing basis information and that that will not be proprietary because we want to make this available to the public and, in fact, our goal is to do that by the first quarter of next year. The database is actually up and running now. There's data being entered and we're going through the quality assurance checks to make sure the data are correct.

One of the things we emphasized in putting this together was that we wanted it to be auditable. By that I mean we wanted five or ten years from now when somebody else wants to understand the condition of a vessel, that they'd be able to go into this database, see what the values are that were projected for upper shelf, for example, and then find out where all the numbers that went into those calculations came from. So, when you look at this database and you see, for example, copper value, there's a reference as to where that copper value came from. We have that documentation. So, the idea again was that somebody five years from now could come and look at this and understand how the evaluations were performed, but also to make it much easier for the staff to continue our assessment of reactor vessels. As new data become available, we can put it into the system and we can see what influence it has, not only for the specific plant but with a database like this we can do what we referred to as cross cuts so that we can look at a particular weld, weld wire heat number and flux, and we can go across the industry and find out what reactor vessels it is in, what surveillance programs it's in and we can get all the data and we can compare those data to make sure that they make sense, that there's no discrepancies and if there are that we understand why.

So, we're very far along in putting this together and, like I say, we hope to have it up and running and available in the first quarter of next year.

COMMISSIONER ROGERS: So, is this in hyper text format then?

MR. STROSNIDER: Hyper text format?

Is Carolyn here?

AUDIENCE: I'm not sure what means by hyper text.

COMMISSIONER ROGERS: Okay. Well, we won't get into it here. If that's the level at which the discussion is, let's talk about it later.

MR. STROSNIDER: I'm sorry.

COMMISSIONER ROGERS: All right. But if you want to do all this cross referencing, that's the way it ought to be constructed, but in a very easy way.

MR. STROSNIDER: We actually had a contractor help put together the database.

COMMISSIONER ROGERS: Maybe the contractor would answer yes, I don't know.

AUDIENCE: We used a commercial piece of software. It's called Fox Pro. It's a relational database from MicroSoft. That's what we're using.

COMMISSIONER ROGERS: Okay. I know a little bit about it. All right. Okay.

MR. STROSNIDER: Okay?

So, with regard to future actions, again the point that this is a continuing effort. We plan to use the computerized database that I just described to assist us in continuing our evaluations. I expect there will be further interaction with the industry as we look at the database and see what it's telling us.

The NUREG report that was transmitted to you in October will be published before the end of the year. In fact, it's already gone to the printer and I understand it will be out within another three weeks in blue cover. It's our intent to update the database and the NUREG on approximately an annual basis. We think that's about the right time frame. It will depend upon what data come in and how it might influence the database and current status.

So that basically concludes the portion of the presentation with regard to our generic assessment. Do you have any questions on that?

COMMISSIONER ROGERS: I just would like to be kept informed of how your discussions are going with the industry group that is reluctant to participate fully. I think that's something that the Commissioners would be very interested in knowing about because this sounds like a very important database and I think that we'd like to know what the problems are that the industry sees that give them some difficulty in participating, just exactly what are the proprietary aspects here that they're concerned about for their own interests because I think we have to know where these things are coming from, just what the difficulties are. But I would hope we could get over that hurdle and get as complete a database as it possible for the U.S.

MR. RUSSELL: We agree and we're working it on a basis. We expect to make a decision on denying a request for withholding of information where the basis for the request was that it would reveal information about how welds were fabricated which would cause a loss of competitive situations for vessels that were manufactured 20, 30 years ago with the techniques that are no longer being used. So, at this point in time we're looking at the process. There is one other option and that is even though it may be proprietary or otherwise protected information, we can conclude that it's in the public interest for safety and choose to reveal it at any event. We're still working through that process at this point in time and have not reached closure. I'm hopeful that we will have voluntary agreement to share the information.

MR. TAYLOR: We'll keep you advised.

MR. STROSNIDER: Yes, are working that issue. I would like, before I move onto the plant-specific discussion though, to acknowledge the cooperation that we've had from the industry in performing the work that I just described and also to the Research Office which helped us a lot. This was a fairly extensive effort, to assess all the reactor vessels and there's a lot of resources on the part of the industry and the staff.

The next subject then is the Palisades pressurized thermal shock assessment. I think I may have mentioned earlier, in SECY-94-267 which we sent to you on October 28th of this year, we indicated that Palisades was one of two plants that could exceed the screening criteria before end of life. In fact, we indicated that that would be in the year 2004 versus their end of license in 2007. Again, we indicated that could change and, in fact, we knew at that time that the licensee was planning to acquire additional data from their retired steam generators. The retired steam generators have welds in them which were made by the same process and the same weld wire and the same flux as the welds of interest in the reactor vessel.

The intent here is to present some additional information that we've received since we sent that report up to you because they have acquired that material and they've done some testing.

COMMISSIONER ROGERS: How do they determine the radiation effects?

MR. STROSNIDER: Well, the real intent here was --

COMMISSIONER ROGERS: That's not part of the --

MR. RUSSELL: It's not critical. They've achieved so much irradiation damage. The issue is determining what is the chemistry. At this point in time, that's the fundamental issue of concern. Early in life they had fairly high fluence and it's still high. It's in the 10 to the 19 range and --

COMMISSIONER ROGERS: I see. So, it's high enough so that -- the integrated is high enough that it isn't important anymore.

MR. STROSNIDER: The intent was to acquire some additional unirradiated material properties, initial RT-NDT, reference temperature values, and also to look at the chemistry. This was to add to the database that was available on this particular material.

[Slide.]

MR. STROSNIDER: On the next viewgraph, in the way of background, I indicated earlier that all the plants, including Palisades, do have surveillance programs which satisfy the regulations, but they didn't necessarily have the material of greatest interest in them and that is the case in Palisades. Delimiting weld material is not in their surveillance program. So, the evaluations that had been performed were relying on welds that were in other people's, other plants surveillance programs. So, they decided that they would go get some additional data from the retired steam generators.

We had issued an interim safety evaluation to Palisades back in July of 1994 which indicated the summary I just gave earlier, that they would reach the criteria in 2004, that there could be changes. That's what was reflected in the SECY paper that got to you in October. Since we sent that paper up, they have acquired data from the steam generators, they have performed testing. In particular, they did some drop weight and some charpy testing to determine the initial reference temperature and it turned out to be high. It was one of the higher values measured for this type of weld. They also did some chemistry measurements and they found that copper values were high also.

So, they had to include those data in the assessment of their pressurized thermal shock evaluation and these data were developed in the first few weeks of November. November 18th they submitted their revised RT-

PTS evaluation to us and their evaluation indicates now that they would reach the screening criteria in 1999. The upper shelf energy, it would be affected, but they still satisfied the criteria of Appendix G with regard to upper shelf.

The staff is currently reviewing the licensee's evaluation. There are some technical issues that need to be discussed or resolved.

[Slide.]

MR. STROSNIDER: The important areas of the review include -- and on the next viewgraph these are listed actually -- the thermal aging, heat treatment, and changes in testing methods. This refers primarily to determination of the initial RT-NDT. The value that was measured from the steam generator welds, it's within the scatter of the population for Combustion Engineering welds, but it's on the high end. So, there's some work being done to determine if it was possibly affected by thermal aging or if the heat treatment of the steam generators was different than that of the reactor vessel.

There were also some changes in the way these drop weight specimens were prepared over the years. So, there's some -- we're taking a look at that to see if any of those things could affect the value that was measured. We're also looking at it to see if it's just within the statistical scatter of material properties.

So, the other issue which I think appears to be more critical to us at this point in time is the best estimate of the copper content. The rule, PTS rule, indicates that you should get a best estimate of the copper value for the material in the vessel. Of course, we don't have a sample from the reactor vessel weld itself. We have chemistry measurements that are taken from surrogate welds that were made up using the same sort of weld wire, same heat of weld wire, et cetera.

What the rule indicates is that you would typically take a mean value of the population of data that are available. That's probably not quite as easy as it sounds because what you find when you start looking at this is that the welds, first of all, they could have been made either with a single wire or a tandem wire process. The copper is introduced from the weld wire. If you had all the welds out there were made with a single wire process and one wire to a weld, you could just take the numbers and average them. That would be pretty easy. But some of them are made with a single wire. Some of them are made with two wires being fed in. So, what you have is actually an average of two wires. Then the welds may have more than -- they may have changed coils during the process of making the welds.

For example, if you look at the three seams that -- there were three seam welds in the steam generators at Palisades. There were actually six different coils that went into making those three different weld seams. They'd start one weld and then move to the next and move to the next in order to minimize distortion. So, you had some of the same coils going into each one of those welds, but maybe halfway through you had to change weld wires. So, it's not just a simple let's take the numbers and average them. We have some statisticians working with us and we're also getting as much information as we can on the actual fabrication of those welds so that we can determine what really is the best estimate copper.

As we indicated earlier, it's very sensitive to this copper measurement. Depending upon how you treat these data, the date at which the criteria would be reached can change. If you treat it in the worst case, what we're looking at now, it could be as early as 1995. So, that's why it's very important that we get the statistical evaluation done correctly and we have people through the research office and some of the best people helping us with that. The industry is also, of course, evaluating this.

We plan to complete our evaluation of the November 18th submittal and some additional information we've requested in January, by the end of January. So, that's the status. We're reviewing it now.

MR. RUSSELL: There are some generic implications of this as well. That is the total number of welds that have been evaluated for copper and the conditions under which they are fabricated is not a large set. So, as you add data to it, depending upon how much of that set you use to determine the best estimate for your plant, this could change some other plants. The staff has looked at other facilities which could be of concern. At this point in time it appears that they all have either a site-specific surveillance program where they have capsules where they are monitoring, or they have lower fluence at this point in time. So, it appears, at least preliminarily, that the principal focus is on the Palisades facility and not other facilities with respect to this new information about this particular CE weld type.

[Slide.]

MR. STROSNIDER: Actually, if you put up the last viewgraph, the only other thing I wanted to add with regard to the generic implications is that, as we've indicated, the date at which a reactor vessel is projected to reach the screening criteria can be very sensitive to the chemistry if they have a very high fluence value. So, there was a table earlier in the presentation where we indicated that there are some plants which would be within ten degrees or 30 degrees. We are going back to look at the sensitivities of those plants to small changes in chemistry. In some cases, as Bill indicated, they may be relying on actual surveillance data. That is, they have the material of interest in their program and they can actually make measurements, so they're not relying on the chemistry. In some other cases, we want to understand if they're relying on chemistry or do they have a high value or low value and how sensitive might it be when additional data are added to that. So, we're in the process of doing that now.

That concludes the prepared part of the presentation.

COMMISSIONER de PLANQUE: A technical question because I really don't know how you do this. How big a sample of the weld do you need to determine the copper content? How uniform is it? What constitutes a representative sample?

MR. STROSNIDER: Well, there's --

COMMISSIONER de PLANQUE: Do we know the answer?

MR. STROSNIDER: Yes. There were discussions, I guess, during Yankee-Rowe discussions about sampling material from a vessel. That's basically what you could look at as a small ice cream scoop, maybe an inch deep including the cladding in order to get away from the cladding to heat affected zone and to get -- you don't need a whole lot of material to do the actual chemistry. Of course, that's one measurement. If you look within a weld, there is going to be some variability in the copper. That's what the margin term in the RT-PTS evaluation is intended to cover. But you would have more than one measurement probably to come up with an accurate mean. Point estimate is just that.

COMMISSIONER de PLANQUE: Yes. Well, if you do real sophisticated analysis, accelerator mass spectrometer or something like that, you don't need much of a sample. But then it's the representativeness of that sample that's the problem.

MR. STROSNIDER: Right. There have been studies done through the Research Office where welds have been taken and sliced and looked at through the thickness and through the length. We have some understanding, you know, the sort of variability that you would expect to see within a volume of weld that's made with a single coil of wire. Some of the work shows standard deviations on the order of about .025 copper as you go.

Now, the variability in mean values from coil to coil could be much larger. So, we do have some information on that. We understand if we can get a good mean value estimate for a weld, I think we have sufficient data to account for the fact that there is variability within the weld. But you need first to get that mean value.

COMMISSIONER ROGERS: Just on this question, the weld properties, the mechanical property's dependence on the chemistry, particularly copper content, as I recall from the Yankee-Rowe discussions there was a high degree of sensitivity there. Just very small differences in percentage gave rise to very big differences in physical properties. Do those data come from actual weld materials or do they come from alloys? In other words, is there -- the sensitivity on the chemistry, was that determined by analyzing actual weld materials or was it by looking at the properties of, let's say, laboratory samples of alloys of the same percentage, composition.

MR. STROSNIDER: The correlations that are used to predict shift in temperature are in Regulatory Guide 199, as I indicated.

COMMISSIONER ROGERS: Yes.

MR. STROSNIDER: And they are based on actual surveillance data. The weld population separate from the base metal and it's an empirically derived relationship doing regression analyses to get the best fit and --

COMMISSIONER ROGERS: But actual weld material, not alloys of the same composition.

MR. STROSNIDER: The sort of welds that are in the surveillance programs, I think probably the most common are what you'd refer to as a surrogate weld where when they made the vessel they took the same type of wire and went and made a weld. Some cases there may actually be some samples take from dropouts or prolongations of plates. But they are actual weld material specimens that are in the surveillance program and that are reflected in the reg. guide. So, it's an empirical evaluation that indicates this sensitivity.

COMMISSIONER ROGERS: Do you have anything?

COMMISSIONER de PLANQUE: No, I have nothing.

COMMISSIONER ROGERS: Beaver Valley was also mentioned as one of the plants that may be coming up early with a problem here. You didn't mention Beaver Valley at all. Is there anything to be said about it?

MR. STROSNIDER: Only that they've indicated to us that they are considering additional flux reduction actions in terms of inserting poison materials or neutron-absorbing materials in the core. We'd not seen that assessment. I don't believe that's been submitted yet, but I expect that we will see something with regard to their claims in that area.

MR. TAYLOR: Thank you.

COMMISSIONER ROGERS: Well, thank you very much. I think this was a very informative briefing and I think we've learned a good deal about the status. I hope that we'll be successful ultimately in filling out that database.

MR. STROSNIDER: Thank you.

[Whereupon, at 3:15 p.m., the above-entitled meeting was concluded.]

CERTIFICATE

This is to certify that the attached description of a meeting of the U.S. Nuclear Regulatory Commission entitled:

TITLE OF MEETING: BRIEFING ON STATUS OF REACTOR PRESSURE VESSELS IN COMMERCIAL NUCLEAR POWER PLANTS - PUBLIC MEETING

PLACE OF MEETING: Rockville, Maryland

DATE OF MEETING: Wednesday, December 7, 1994

was held as herein appears, is a true and accurate record of the meeting, and that this is the original transcript thereof taken stenographically by me, thereafter reduced to typewriting by me or under the direction of the court reporting company

Transcriber: Carol Lynch

Reporter: Peter Lynch

REACTOR PRESSURE VESSEL STATUS REPORT

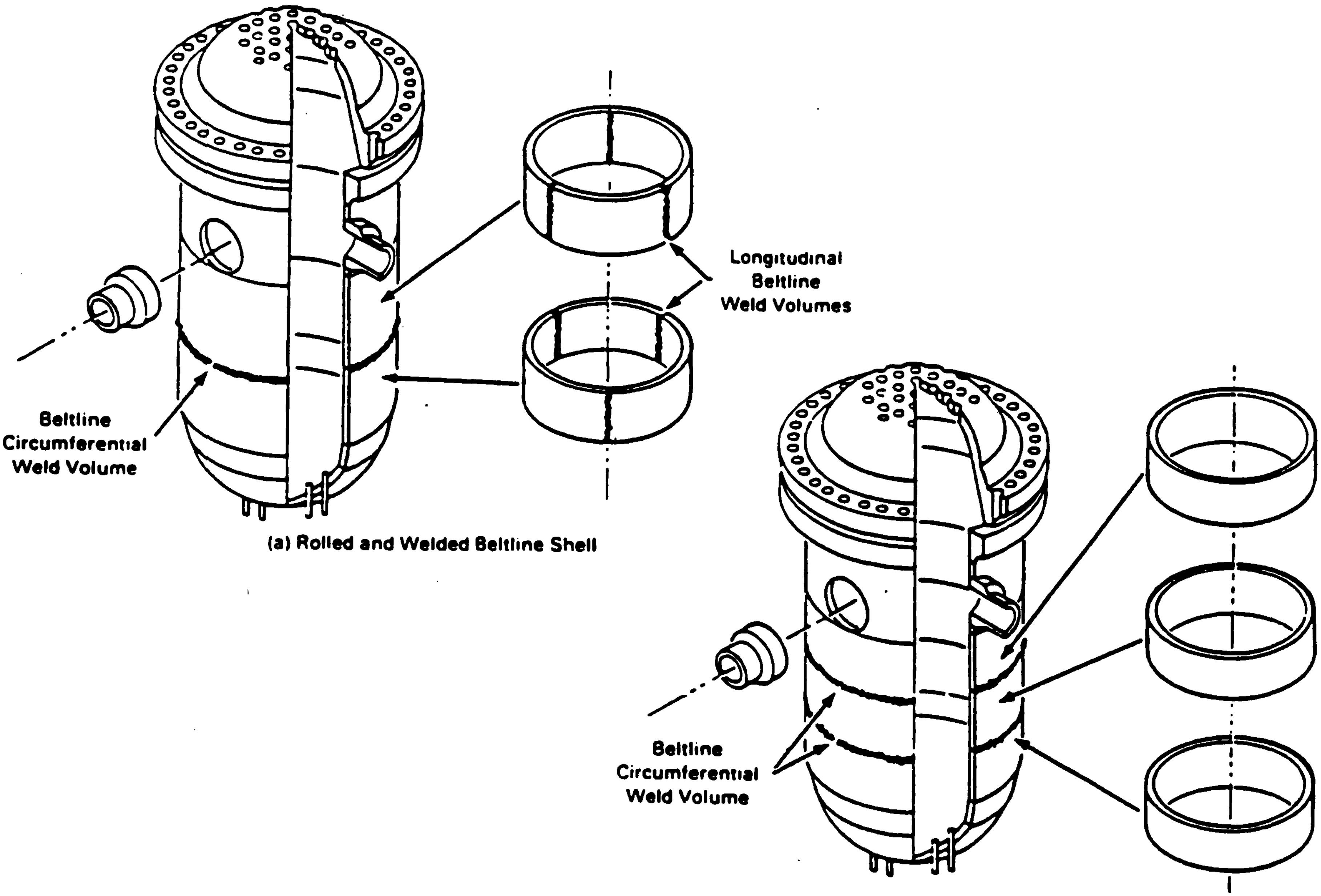
DECEMBER 7, 1994

JACK R. STROSNIDER, JR.
DIVISION OF ENGINEERING, NRR
(301)-504-2795

o OBJECTIVES OF REACTOR PRESSURE VESSEL PROGRAM

- Establish baseline condition of all reactor vessels
- Establish a system for proactive evaluation of changing material properties

REACTOR PRESSURE VESSEL CONFIGURATIONS



(a) Rolled and Welded Beltline Shell

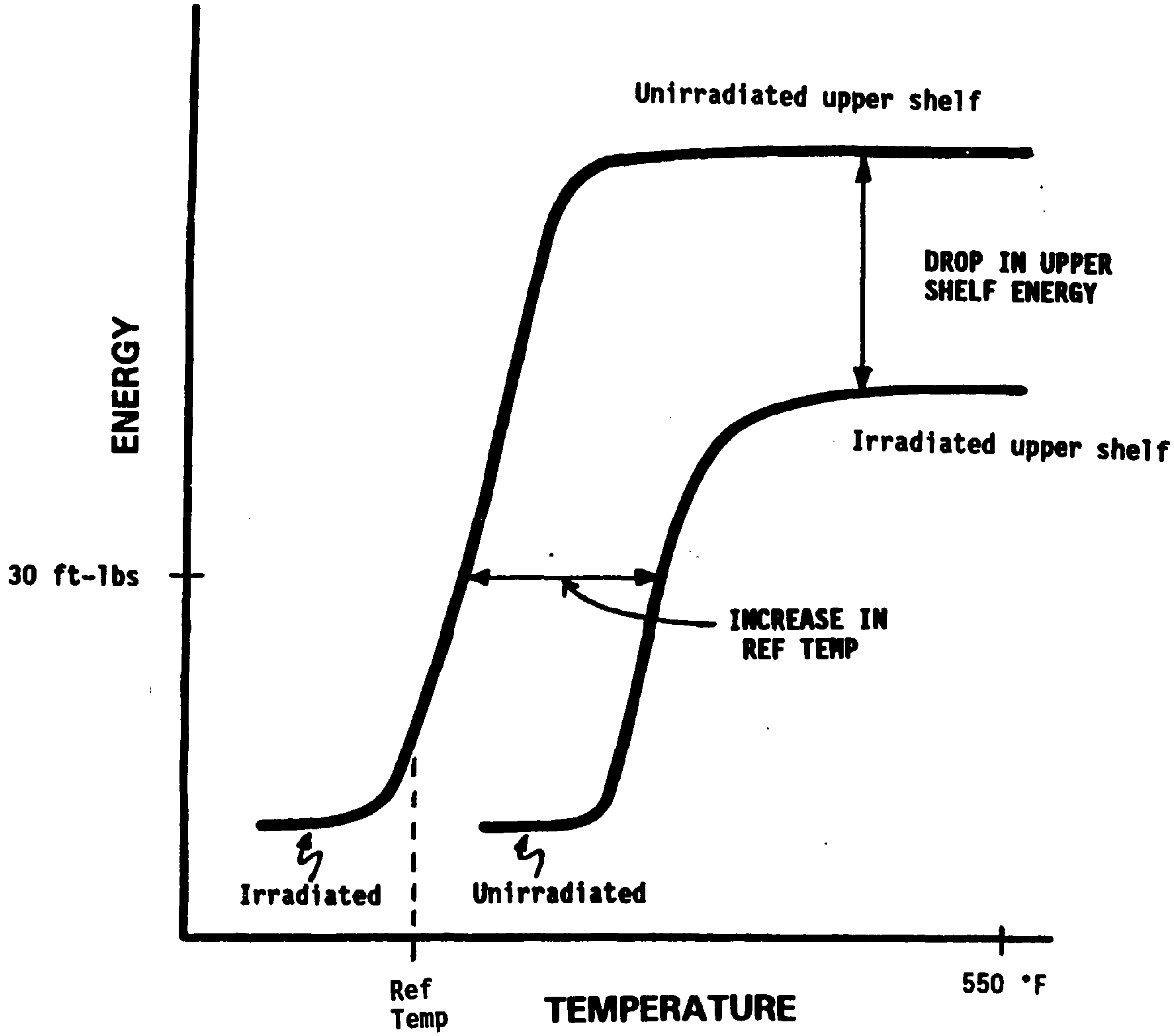
(b) Welded-Ring-Forging Beltline Shell

o FRACTURE TOUGHNESS ≡ RESISTANCE TO PROPAGATION OF A PRE-EXISTING CRACK

- Increases with temperature

- Decreases with irradiation

CHANGE IN MATERIAL PROPERTIES WITH TEMPERATURE AND IRRADIATION



- APPENDIX H SURVEILLANCE PROGRAM
  - Specimens irradiated in RPV surveillance capsules
  - Specimens withdrawn periodically and tested
  - Test results used to predict radiation effects
  - RPV's limiting material may not be in its surveillance program
  - Integrated surveillance programs are utilized

- o **UPPER SHELF ENERGY (U.S.E.)**
  - **DECREASES WITH IRRADIATION**
  - **U.S.E. = Initial U.S.E. - Δ U.S.E.**

- o **PER 10 CFR 50 APP G**
  - **U.S.E. $\geq$ 50 ft-lbs**

    or

  - **Equivalent margins analyses**

- REFERENCE TEMPERATURE FOR PRESSURIZED THERMAL SHOCK, RT_{PTS}

  - Measures shift in toughness curve

  - RT_{PTS} = Initial Ref Temp + Shift in Ref Temp + Margin Term

- RT_{PTS} SCREENING CRITERIA PER 10 CFR 50.61

  - 270 °F for axial welds

  - 300 °F for circ welds

- GENERIC LETTER 92-01
  - Issued March 6, 1992
  - SECY 93-48 (Feb 25, 1993) summarized preliminary review
  - Review of 92-01 responses is complete
  - Upper shelf energy and RT_{PTS} evaluated for all plants

- o UPPER SHELF ENERGY EVALUATIONS
  - Upper shelf energies could not be reliably determined in all cases

- o EQUIVALENT MARGINS ANALYSES
  - Demonstrate margins of safety equivalent to ASME Code
  - Performed in accordance with ASME Code Case N-512 and draft R.G. 1023

- o RES PERFORMED INDEPENDENT GENERIC EQUIVALENT MARGINS ANALYSES

- o ALL PLANTS SHOULD HAVE ADEQUATE UPPER SHELF ENERGY THROUGH END OF CURRENT OPERATING LICENSE

- o RT_{PTS} EVALUATIONS

  - All domestic, commercial PWRs were evaluated

  - Two plants could potentially exceed RT_{PTS} screening criteria before end-of-license

  - Distribution of remaining plants relative RT_{PTS} screening criteria at end-of-license

°F Below RT_{PTS} Criteria at EOL	No. of Plants
$\leq$ 10	4
11 to 30	7
31 to 50	8
> 50	55

- RT_{PTS} VALUES WILL CHANGE
  - New surveillance data
  - Fuel management

o REACTOR VESSEL INTEGRITY DATA BASE (RVID)

- Computerized data base
- Summarizes properties of RPV materials for all plants
- Based on docketed information
- Can be audited
- Allows integrated review of surveillance data
- Scheduled public availability: 1st Qtr 1995

o **FUTURE ACTIONS**

- **RPV assessment is a continuing process**
- **Use RVID for continued monitoring and assessment**
- **Publish NUREG report this year**
- **Approximately annual updates of RVID and NUREG**

PALISADES RT_{PTS} ASSESSMENT

- o PALISADES LIMITING WELD MATERIAL NOT IN PLANT'S SURVEILLANCE PROGRAM

  - Properties determined from similar welds in other plant's programs

  - Initial Ref Temp and copper content are important parameters

- o INTERIM SAFETY EVALUATION ISSUED ON JULY 12, 1994

  - Screening criteria would be reached in 2004

  - Based on data available at that time

  - Indicated date could change based on additional information

- o EVALUATION OF RETIRED STEAM GENERATOR WELD MATERIAL
  - High initial Ref Temp
  - High copper content
- o LICENSEE'S REVISED RT_{PTS} EVALUATION
  - Submitted November 18, 1994
  - Indicates Palisades will reach the screening criteria in 1999
- o UPPER SHELF ENERGY CRITERIA STILL SATISFIED

- o LICENSEE'S EVALUATION IS UNDER REVIEW
- o IMPORTANT AREAS OF REVIEW INCLUDE
  - THERMAL AGING, HEAT TREATMENT, CHANGES IN TESTING
  - BEST ESTIMATE COPPER CONTENT
- o RES AND ORNL ASSISTING IN REVIEW
- o STAFF EVALUATION BY JAN 31, 1995
- o PTS SCREENING CRITERIA COULD BE REACHED BEFORE 1999

- o GENERIC IMPLICATIONS

- o REVIEW OF OTHER RPVs WITH PALISADES WELD MATERIAL

    - Other plants still satisfy RT_{PTS} and upper shelf energy criteria

    - Lower fluence or use of actual surveillance data

- o OTHER PLANTS CLOSE TO SCREENING CRITERIA BEFORE END-OF-LICENSE

    - Sensitivities being studied

    - Proactive measures may be appropriate