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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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MEETING OF THE SUBCOMMITTEES ON

MATERIALS & METALLURGY AND PLANT OPERATIONS

+ + + + +

PROPOSED GENERIC COMMUNICATION REGARDING INSPECTION

OF

INCONEL ALLOY 82/182/600 PRESSURIZER PENETRATIONS

AND STEAM-SPACE PIPING CONNECTIONS

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FRIDAY,

APRIL 2, 2004

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T-2B3, 11545 Rockville Pike, at 8:30 a.m., Dr. F. Peter Ford, Chairman, presiding.

COMMITTEE MEMBERS PRESENT:

F. PETER FORD, Chairman

JOHN D. SIEBER, Co-Chairman

MARIO V. BONACA, Member

THOMAS S. KRESS, Member

GRAHAM M. LEITCH, Member

VICTOR H. RANSOM, Member

WILLIAM J. SHACK, Member

MAGGALEAN W. WESTON, Staff Engineer

NRC STAFF PRESENT:

BILL BATEMAN

STEPHANIE COFFIN

TIMOTHY G. COLBURN

BILL CULLEN

ALLEN HISER

STEVE LONG

MATTHEW MITCHELL

CONTENTS

	PAGE
Introduction, F. Peter Ford	4
Staff Opening Remarks, Bill Bateman	5
Staff Presentation, Matt Mitchell	7
Commission Discussion	60

P R O C E E D I N G S

(8:31 a.m.)

CO-CHAIRMAN FORD: Good morning. The meeting will now come to order.

This is a meeting of the ACRS Joint Subcommittees on Materials & Metallurgy and on Plant Operations.

I am Peter Ford, Chairman of the Materials & Metallurgy Subcommittee. My Co-chair is Jack Sieber, Chairman of the Plant Operations Subcommittee.

Other members in attendance are Mario Bonaca, Tom Kress, Graham Leitch, Victor Ransom, Bill Shack, and Graham Wallace.

The purpose of this meeting is to discuss the proposed bulletin regarding pressurize dissimilar metal weld cracking issues.

Maggalean Weston is the cognizant ACRS staff engineer for this meeting.

The rules for participation in today's meeting have been announced as part of a notice of this meeting published in the Federal Register on March 23rd, 2004.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice.

It is requested that speakers use one of the microphones available, identify themselves, and speak with sufficient clarity and volume that they may be readily heard.

We have received no written comments from the members of the public regarding today's meeting.

The concern that we're going to be discussing today is the question of a potential for unset of circumferential cracking and pressurizer penetrations and whether the licensees can inspect and identify these particular cracks in a timely manner.

We are potentially having a letter on this, a writing to the full committee meeting later this month.

Jack, would you like to add any comments?

CO-CHAIRMAN SIEBER: Not at this time.

CO-CHAIRMAN FORD: Okay. Bill, can I pass the meting on to you, please?

MR. BATEMAN: Yes, you can. Thank you, Dr. Ford.

I'm Bill Bateman, Chief of the Materials and Chemical Engineering Branch, and with me this morning is Matthew Mitchell, a senior engineer on my staff.

We're here to talk to you about

pressurizer penetrations. During the last refueling outage season, we had a couple of plants identify leakage from heater sleeves.

One thing that was somewhat unique about this was the licensees did some non-specific examination of these leaks to characterize the flaws. That was kind of new data that we were gathering. We don't have an awful lot of data about the characterization of the flaws when these heater sleeves do leak, but we do have some, and that data base to date has shown axial cracking in the pressure boundary portion of the heater sleeve.

Palo Verde was undergoing a campaign last outage season to replace some of the Alloy 600 penetrations in one of their pressurizers, and they did some volumetric inspection of those heater sleeves as part of that exercise. They did identify some circumferential cracking in penetration above the weld, but that is in the non-pressure boundary portion of the pressurizer.

We didn't expect to find that. We didn't expect licensees would find that kind of cracking. So it kind of escalated our concern about where we're at with Alloy 600 cracking on the pressurizer, given particularly that the pressurizer is the hottest spot

in the reactor coolant system, and we know that the heat temperature, time at temperature, as the susceptibility model we've used for the upper vessel head. So if you kind of transpose that over to the pressurizer, you would think, well, the pressurizer has got the potential for problems.

So that's kind of how we got into thinking about what do we need to do about it, and the decision was made to generate a piece of generic correspondence to go out to industry to request specific information.

I will say that industry has been proactive in this regard, and Matt will cover some of the details of that in his discussion.

So I guess at this point, Matt, I'll turn it over to you.

MR. MITCHELL: Okay. Thank you, Bill.

I think in keeping with the guidance we've received from the ACRS staff, I'd like to start by trying to sort of give you the conclusions or the synopsis of the message that we are trying to bring to the ACRS Subcommittees today.

And it starts with the first bullet, that we have, indeed, developed a proposed bulletin to address the inspection of these Alloy 82/182/600 type locations in or near the boundary of the pressurizer

and susceptible to primary water stress corrosion cracking.

And as a point of clarification, and I'll get to it in a couple of slides when I have a diagram of a pressurizer to put up, one of the locations, however, which we have not included within the scope of this particular bulletin would be the bimetallic weld between the surge line and the pressurizer shell. We have essentially, if you will, drawn the boundary of this proposed bulletin just above the elevation of that bimetallic weld, and then for locations above that in and around the pressurizer shell.

CO-CHAIRMAN FORD: Will you be returning to this question? I'm interested in reading the draft of the bulletin that I have anyway. Surge line is not within the scope. Will we be coming back to that later on? And what's the risk by not having it in scope?

MR. MITCHELL: Well, and that is, indeed, a question that also I think that when we took the bulleting to the committee to review generic requirements last week, they asked that we be a little more explicit in the way that we address that within the scope of this draft bulletin to note that the staff is in the process of considering whether or not

we need to take action by means of another generic communication to address not only the surge line, but piping butt welds throughout the boundary of the reactor coolant system.

So that is a following step that the staff is at this point -- the staff has under consideration.

CO-CHAIRMAN FORD: So it wasn't excluded because you didn't think there would be any problem from a risk point of view. It was just because you had to put a boundary on the --

MR. MITCHELL: Right, right. Yeah, that should not -- yeah, we're not claiming that that is not an issue certainly.

CO-CHAIRMAN FORD: Right.

DR. LEITCH: The question I had was why are we limited to 600. Is there no 690 in service in this application?

MR. MITCHELL: The locations which could potentially have 690 would be if licensees, and in the case of some of the CE designed facilities they have gone in and put in half nozzle repairs. As Bill was mentioning, Palo Verde Unit 2, when they were in their last refueling outage, that was their proactive step to try to address the potential for cracking in their original configuration. They were going in and

putting half nozzle repairs throughout the heater sleeves.

And so there would be a limited amount of 690 in service. I don't believe we have any experience, however, at this point in time with 690 having started to show evidence of primary water stress corrosion cracking in these applications.

DR. LEITCH: It seemed to me that someone, and I forget which plant, came up in the license renewal, was planning to replace their pressurizer next year, I think.

CO-CHAIRMAN SIEBER: Ginna?

DR. LEITCH: I think it was Ginna, Jack, yeah. And I would assume they would be using 690 in that application.

MR. MITCHELL: I can't say that I'm familiar with that particular aspect. If anyone else. Stephanie?

MS. COFFIN: Stephanie Coffin, NRR.

Just last week Fort Calhoun Station came in and made a presentation to the staff on their plans for replacing the pressurizer, their steam generators, and the reactor vessel head.

MR. MITCHELL: I think it was Fort Calhoun, yeah.

MS. COFFIN: Over the next two years. I'm not sure of the exact schedule. All of the materials in all three of these components will be 690/52/152 materials.

DR. LEITCH: So we don't think it's -- I mean I know 690 is not as susceptible, but I guess we're saying that as we begin to get some of these 690 applications, we don't think this bulletin is applicable to 690?

MR. MITCHELL: Well, certainly in keeping with the context of a bulletin or a proposed bulletin being a one time, we're looking for a specific defined response. I think we would need to contemplate what other vehicles we would need to use to deal with the fleet going forward and engage them on the 690 issue as a more far reaching application.

DR. LEITCH: Okay. Thank you.

MR. BATEMAN: Let me just add we have a substantial amount of experience with steam generator tubes, which are kind of leading the information with respect to the performance of 690, and we don't have any problems with those steam generator tubes at this point that have been in service for a number of years. We really haven't seen any cracking in 690.

So whether or not it's the right material

to last for the lifetime of a plant, we don't know that yet.

MR. MITCHELL: Yea.

DR. SHACK: Just a question on this butt weld. When we had the summer issue, was there a campaign to inspect all of the 182 butt welds? You know, how much experience do we have with people who have done inspections on butt welds?

Presumably better volumetric inspections now that we've had the summer experience on how to do this.

MR. MITCHELL: Certainly the experience with Summer has sensitized both the staff and the industry to the issue of PWSCC and piping butt welds. We've been awaiting information from the industry in terms of their evaluation of the degree of the problem, given some of the particular nuances about Summer, which you may recollect it would not be characterized as your typical reactor coolant system weld given the degree of weld repairs which were evident there.

But we have challenged the industry to give us a more thorough assessment of the overall scope of the potential for PWSCC in piping butt welds and to provide us with their proposals in terms of

inspecting those welds going forward.

And as you pointed out, the application of more advanced volumetric inspections has been working its way into the fleet with Supplement 10 to Appendix A of Section 11 type inspections of those piping butt welds.

I can't say that we know immediately or that I know immediately today just to what extent a fleet's welds have been inspected using those updated methods. We know that they're there. We know that they're available.

Part of the consideration for the potential need for an additional generic communication could be to obtain an appropriate collection of information regarding just how many inspections of that type have been performed and what the results have been.

MR. BATEMAN: Well, I might add that we have information, early information. Obviously, you know, this new PDI inspection has just started, but we have information that plants are finding indications, and they're going back and looking at previous UT inspection data, which they didn't make the call on before and said, "Oh, yeah. Well, now that we know about this improved technique, we have a flaw there.

We can go back and look at some of our old data and say, yeah, that was there, but we just didn't call it."

So I think we're going to see more of that with the new inspection techniques, and the question will come up is this some kind of a preexisting flaw. Is it a growing flaw? You know, all of that has yet to play out.

MR. MITCHELL: But then getting back again to the topic of the proposed bulleting today, the intent of the bulletin is to request information from the PWR licensees regarding their past, present, and future inspection plans for the locations covered under the scope of the proposed bulletin, and it is the NRC staff's position that the information requested is necessary for us to determine whether there is need for additional regulatory action.

I think you've heard us say that before in the context of other bulletins that we have brought before you on PWSCC and other locations.

CO-CHAIRMAN FORD: And that presumably in relation to the last two questions will include a quantitative qualification of either materials changes, 690, or 152/52, and also the volumetric exams. You would be asking the industry to give you

a quantitative qualification of those changes; is that right?

MR. MITCHELL: I'll get to the requested information as I move through the presentation. Maybe it would be better if I tried to address that question a little bit later.

CO-CHAIRMAN FORD: Sounds good.

MR. MITCHELL: As Bill had pointed out in his introduction, we have had extensive experience with cracking of the locations covered within the scope of this bulletin throughout the past history of PWR operations. It does include evidence of cracking, I believe, at all three PWR designs. Both the CE designed fleet has certainly seen evidence of Alloy 600 cracking in the pressurizer heater sleeves.

We've seen Alloy 600 diaphragm plate cracking in the heater bundle design at the Babcock and Wilcox facilities.

We've seen instrument line cracking at all three designs, and there has also been some evidence, particularly foreign operating experience, at Tsuruga in Japan involving the cracking of butt welded connections in safety relief valve lines and spray lines connected to the steam space of the pressurizer.

And the bullet at the bottom of the page

is just sort of the general recap that, indeed, with the temperatures evident in the pressurizer, one would expect PWSCC to occur at these locations, given what we've seen in the upper and lower vessel heads at other facilities.

So moving to my rather sparse diagram of a typical CE or Westinghouse pressurizer, the locations that you see numbered there, there's no legend for those, but I think it's probably fairly evident that Location 3 up at the top is a spray line coming into the top of the pressurizer. Location 4 would be around the area where you would expect to have safety or relief valve lines. Locations 5 and 7 are instruments taps, and Location 8 down at the bottom are emersion heaters that you would see in the CE and Westinghouse designs, and in those facilities you could potentially have Inconel Alloy 82/182/600 type materials at any of those locations.

I should point out at this stage, however, that as far as the Westinghouse design fleet goes, we are not aware of any of those units which have used Alloy 82/182/600 type materials in the heater sleeves themselves or in their connection to the pressurizer. That seems to be isolated to a feature of the CE designed fleet. Westinghouse units have used

stainless steel.

The next slide is a little more of the detailed operational experience and particularly the recent operational experience. In part, as also Bill had mentioned in his introduction, in the fall of last year, there were a couple of instances of leakage observed from CE designed units at Milstone II and Waterford III, which were confirmed to be the result of actually oriented PWSCC in their heater sleeves.

The seminal event is the second bullet. In October of 2003, with Palo Verde Unit II discovering circumferentially oriented PWSCC in the non-pressure boundary portion of five heater sleeves during their efforts to do widespread Alloy 690 half nozzle replacements has been the impetus for us to really go back and revisit this issue at this point in time and seek additional information regarding the status of the entire fleet.

In addition, the foreign experience that I alluded --

CO-CHAIRMAN FORD: Excuse me, Matt. Are we going to come back to the details of the Palo Verde incident?

MR. MITCHELL: We can cover that now. Please, go ahead.

CO-CHAIRMAN FORD: Could put up this up so that we can discuss it in a bit more detail?

MR. MITCHELL: Okay, certainly.

CO-CHAIRMAN FORD: There was no leakage, as I understand it.

MR. MITCHELL: That is correct. At Palo Verde Unit II, again, all of that work that was being done last fall was as part of this planned proactive replacement.

CO-CHAIRMAN FORD: Right.

MR. MITCHELL: There was no evidence of leakage at the unit when the unit had shut down from any of those particular heater sleeves.

CO-CHAIRMAN FORD: Okay.

MR. MITCHELL: Okay, and what Peter has asked me to put up is sort of my typical drawing of a CE designed heater sleeve that I've used for a number of presentations now over the past few months, and it short of lays out for you sort of a general schematic of what this looks like.

And in fact, I believe this drawing did actually come from Palo Verde during the time when we were discussing the indications they found last fall, and so the circumferential cracking that we're discussing would have been above that elevation of a

dashed line that you see drawn across sort of the middle of the picture. It's above that. So it would have been in the non-pressure boundary portion.

CO-CHAIRMAN FORD: Could you point to it? Sorry.

MR. MITCHELL: It would be -- would have been up in this region. So above the elevation of where the welds tie into the actual shell of the pressurizer.

CO-CHAIRMAN FORD: Okay.

MR. MITCHELL: So your dashed line here is where I've tried to sort of point out the difference between pressure boundary and non-pressure boundary portions.

CO-CHAIRMAN FORD: Okay. So not having an ejection possibility here.

MR. MITCHELL: Not based upon what was observed at Palo Verde Unit II, no.

CO-CHAIRMAN FORD: Now, if you're getting cracking at that heat affected zone, why couldn't you get cracking at the lower heat affected zone?

MR. MITCHELL: That has been our question as well.

CO-CHAIRMAN FORD: Ah, good.

MR. MITCHELL: That is what we are -- that

is in large part the reason why we are pursuing this proposed bulletin. There would be reason to believe that you would, of course, be potentially susceptible to circumferential cracking below the weld.

Now, there have been some analytical -- has been some analytical work performed on the part of the industry as we've challenged them to provide us with a justification for continued operation of the CE units in light of this information, which has suggested that the residual stresses below the weld would be somewhat lower than those above the weld.

The best characterization that the industry has provided for us is that they had believed the cracking observed at Palo Verde Unit II may very well have been OD initiated. On the downhill side all of the cracking observed at Unit II was on the down slope side of these penetrations. So it's at this location.

And it was essentially equally length on both the ID and the OD of the tube. So just from the UT information, it was essentially impossible to delineate between ID initiated and OD initiated because you couldn't see any real difference in the extent on either surface.

But when they provided residual stress

analyses, then it was apparent that those results indicated that it would have been potentially more likely to have been OD initiated due to slightly higher stress on the OD.

CO-CHAIRMAN FORD: And so their analyses are showing that you got a compressive stress on the ID and a tensile stress on the OD?

MR. MITCHELL: No.

CO-CHAIRMAN FORD: No?

MR. MITCHELL: Actually they were showing tensile on both surfaces.

CO-CHAIRMAN FORD: Oh, so it's just like a large pipe.

MR. MITCHELL: Yeah.

CO-CHAIRMAN FORD: So their argument completely falls apart then, does it not?

MR. MITCHELL: Well, indeed, based upon those analyses, there were also tensile stresses below the weld on the ID surface. So that would make you potentially susceptible to PWSCC below the elevation of the weld, yes.

CO-CHAIRMAN FORD: So when I read comments that this is not -- conclusions that this is not a safety issue because you couldn't get tube ejection, that's not entirely supportable, is it?

MR. MITCHELL: Well, there would be a difference between having the ability to initiate PWSCC below the weld and to have the expectation that there's a high likelihood for it to grow to an extent where you could reach tube ejection. Just like with the upper vessel head penetrations, the results of the stress analyses have indicated that you would need a very substantial flaw even below the weld to lead to an ejection, again, something on the order of 300 degrees around and completely through wall, 300 to 320 degrees around and completely through wall before you would reach sort of a limit load solution, which would suggest that the thing could possibly separate and cause ejection.

So these are still substantially resistent to full scale rupture and failure.

CO-CHAIRMAN FORD: Okay. But where you stand right now, hearing the industry coming along and making this argument. Hey, they believe that it was an OD initiated crack on the top side. I'm hearing you say you're not just taking that at face value.

MR. BATEMAN: No, and probably it wouldn't be fair to characterize the industry as taking a position on this. We've had discussions with industry, and we haven't sensed any reluctance on

their part to deal with this at this point in time.

CO-CHAIRMAN FORD: Okay. Good, good, good.

MR. MITCHELL: I'm going to step back to the detailed operational experience slide for just one second because I want to mention also the last bullet on the slide, which, again, goes to the susceptibility of the B&W designed facilities because we did have a recent event in which TMI I found evidence of cracking in their diaphragm plate in their heater bundle assembly. At that unit they eventually replaced the assembly to bring the unit back to power operation.

But it was in the heat affected zone of a seal weld around the exterior of that diaphragm plate.

CO-CHAIRMAN SIEBER: That's this drawing?

MR. MITCHELL: It's this other sketch we have.

MR. BATEMAN: That is, yes.

MR. MITCHELL: Would you like me to put that up, as well?

CO-CHAIRMAN SIEBER: Sure.

MR. MITCHELL: I get to make use of all of my background slides.

(Laughter.)

MR. MITCHELL: Yes, and this is, again, a

diagram that we actually received from TMI during the course of those discussions, and the cracking would have been in this area which you see circled here, where the diaphragm plate meets up with the shell of the pressurizer, and then a seal weld was located around the edge of that diaphragm plate.

DR. LEITCH: So that's a welded joint there?

MR. MITCHELL: Actually the structural --

CO-CHAIRMAN SIEBER: It's bolted.

MR. MITCHELL: The structural support is provided by this strongback which is bolted to the shell of the pressurizer.

DR. LEITCH: Okay, okay.

MR. MITCHELL: That is just a seal weld. That is not a nonstructural weld at that location.

DR. LEITCH: Got you.

CO-CHAIRMAN FORD: I'm sorry. Where was the crack?

MR. MITCHELL: The crack was actually around this seal weld essentially in the heat effected zone portion in this Alloy 600 plate. So if I had a blow-up of this diagram, you could show it sort of in this location.

CO-CHAIRMAN SIEBER: The heaters here are

horizontal as opposed to Combustion's which are vertical.

MR. MITCHELL: Correct. These come in from the side of the pressurizer shell.

CO-CHAIRMAN FORD: And what is that bolt made of? Is that a bolt at the top, isn't it?

MR. MITCHELL: This?

CO-CHAIRMAN FORD: Yeah.

MR. MITCHELL: Yeah, that's --

CO-CHAIRMAN FORD: Is it all the way a steel stud?

MR. MITCHELL: I can't --

CO-CHAIRMAN FORD: High strength?

MR. MITCHELL: I would assume it's a typical ASME code bolting material. I don't know exactly what designation material they're using for this particular application. I can say this is a typical low alloy steel strongback, however.

CO-CHAIRMAN FORD: And I read somewhere that you saw boric acid corrosion in that region.

MR. MITCHELL: That is correct. That was evidence of corrosion of the strongback itself due to the boric -- borated water leakage which came through the crack around the seal weld and then interacted with the carbon steel, low alloy steel of the

strongback.

CO-CHAIRMAN FORD: But no attack on the bold, on the stud?

MR. MITCHELL: Not to my recollection, no.

MR. BATEMAN: And we don't really know if it was even in contact with the bolt. So you know, if it was maybe it would have been, but I don't think we got any information indicated that where the leak was there was also a bolt in that vicinity.

CO-CHAIRMAN FORD: So that's just a schematic?

MR. BATEMAN: Yes.

CO-CHAIRMAN FORD: Okay.

DR. LEITCH: And as I recall, TMI made a repair and then came back up and it leaked again, and they had to make another repair. What was the nature of the repair?

MR. MITCHELL: they did attempt to grind out the flaws and essentially reestablish the seal weld and go back to an operation that was their first attempt at repairing it. When they attempted to go back to power, they found additional evidence of leakage.

At that time I believe the licensee made the determination that it would be more effective to

simply acquire a replacement, pressurizer heater assembly, and then just install an entirely new diaphragm plate and assembly in terms of getting the unit back on line.

That was the ultimate repair that they effected.

DR. LEITCH: And they would have to remake that seal weld obviously.

MR. MITCHELL: Yes.

DR. LEITCH: So rather than repair the other one, it was a complete reweld.

MR. BATEMAN: Right. Just a replacement instead of a repair.

MR. MITCHELL: This replacement is probably 600 again.

DR. LEITCH: Yeah, that was my question.

PARTICIPANT: Took it off the shelf.

MR. MITCHELL: They got it from another unit, and I can't tell you specifically what the material was that that plate was made from. I think you are correct. I think it was a 600 plate, but we can find that out for you.

DR. SHACK: And so all of the experience, again, has been that the cracking has been in the 600 rather than the 182.

MR. MITCHELL: That's correct. Yes, the cracking that has been observed to date particularly in the CE heater sleeves has been identified within the tube material rather than cracking attributable to being in the weld. Part of that, of course, may be that the weld material is more difficult to inspect.

When evidence of leakage has been observed and the crack has been tracked to find out, you know, what the source of the leakage is, there has been a consistent theme of finding cracks within the tube, which would give you the leakage which has been observed.

DR. SHACK: And how were these tubes made? Do you know?

MR. MITCHELL: Specifically, no. I don't know. I believe they are similar in fabrication to the tubes which have been made for BMI penetrations, lower vessel head penetrations, but if there are significant differences between the way these particular tubes have been manufactured and those, I can't tell you that. We haven't traced that particular aspect of it to completion at this point.

DR. SHACK: I mean, you haven't noticed any difference in susceptibility between suppliers or there's just not enough evidence to --

MR. MITCHELL: We haven't gathered that level of detail yet.

CO-CHAIRMAN FORD: That has really a complicated region. You've got low alloy steel nozzle. You've got presumably what, the 308 clad? What is the cladding material?

MR. MITCHELL: The cladding is -- I'm trying to remember whether there's a diagram. The cladding, I do not recollect whether that is a stainless cladding or whether that is an Inconel cladding that they happen to use in this particular design.

CO-CHAIRMAN FORD: Then presumably it is milled flat, where the diaphragm touches it.

MR. MITCHELL: Yes.

CO-CHAIRMAN FORD: And then you put a 182 weld to keep it in place.

MR. MITCHELL: Yes, the seal weld was an Inconel.

CO-CHAIRMAN FORD: So the primary water gets to it by capillary action up that mating surface, and then it hits the weld.

MR. MITCHELL: Un-huh.

CO-CHAIRMAN FORD: Okay, fine, okay.

MR. MITCHELL: As we noted, our principal

interest, however, had resulted from the Palo Verde Unit 2 experience and the new evidence of circumferential cracking at those locations. As a result of that, the NRC staff engaged the industry, and in particular the Westinghouse Owners Group to whom the CE designed fleet now belongs essentially, and asked that they provide both an operability assessment to justify the continued safe operation of these facilities over the near term, and then a proposal in terms of a long-term inspection program for providing the staff with assurance that unacceptable degradation of the heater sleeves and/or pressurizer head would be identified, characterized, and corrected in a timely manner, and that the extent of degradation of pressurizer heater penetrations would be adequately understood, in particular, if follow-up NDE for any evidence of future leakage showed that it was due to circumferentially oriented cracking.

CO-CHAIRMAN FORD: So that was your instructions or your request of them well before this bulletin.

MR. MITCHELL: That was based upon a dialogue that we had had with the industry back in the November time frame from last year.

CO-CHAIRMAN FORD: Okay. So now we're going to hear what their response was.

MR. MITCHELL: That is correct.

And the industry did respond in December of 2003 and provided their operability assessment. We have issued a substantial number of RAI questions, and we are still awaiting the response with regard to those RAI questions, many of them focused as you might expect on the details of, for example, their finite element stress analysis and their other evaluations which support their continued operational determination.

CO-CHAIRMAN FORD: So this analysis on your behalf hasn't been finished yet?

MR. MITCHELL: Yes.

CO-CHAIRMAN FORD: It's still RAI's.

MR. MITCHELL: That is correct.

CO-CHAIRMAN FORD: But I'm assuming that when you say in the first sub-bullet "the CE designed fleet is justified as a continued operation," they do give some specifics of inspection techniques and periodicities and the justification for those?

MR. MITCHELL: There was a proposal in the original December 23rd letter from the Westinghouse Owners Group regarding future inspection plans. We

had additional dialogue with the Owners Group, which gets me to the second bullet on this slide. And the final owners group proposal came in in January 30th, 2004, and it essentially contains three elements or three phases with regard to how they would manage this type of degradation, the first phase being a 100 percent bare metal visual examination of all heater sleeves during every refueling outage, and in this sense bare metal visual could include obviously removing all of the insulation and having exposed the entire bottom head surface or having access to, for example, put a baroscope up in the area around the heater sleeve so that you could see the metal, the intersection between each heater sleeve and the shell. Either of those we would qualify as adequate to meet a 100 percent bare metal visual definition.

The second phase would be the follow-up NDE would be performed if any heater sleeve showed evidence of leakage. A follow-up NDE would be performed to characterize the cracking in that particularly degraded heater sleeve before the unit was returned to service. So before any repairs were effected and the unit was brought back to power characterization of it would occur.

CO-CHAIRMAN FORD: Now, that would presume

that as we had many discussions for the RPV penetrations, that bare metal visual examination will always detect or indicate that there's a crack. It doesn't tell you anything about the orientation of the size, but it will always say a crack has gone through; the pressure is gone somehow.

And yet we have had incidences, North Anna being one, where there was no boric acid observation, and yet there was a crack. So how are we assured that we cannot have a crack there and not be kind of called (phonetic) by the boric acid?

MR. MITCHELL: Well, I'll bring out one distinction again between these penetrations and what you may have been used to seeing, particularly with upper head penetrations, and that is that these heater sleeve penetrations are not interference fit. There is a design gap around the heater sleeve.

CO-CHAIRMAN FORD: Right.

MR. MITCHELL: Between the heater sleeve and the shell approximately four mLs in width, very much like the penetration configuration on the reactor pressure vessel bottom head.

And if you'll recollect the South Texas experience, that was a very, very small amount of leakage that was coming from the South Texas BMI

penetrations, which was able to be identified by a bare metal visual examination.

And, indeed, we have also had good experience with the pressurizers in terms of the CE fleet being able to identify evidence of leakage to go in and make appropriate repairs to any leaking heater sleeves.

I don't think I can quantify for you the level of assurance related to bare metal visual examinations, but I think the qualitative evidence suggests that they have been effective in penetrations of this type of configuration at finding evidence of leakage.

CO-CHAIRMAN FORD: Now, I accept that. As you look at their proposal, the Westinghouse proposal, what about the situation where you've got a crack 90 percent of the way through the wall, i.e., no through wall leakage, and my being a lead man here, and then given the high temperature, then during that next operational cycle you could go straight through?

MR. MITCHELL: Well, part of the information provided by the industry in their analysis supporting their justification for continued operation was an argument that you would not, given the geometry of these penetrations and the way they were

fabricated, you would not expect to get even a circumferentially oriented flaw below the weld, which would be 360 degrees around a 90 percent through wall prior to a portion of it making its way through wall and showing evidence of leakage.

CO-CHAIRMAN FORD: Now, why do you say that?

MR. MITCHELL: In large part due to the asymmetry.

CO-CHAIRMAN FORD: Oh, the residual stress broken?

MR. MITCHELL: The penetration because, again, you're welding this into a sloping surface. The asymmetry was supporting the notion that you would with high reliability get cracking to punch through over a sector and provide evidence of leakage prior to crack growth, growing a flaw to such an extent that it could lead to substantial probability of failure of the penetration, full scale gross rupture.

DR. SHACK: You also said that you had through wall tensile stresses, which would mean that you get no retardation in the crack as it's growing through the wall.

MR. MITCHELL: The tensile stresses throughout the wall -- I'm sorry. Let me rephrase it.

The stresses throughout the wall were not necessarily tensile. There were sectors that were compressive around the circumference of the penetration, and that would be why you would expect a punch-through over a sector versus the development of a complete 360 degree --

DR. SHACK: I was thinking more through wall, you know. One of the things you get in a BWR pipe is that you can grow the crack through the wall, but then it shows down, which gives it a chance to grow around.

You know, what you want is once it starts growing you want it to grow.

CO-CHAIRMAN FORD: To give you a leak which you see.

How much does your safety argument rely on that assumption that you're going to get a leak before you get a 360 degree crack?

Because, you know, if you look at the BWR short, you can get a 360 degree crack. Unusual, but you can get it. So how much does your safety argument rely on this defensible presumption that you will get a punching through rather going all the way around?

MR. MITCHELL: I would say that that belief does provide a substantial basis for why we are

comfortable with the use of bare metal visual examinations as the first stage in terms of inspecting these penetrations rather than the need to go to full scale, 100 percent volumetric examinations as the initial inspection regime for these locations.

CO-CHAIRMAN FORD: During the Oconee vessel head penetration, remember the very first, one of the first ones where we had circumferential cracking, there was a risk analysis done in terms of conditional CDF. Has anything similar been done for this, this being the first major question being brought up about circumferential cracking in the pressurizer?

Has anyone done that kind of even rough analysis of what the risk is?

MR. MITCHELL: That aspect has certainly been considered. I'm not sure if any of the other staff here would like to provide any additional insights regarding the severity of a break at this particular location, if one were to occur.

Obviously, there is a difference between having a failure of a penetration of this nature and the location of the pressurizer versus an upper vessel head failure.

MR. LONG: This is Steve Long from NRR,

PRA staff.

We've looked at the conditional core damage probability given that the break would occur, and it's roughly one times ten to the minus three for a small LOCA. It varies by an almost order of magnitude from plant to plant as it's calculated from, I guess, one times ten to the minus four up to about three times ten to the minus three.

In terms of trying to figure out the probability of actually having the break, we don't really have the inspection data that would tell us that. You would need something that, you know, creates that crack of a size that can fail staging from some condition that wasn't really detected by whatever inspections are happening and going to failure before the next inspection.

So without knowing how frequently we actually have circumferential cracks and pressure boundary and not having seen any, there isn't any data to work from for that. I mean zero seen. If you assume it is zero, the answer is zero.

What the probability is that we're correct that there is zero there is the real question.

I don't think I can help you any more than that.

CO-CHAIRMAN FORD: Well, it's good to know that somebody has done that, and that's good.

Thank you.

MR. MITCHELL: And so I guess the Phase 3 or the final step of what was proposed by the industry in their January 30 letter was to expand NDE to non-leaking penetrations if, as part of Phase 2, circumferential cracking was observed in the pressure boundary portion of the leaking heater sleeve.

In subsequent dialogue that we've had with the industry about that particular step, I think they have made it clear that they were not intending to preclude the possibility of a licensee choosing to expand the scope of their NDE if they found circumferential above the weld. It was just not explicitly stated within the scope of what their proposal included.

DR. LEITCH: The viewgraph is a response from Westinghouse and CE, right?

MR. MITCHELL: Yes.

DR. LEITCH: Was there a B&W response to address this TMI type of situation?

MR. MITCHELL: We did not engage the B&W Owners Group with respect to the TMI experience when that occurred. We had focused on the circumferential

cracking question with the CE fleet. That was sort of our intro, our step into this particular issue.

DR. LEITCH: So I would assume as part of their boron inspection program they would be looking at this joint around the strongback there.

MR. MITCHELL: Yes.

DR. LEITCH: Which would give them some indication, I guess, of leakage.

MR. MITCHELL: And that is, in fact, how the TMI licensee did identify the leakage at the diaphragm point. It was part of their boric acid corrosion control walk-down program.

DR. LEITCH: Yeah, and again, I would think the safety ramifications of that would be fairly small because it would seem as though the strongback itself would limit the leakage.

Actually I guess the joint is really -- in other words, it seems to me that the main joint is where the plate butts up against the forging, and the strongback just holds that in place. The weld is kind of belt and suspenders there, is it not?

MR. MITCHELL: Well, provided that the leakage was not sufficient to start to degrade the bolting and the strongback to the point where you would lose structural integrity of that location.

Your probability of having a severe event would be limited, leakage could occur, but gross failure would be unlikely.

DR. SHACK: Are we measuring the boric acid in pounds, grams?

MR. BATEMAN: Milligrams.

MR. MITCHELL: It was more than milligrams and less than hundreds of pounds, but I don't recollect off the top of my head exactly how much boron we were talking about in terms of the TMI experience. I seem to recollect there was a fair amount, but nothing gross and egregious like what was observed, for example, a Summer.

DR. SHACK: But, I mean, it wouldn't take an extraordinarily sensitive and lucky break then to stop this leak either. I mean --

MR. MITCHELL: That's my recollection, that that was not the case.

MR. BATEMAN: There's an insulation package over this. Obviously, you'd have to pull that up for access.

One of the things just to make sure you're all aware, in order to do the inspection of a heater sleeve, there's a weld that has to be ground off. There is a weld that connects the heater mechanism

itself to the heater sleeve. That weld has to be ground off. The heater then has to be pulled out. Then you have access to go on and do your inspection. Then you've got to put the heater back in and remake that weld.

So it's a lot of work to do an inspection, you know, an internal inspection of a heater sleeve, and the other thing I'd like to remind everybody, I know we're focusing on heater sleeves, but this bulletin covers all of the penetrations in the pressurizer, not just the heater sleeve. So in the case, for example, of TMI where, you know, you can look at that and really it's not similar to the other one, but there's a lot of other penetrations in the pressurizer that this bulletin is also going to address.

MR. MITCHELL: Yeah, and Bill is leading me into my next slide actually. Based on the staff then taking this issue and discussing it with NRR senior management, we were challenged to think more broadly than just focusing on CE pressurizer heater sleeves and to develop a proposed bulletin which would, in fact, address all of the materials from each of the PWR designs that would constitute the boundary of the pressurizer. So this would include vent lines

in the steam space, spray lines, instrument taps, heater sleeves, the entire gamut of these types of locations for all three PWR designs.

As part of the bulletin, the staff reflected on the proposal by the Westinghouse Owners Group and would note that in our opinion, an acceptable degradation management program for these locations would effectively include the first two phases proposed by Westinghouse or the Westinghouse Owners Group in their January 30th letter, and then as Phase 3, to make an explicit statement that NDE expansion should be considered for circumferential cracking not only in the pressure boundary, but if it were observed in the non-pressure boundary portion of any of these types of penetrations.

So that would be our one expansion, if you will, of the original proposal that had come in from the Westinghouse Owners Group.

In terms of the information requested or as is currently being contemplated to be requested in the proposed bulletin, I've tried to sort of synopsize briefly what each of the elements would entail, and you'll notice that the numbering is slightly different than what I believe the committee was provided in terms of a draft bulletin because we've modified some

of the language in there based upon CRGR comments.

So the current best thinking regarding what the request for information would look like would include an Item 1(a) asking for a description of essentially the configuration of the facilities, pressurizer, where they have these types of materials and any type of information which would be relevant in terms of establishing their susceptibility to primary water stress corrosion cracking.

In 1(b), a description of the inspection program the licensee has implemented in the past.

Then a description of what the licensee's intended inspection program would be for the next and future refueling outages.

CO-CHAIRMAN FORD: Now, on those (b) and (c), now they're talking about the whole question of qualification of inspection technique and the periodicity. What input are you getting from the MRP on this?

MR. MITCHELL: In terms of sort of a holistic approach to the reactor coolant system, there has been a letter drafted and issued by Leslie Hartz under the banner of the MRP to the PWR industry or to the nuclear industry recommending that licensees perform bare metal visual examinations of all Alloy

82/182/600 type locations throughout the boundary of the reactor coolant system within their next two refueling outages if a bare metal visual inspection had not been performed in their last refueling outage.

CO-CHAIRMAN FORD: That's a good deal more forgiving than the Westinghouse proposal, isn't it?

MR. MITCHELL: Well, and that proposal from the MRP is intended to cover obviously not only the pressurizer, but other locations which could be at substantially lower temperatures. So the scope of that proposal was broader, and the detail and the periodicity of it was a bit more relaxed than what one might like to see for a high temperature location like the pressurizer.

There was also emphasis provided, however, in the MRP letter to licensees to consider doing inspections of higher temperature locations on a more expedited basis. So to look at pressurizers and hot legs at least from a one time perspective as soon as possible.

CO-CHAIRMAN FORD: Now, if you were Draconian about it and said, "Well, okay. Taking the experience we've had with the reactor pressure vessel, this is a good deal higher temperature. Therefore, if you use the criteria given the order last year, and

all of these components would have to be classified as high susceptibility, and therefore, they would all have to have the full 100 percent volumetric.

What is wrong with that argument?

MR. MITCHELL: I think the staff certainly considered that and balanced that observation with our understanding of the configuration of penetrations like the heater sleeves, and the feasibility of doing inspections, particularly 100 percent volumetric inspections and the fact that such inspections can only be classified as nondestructive in a particular sense of that word, given that you have to go in and actually penetrate the pressure boundary to remove the heater sleeve in the first place to be able to get to an elevation in the first place where you can actually do a 100 percent volumetric inspection of those welds.

And we felt that the experience that we have had in terms of licensees being able to find evidence of leakage effectively due to volumetric exam or due to bare metal visual examinations warranted that as the first step before trying to, as you put it, be Draconian and lead people toward 100 percent volumetric examinations.

There was thought given to the balance between the feasibility of doing these and the benefit

which would be gained in terms of doing 100 percent volumetric exams.

CO-CHAIRMAN FORD: I can understand that pragmatic balance you're going through, but the whole thing hinges, therefore, on that big assumption that you've got that you're going to get a leak situation and see it. Given the fact that the annulus is wide, you're going to see it. It's not going to be captured in that annulus, as opposed to, you know, the 360 degree argument, the 360 penetration and you shoot through in one operation.

The whole thing hinges on that technical assumption.

MR. MITCHELL: I think that would be a fair characterization, but that is certainly a significant element of relying on bare metal visual --

CO-CHAIRMAN FORD: Now, does the industry -- when Westinghouse is making this argument and presumably MRP backing it, the data they took into account, this technical assumption that is inherent in their approach?

MR. MITCHELL: Certainly the arguments and the analysis that they provided would support that conclusion that you would be able to effective find even circumferential cracking in the pressure boundary

portion by means of a bare metal visual examination prior to the cracking reaching anywhere near a size large enough to cause gross rupture of, for example, the heater sleeve.

Now, again, I should caveat that by noting we do have questions on the table in terms of our RAI that we have issued, which could affect that conclusion. I think the staff at this point, based upon what we have been able to review of the Westinghouse argument doesn't believe that the questions we have asked will change the bottom line conclusion. It may change the details of how much time one might have between a crack large enough to be observable and one which might lead to a failure, but not to a point where it would substantially undermine relying at least at this time on bare metal visual examinations.

CO-CHAIRMAN FORD: This isn't concluded at this point. This is still an ongoing technical discussion, is it, hopefully?

MR. MITCHELL: We will be reviewing the responses that we get from the industry. We will be, in terms of going forward, we will continue to evaluate the operational experience that we have with these locations to see if there is a need in the

future to modify our position regarding the acceptability of 100 percent bare metal visual examination.

We are basically going today on our experience to date.

Item 1(d) then would request an explanation from each licensee regarding why their proposed inspection program was inadequate for purpose of maintaining the integrity of the facility's reactor coolant pressure boundary and meeting all applicable regulatory requirements pertaining to that facility, and I think that goes to a large extent to Dr. Ford's question in terms of asking the licensees why they feel that their program is acceptable.

And then Item 2 would be, of course, asking for the results of their next inspection or the inspections conducted in their next refueling outage with a reflection on the fact that they do not complete the inspections they identified in 1(c) in their initial response to the bulletin, they supplement their answer to 1(d) to explain why what they did also met the intent of maintaining the integrity of the reactor coolant pressure boundary.

MS. WESTON: Matt, has the preliminary plans for the piping butt welds been included as

suggested by CRGR?

MR. MITCHELL: I'm sorry. Maybe could you rephrase that question?

MS. WESTON: Apparently CRGC made a comment about the inclusion of preliminary plans regarding the piping butt welds. Has that been included?

MR. MITCHELL: Yes. It has been included to the extent that we have inserted a statement that says that the staff is considering the need to issue a generic communication on that topic. We did not provide any additional details because anything beyond that would be pre-decisional at this point to the staff's plans for potentially needing to address that issue.

So in conclusion, obviously the high operating temperatures associated with these pressurizer penetrations make them highly susceptible to PWSCC.

Adequate inspections for the purposes of identifying deposits resulting from these types of flaws may include the need to perform bare metal visual examinations of these penetrations.

Adequate inspections are necessary to insure that any degradation of these material

locations within the boundary of facilities' pressurizers are promptly identified and corrected in a manner consistent with a discovery which would be contradictory to facility technical specifications on no reactor coolant pressure boundary leakage.

And, again, the staff feels that the information that has been formatted into the proposed bulletin is necessary to determine whether any additional regulatory action is required.

And that concludes my planned remarks regarding the proposed bulletin. Are there more questions?

CO-CHAIRMAN FORD: Now, there was something about the CRGR comments. Can you cover those?

MR. MITCHELL: That was a back-up slide. So if I can find where I put that.

CO-CHAIRMAN FORD: Because that presumably will determine or have an influence on the wording, the final wording. How it will change from the draft we have got in front of us.

MR. MITCHELL: The comments that we received from the CRGR did or have had an effect on the precise wording of the proposed bulletin versus what you did see as a draft, and I'm still looking for

my --

CO-CHAIRMAN FORD: Actually we've got it. We have it in front of us.

MR. MITCHELL: You have it in front of you.

CO-CHAIRMAN FORD: Yeah.

MR. MITCHELL: Okay. One of the items they asked that CRGR requested was that we explicitly address the issue of NDE scope expansion in the event that circumferential cracking is located in the non-pressure boundary portion of any of these penetrations, and that has been included within the proposed bulletin.

A second item, of course, we're always sensitive to the way we select our wording in any type of a proposed bulletin to eliminate the perception that there could be an implicit backfit involved with the information that we're requesting, and we were given a task to go back and modify some of the verbiage that we chose to make sure that perception was not evident.

And then to explicitly address the preliminary plans regarding piping butt welds and that goes to the inclusion of a statement noting that we are, in fact, considering whether or not a generic

communication on that topic is appropriate.

CO-CHAIRMAN FORD: You know, that would include, for instance, surge lines.

MR. MITCHELL: Absolutely.

CO-CHAIRMAN FORD: Okay.

MR. MITCHELL: And then the last comment or the last significant comment was there was originally an inconsistency in the response period that we were considering for the proposed bulletin based upon plants that may be coming down for fall outages versus plants which were coming down later, and upon reflecting on the CRGR comments, we determined that our delineation between those two groups may not be justified.

So we're revised the response period accordingly.

CO-CHAIRMAN FORD: Okay. Thanks, Matt.

DR. LEITCH: What's your expected time for issuance of this bulletin?

MR. MITCHELL: That I would have to say is a pre-decisional issue at this point in time. Since it is still undergoing review, I couldn't tell you today exactly when this will be issued. We are, of course --

DR. LEITCH: But presumably it would be

out in time to impact the fall outage schedule; is that --

MR. MITCHELL: That was the intent with the schedule that was originally developed for putting this proposed bulletin together, yes, to provide licensees with adequate time, to provide us with a response, and to provide the staff with adequate time to review those responses prior to the facilities who will be coming down in the fall.

CO-CHAIRMAN FORD: As into the future, we've now got another instance of cracking, not surprisingly, cracking in the pressurizers. Last April we had a meeting and in May to these subcommittees and the full committee on our, the NRC's, and the industry's plans for managing all of these cracking events so that we don't keep being surprised.

That was a year ago. Do we have any feeling; do you have any feeling whiles you have been talking to the industry on this specific matter as to whether we're moving forward in terms of managing these situations?

It's an unfair question, I know, but I'm just --

MR. BATEMAN: I see an individual in the

audience here who would probably be more than happy to address what industry has been doing.

(Laughter.)

MR. BATEMAN: But industry has been moving ahead. They formed the Materials Executive Oversight Group, the MTAG. In fact, Alex was in talking with some NRR management about a strategic issue matrix that wherein they've tried to prioritize and apply resources to various issues.

My sense is that industry does recognize the significance of this, and they are moving ahead on it. Alex, I mean, if you want to add anything.

CO-CHAIRMAN FORD: I guess before you get up, Alex, I guess my question is I'm naturally an impatient chap, and we heard this in April, and we were told this would all be resolved by the end of the year, that is, 2003, and I suspect it has not been resolved in that time frame. This is the management aspect.

It's a prediction, inspection, the whole question of managing these incidences.

MR. BATEMAN: I don't know where you heard that, dr. Ford. I mean, we basically have tasked, we, NRR, have tasked research to go off and do a study to determine what potential future cracking mechanisms --

CO-CHAIRMAN FORD: No, no. I understand that.

MR. BATEMAN: -- could be out there, you know, so that hopefully we won't be surprised by the next one.

CO-CHAIRMAN FORD: I overspoke, Bill. You're absolutely correct. It was more in terms of managing the reactor pressure vessel penetration issues, not the wide issue.

MR. BATEMAN: Okay. Well, in terms of the reactor pressure vessel issues, we have the orders out there, and we feel we're in real good position to be on top of that issue of the upper vessel head, and of course, we're doing something similar to what we discussed today with the pressurizer with the lower vessel head.

I think there has been a couple of outages since the South Texas and no other plants have identified any evidence of leakage there. So, you know, in terms of data gathering we haven't found anything else that would give us concern about there being some kind of a widespread generic problem in the lower vessel head.

So I think the vessel we feel pretty comfortable, and we're also going through a rulemaking

process to get the order, the inspection requirements and the order into the rules. So I feel pretty confident that if that was the objective by the end of 2003 that you understood, I think we accomplished it for at least the upper vessel head.

CO-CHAIRMAN FORD: No, my time frame to 2003, I think, was something that was intimated by NEI.

MR. BATEMAN: All right. Then Alex.

MR. MARION: I'm Alex Marion. I'm the Senior Director of Engineering at the Nuclear Energy Institute.

Mr. Mitchell referred to a letter that the MRP had issued in January of this year, recommending that utilities do bare metal visual examinations of all pressure boundary applications of Alloy 600/82/182 at operating temperatures in excess, equal to or exceeding 350 degrees Fahrenheit. That is in place.

That letter was also an enclosure to an NEI letter that went out to the industry chief nuclear officers strongly encouraging and recommending that they implement the MRP recommendations.

There are additional discussions within the MRP program providing further clarification and highlighting some of the more susceptible locations.

As a matter of fact, there's a conference call this afternoon, and I suspect within the next week or so, the MRP is going to send out a letter that's going to focus on the pressurizer locations similar to what the NRC is proposing in this bulleting.

There is an effort that Bill Bateman referred to that resulted in an industry initiative through the NEI process to put in place an integrated, coordinated and proactive plan for dealing with materials degradation issues in the future, and I would be more than happy to give this committee or the full ACRS if you so choose it's valuable a comprehensive presentation on that plan, and I'd be more than happy to do that at a future date.

But the basic objective is to put the industry on the leading edge of these issues instead of being in a reactive mode as we have been in the past.

CO-CHAIRMAN FORD: I think we have a subcommittee meeting scheduled for June the 1st in which is it a carry-on from the last April 2003 meeting, which I hope we can discuss that.

MR. MARION: Sure. I'd be happy to.

Thank you.

CO-CHAIRMAN FORD: Before going around the

table, I just ask Bill, when you finish Bill.

MR. BATEMAN: Go ahead.

CO-CHAIRMAN FORD: I'd just like your opinion, please, on what you would wish the ACRS to do from this point onwards. You've very kindly told us what you're planning on doing. We've got some, I think, as we go around the table, there will be some technical issues that you'd like to bring up.

What is your wish as far as a letter is concerned?

MR. BATEMAN: That's what Mr. Mitchell and I were just discussing.

CO-CHAIRMAN FORD: Good.

MR. BATEMAN: I don't think we need a letter.

CO-CHAIRMAN FORD: Okay.

MR. BATEMAN: So I think that's where --

CO-CHAIRMAN FORD: Is there a reason for why you don't need a letter, bearing in mind that we did write a letter at the very first bulletin that was issued in that case on the VHP issues, the CRD housing cracking?

If it's not going to be helpful to you --

MR. BATEMAN: I'm not saying it wouldn't be helpful to us, but I think this is a pretty

straightforward issue. It's similar to other issues that we've dealt with similarly, and so I guess I'm just using that as a basis for that.

I don't think that the effort that you folks would put into writing a letter would yield enough benefit one way or the other, you know, to justify the efforts you put into it, given our history of I think thinks is -- I don't know -- the third of fourth or fifth bulletin we've issued on Alloy 600 type issues and similar in nature and this one isn't unique in any way really.

So I think that's the basis for why I said that.

CO-CHAIRMAN FORD: Okay. Could I go around the table and ask members about their opinions of what they've heard today and also your opinion about the letter?

Jack.

CO-CHAIRMAN SIEBER: All I can say is I concur with what the staff is doing, and I think the analysis is appropriate, and they should move forward on their schedule.

CO-CHAIRMAN FORD: And do you agree that there's no need for us, the ACRS, to write a letter?

CO-CHAIRMAN SIEBER: I don't think so. If

they need one, we can write one, but otherwise, I don't see any burning issues out there. This is a pretty straightforward kind of a situation.

CO-CHAIRMAN FORD: Thank you.

Bill

DR. SHACK: You know, I think it's an appropriate action. I'm comfortable that there's enough asymmetry in this situation and enough high toughness in the Alloy 600 that the bare middle visual exams do give me, you know, a high degree of confidence that the inspection program that is proposed will detect things in the small leak stage prior to failure. Again, it doesn't seem to be a controversial thing. I don't think there's any particular need for a letter.

CO-CHAIRMAN FORD: Okay. Graham.

DR. LEITCH: I think it's a well though out program, a necessary program, and I have no particular comments on it. I don't really see any reason for a letter either.

There is one thing that is always a concern to me, and it's not really part of this, but it's perhaps a spinoff of it, and that's the BWR lower head penetrations which operate at a considerably lower temperature, I understand, and therefore, it

would be a long time before one might expect some kind of a problem there.

CO-CHAIRMAN SIEBER: No boric acid.

DR. LEITCH: But yet -- well, Just a minute, Jack -- but as we go for license extension and so forth, we're talking about a long time, and I think the boric acid is a two-edged sword. In one sense it gives you corrosion, but in another sense it also gives you a very good tell tale of where a small leak is occurring.

That tell tale, one might not be aware of a small leak, and so I think we have to keep the antenna up for BWR penetrations because the belly of those BWRs are loaded with penetrations, maybe not all quite of this design, but some of them are, and you've got all sorts of instrument penetrations, control rod drive penetrations. There's several hundred penetrations underneath each BWR.

So I just think that's something that we need to keep our antenna up as the years roll on here.

CO-CHAIRMAN FORD: Do you agree that we should not have a letter, Graham?

DR. LEITCH: Yes, I agree we should not have a letter.

CO-CHAIRMAN FORD: Marion?

MR. BONACA: Yeah, I pretty much share the thoughts previously expressed. I mean, that was a good presentation. I think the plan is appropriate. The bulletin seems to be appropriate. I think we have enough confidence from what is planned to do that we will detect degradation before you propagate to acceptable conditions, and I don't see any need for a letter right now.

I mean, I consider this an update to us, and I don't think what we would be able to recommend is other than whatever you have presented to us.CO-CHAIRMAN FORD: Thank you.

MR. KRESS: I think we are all of one mind. It's unanimous.

CO-CHAIRMAN FORD: Vic.

DR. RANSON: I have no comments.

CO-CHAIRMAN FORD: Magg, do you have anything?

MS. WESTON: No comments.

CO-CHAIRMAN FORD: I guess I'm the only one that dissents.

DR. KRESS: You just want to write a letter.

(Laughter.)

CO-CHAIRMAN FORD: I'm being facetious.

I don't dissent. I agree with everything that was said, and yes, the bulletin is appropriate and it is timely, et cetera.

I've still got this nagging feeling that the whole thing in terms of observation of the boric acid is predicated by the morphology about which that crack goes through the tube bowl, but I'm reassured by the fact because continuing these discussions with the WOG, NRP are continuing, that there is good, verifiable evidence of a nonsymmetry of the residual stresses around the pipe azimuth, and that you will have penetration at one spot and, therefore, you see the boric acid before you go whipping through in one fuel cycle, 360 degrees and have a tube reaction.

So my concern is reassured by the fact of this continued work, and I agree with no letter.

Could I open it up for any comments from the public at all? Anybody else?

(No response.)

CO-CHAIRMAN FORD: Okay. I'll thank you very much, indeed. I appreciate your coming and telling us about another problem that we have.

Thank you. It keeps those metallurgists in business.

(Whereupon, at 9:47 a.m., the meeting was concluded.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Reactor Safeguards Materials and Metallurgy & Plant Operations Subcommittee

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings as recorded on tape(s) provided by the NRC.

Rebecca Silberman

Rebecca Silberman
Official Transcriber
Neal R. Gross & Co., Inc.

Proposed Bulletin on Inspection of Alloy 82/182/600 Pressurizer Penetrations and Steam-Space Piping Connections

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Presentation for the
Advisory Committee on Reactor Safeguards

April 2, 2004

Presentation Message

- The NRC staff has developed a proposed bulletin to address the inspection of Alloy 82/182/600 locations in or near the pressurizer boundary and susceptible to primary water stress corrosion cracking

- The proposed bulletin requests information from pressurized water reactor licensees regarding their past, present, and future inspection plans for these locations and their basis for concluding that their planned inspection program is adequate

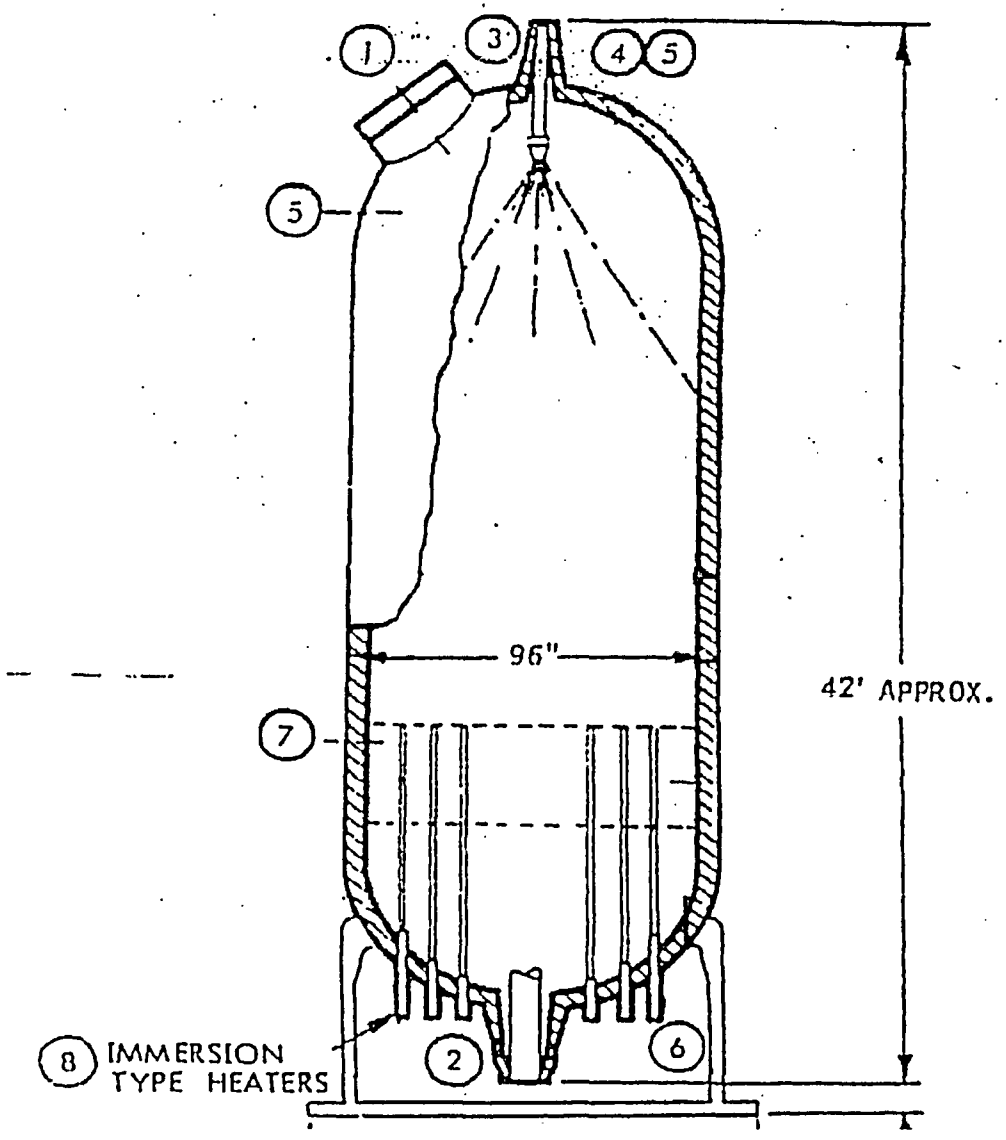
- It is the NRC staff's position that the information requested by the proposed bulletin is necessary for the staff to determine if additional regulatory action is required

Operational Experience

- Extensive facility operating experience has demonstrated that Alloy 82/182/600 materials exposed to the environment present in the pressurizer of pressurized water reactors (PWRs) can lead to primary water stress corrosion cracking (PWSCC) of these materials
  - Alloy 600 pressurizer heater sleeves at Combustion Engineering-designed facilities
  - Alloy 600 diaphragm plates in pressurizer heater bundles at Babcock and Wilcox-designed facilities
  - Alloy 82/182 weld connections for pressurizer instrument lines
  - Alloy 82/182 butt welded connections in spray lines and safety and relief valve lines

- This is should be expected since the environment of the pressurizer consists of water and steam at a temperature of about 650 °F, approximately 50 °F warmer than reactor pressure vessel (RPV) upper heads and 100 °F warmer than RPV lower heads, where PWSCC has also been observed

Pressurizer Diagram



Operational Experience (Cont.)

- Recent operational experience at both domestic and foreign facilities has caused the staff to focus on the inspection of these pressurizer penetrations and steam-space piping connections.
  - In Fall 2003, leakage was observed from pressurizer heater sleeves at Millstone 2 and Waterford 3 and confirmed to be the result of axially-oriented PWSCC in the pressure boundary portion of the heater sleeves
  - In October 2003, Palo Verde 2 discovered circumferentially-oriented PWSCC in the non-pressure boundary portion of five pressurizer heater sleeves during a planned activity to replace the pressure boundary portion of the unit's heater sleeves with Inconel Alloy 690 half-nozzles
  - In September 2003, inspections at Tsuruga Unit 2 in Japan found evidence of axially-oriented PWSCC in the nozzle-to-safe end butt welds in lines leading to the facility's safety and relief valves. Similar to circumferentially-oriented PWSCC found in lines at Palisades in 1993.
  - In November 2003, TMI 1 found PWSCC in heat affected zone of seal weld of pressurizer heater bundle diaphragm plate

Initial NRC Actions

- The NRC staff engaged the industry about the potential implications of the Palo Verde 2 experience and the management of PWSCC in pressurizer heater sleeves at CE-designed facilities

  Requested that Owners Group provide:

  - Operability assessment to justify continued operation of the facilities over the near term

  - Long-term inspection program for addressing this issue which must provide the staff with assurance that:

    (1) unacceptable degradation of the heater sleeves or of the pressurizer head will be identified, characterized, and corrected, and

    (2) the extent of degradation of the pressurizer heater penetrations at the affected facility will be adequately understood

Industry Response

- Operability assessment submitted to NRC on December 23, 2003
  - Proposed a basis upon which to conclude that continued operation of the CE-designed fleet is justified (similar to RPV head analyses)
  - Documented inspections which are currently performed by licensees, not all of whom have been performing bare metal visual (BMV) inspections
- Final Owners Group proposal on inspection program submitted by letter dated January 30, 2004
  - 100 percent BMV of all heater sleeves every refueling outage
  - Followup NDE to characterize flaw orientation during refueling outage when leakage is observed by BMV
  - Expansion of NDE (to be determined through discussion with the NRC) if circumferentially-oriented cracking observed in pressure boundary portion of the leaking heater sleeve

NRC Actions

- Upon presenting the issue of PWSCC of pressurizer heater sleeves at CE-designed facilities to the NRR Executive Team, the staff was directed to develop a proposed bulletin which would address the broader issue of Alloy 82/182/600 materials exposed to the pressurizer environment

- As addressed in the proposed bulletin, an acceptable degradation management program would include:

  - Performing bare metal visual examinations of all Alloy 82/182 pressurizer heater penetrations and connections every refueling outage

  - If leakage is found, before returning to service, perform NDE to characterize the degradation present in the leaking penetration/connection and determine if circumferentially oriented flaws are present

  - If circumferential cracking is found, NDE examination of additional non-leaking penetrations or connections should be discussed with NRC staff in regards to support an extent of condition determination

Proposed Bulletin 2004-xx

- Proposed Bulletin 2004-xx requests:

  (1)(a) Description of pressurizer penetrations and connections

  (1)(b) Description of inspection program that has been implemented by licensee in the past

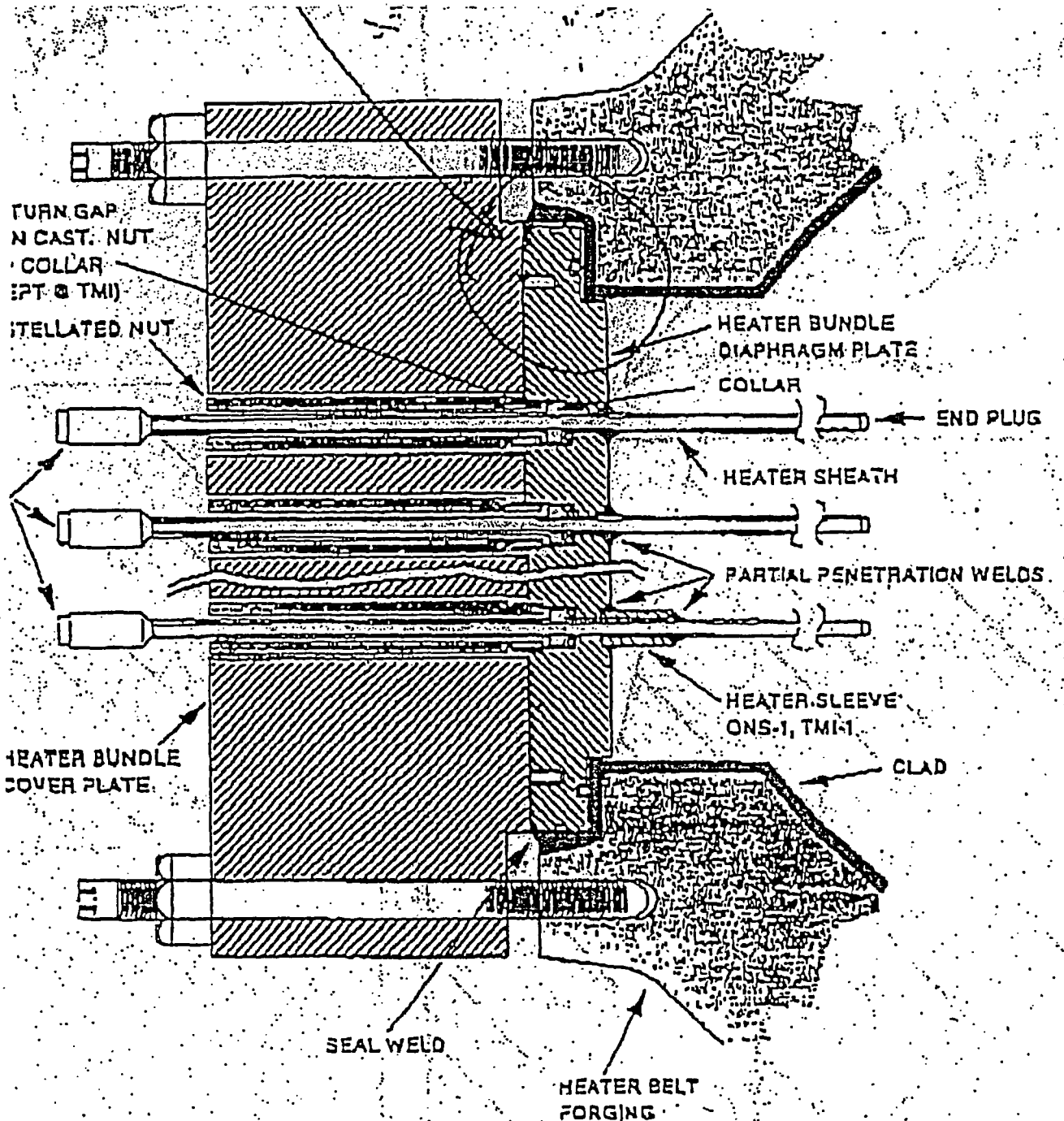
  (1)(c) Description of inspection program that the licensee intends to implement at the next, and future, refueling outages

  (1)(d) An explanation of why the inspection program identified in your response to item (1)(c) s adequate for the purpose of maintaining the integrity of the facility's reactor coolant pressure boundary and for meeting all applicable regulatory requirements

  (2) Results from next pressurizer Alloy 82/182 penetration/connection inspections, a description of the inspections if different from that given in response to (1)(c) (with a supplemented (1)(d) response)

Conclusions

- The high operating temperatures associated with pressurizer penetrations and connections make them highly susceptible to PWSCC
- Adequate inspections for the purpose of identifying deposits resulting from PWSCC flaws may include performing bare metal visual examinations
- Adequate inspections of the subject locations are necessary to promptly identify and correct failures of the reactor coolant pressure boundary, operation with which is contradictory to facility technical specifications
- The information requested by the bulletin is necessary for the staff to determine if additional regulatory action is required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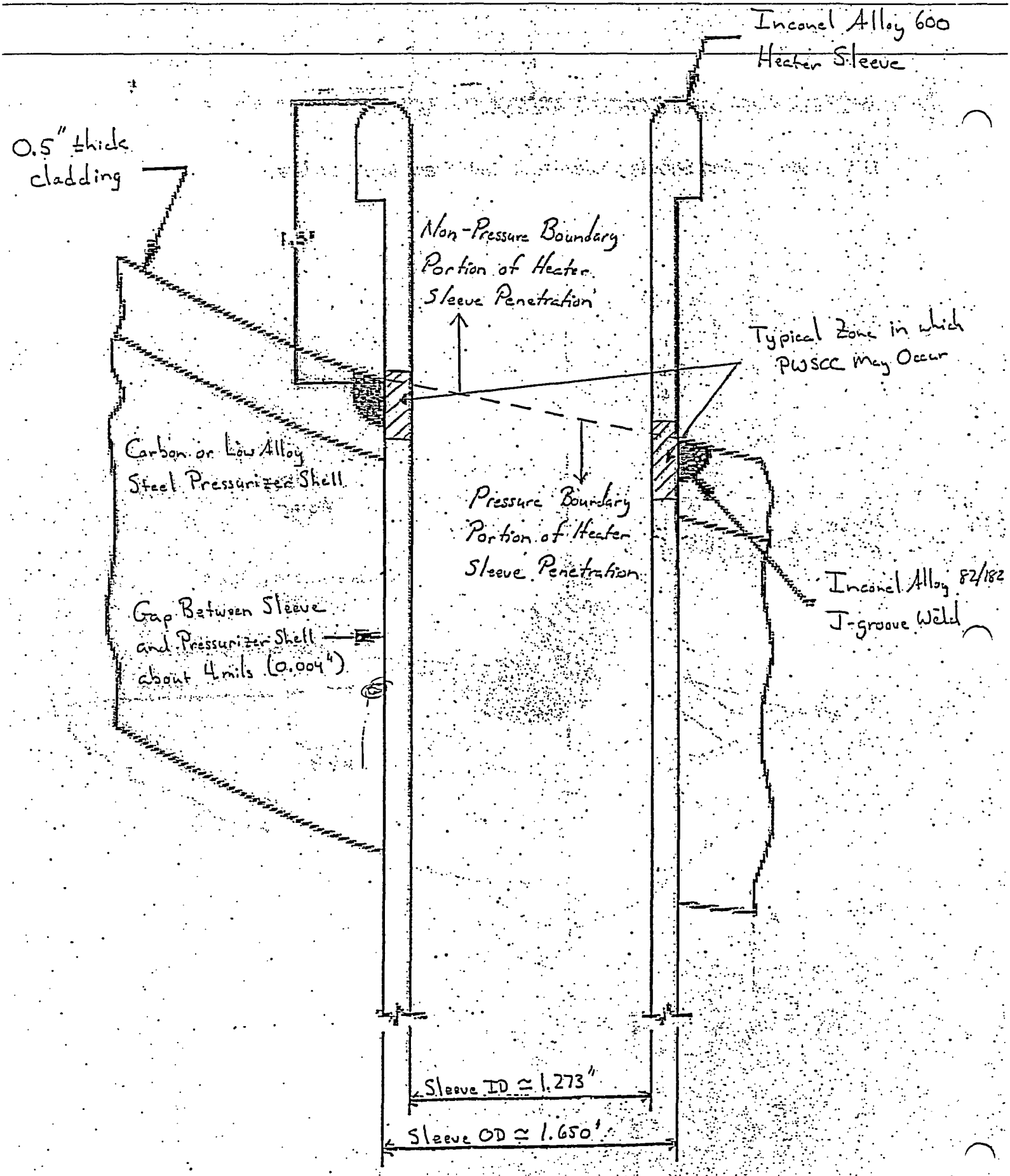
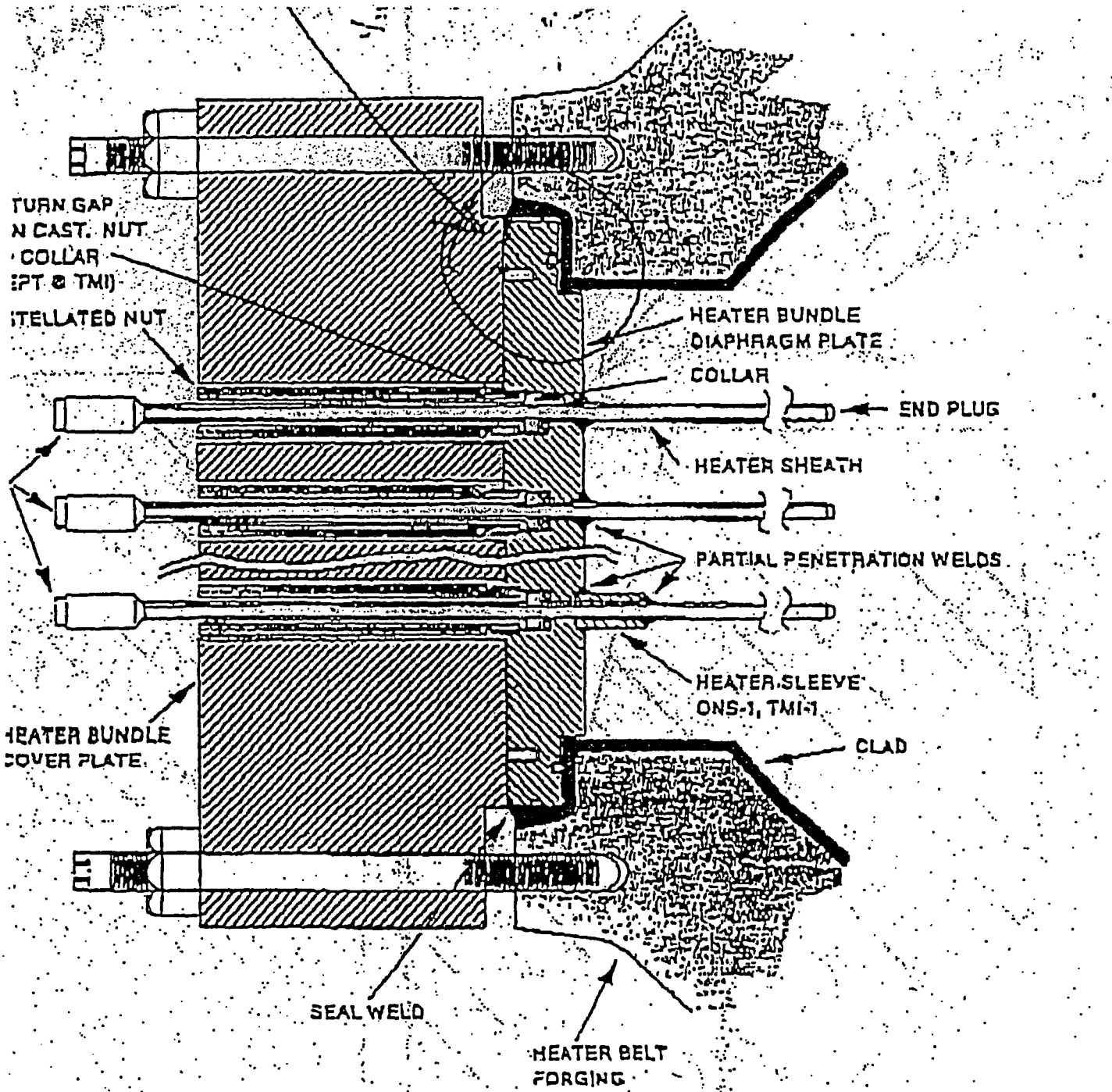
COVER PLATE
SEAL WELD
HEATER BELT
FORGING


Inconel Alloy 600
Heater Sleeve
0.5" thick
cladding
Non-Pressure Boundary
Portion of Heater
Sleeve Penetration
Typical Zone in which
PWSCC may Occur
Carbon or Low Alloy
Steel Pressurizer Shell
Pressure Boundary
Portion of Heater
Sleeve Penetration
Inconel Alloy 82/182
J-groove Weld
Gap Between Sleeve
and Pressurizer Shell
about 4 mils (0.004")
Sleeve ID ≃ 1.273"
Sleeve OD ≃ 1.650"

CRGR Comments

- Explictly address issue of NDE scope expansion in the event that circumferential cracking of non-pressure boundary locations is identified
- Reword parts of the proposed bulletin to eliminate any perceived "implict backfit"
- Explicitly address preliminary plans regarding piping butt welds
- Resolve inconsistency in requested response period (60 vs. 90 days)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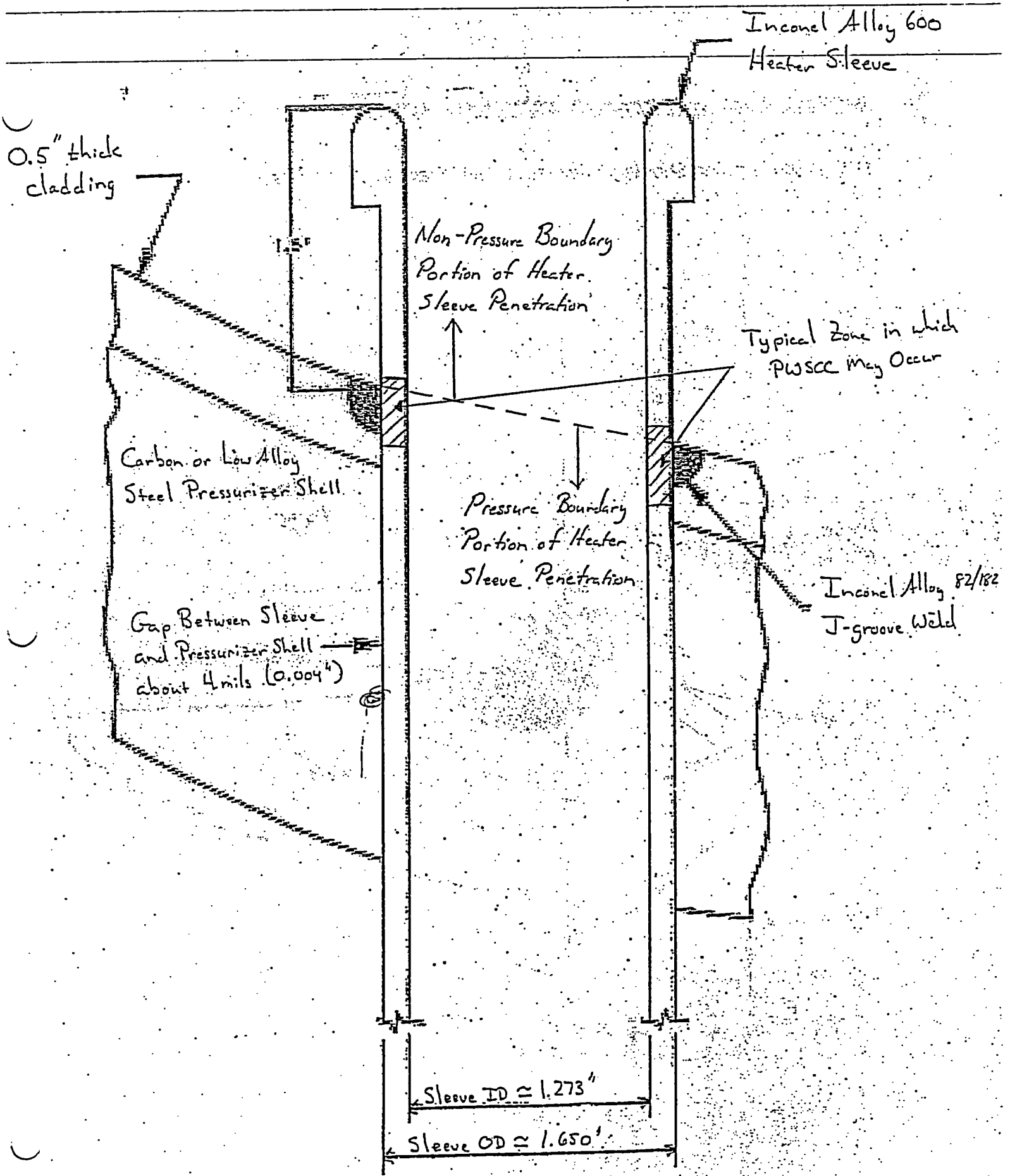
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