NUCLEAR REGULATORY COMMISSION

ORIGINAL

In the Matter of:

CONSUMER POWER COMPANY) DOCKET NOS. 50-329 OM & OL
) 50-330 OM & OL
(Midland Plant, Units 1 & 2)
)

DATE: February 18 1982 PAGES: 7582 thru 7839

AT: Midland, Michigan

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

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In the Matter of:             x
                              x   Docket Nos. 50-329 OM
CONSUMERS POWER COMPANY       x               50-330 OM
                              x
(Midland Plant, Units 1 & 2)  x   Docket Nos. 50-329 OL
                              x               50-330 OL
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Midland County Courthouse
301 West Main Street
Midland, Michigan 48640
February 18, 1982

Evidentiary hearing in the above-entitled matter was resumed pursuant to adjournment, at 9:00 a.m.

BEFORE:

CHARLES BECHHOEFER, Esq., Chairman
Administrative Judge
Atomic Safety and Licensing Board

RALPH S. DECKER, Esq., Member
Administrative Judge
Atomic Safety and Licensing Board

DR. FREDERICK P. COWAN, Esq., Member
Administrative Judge
Atomic Safety and Licensing Board

DR. JERRY HARBOUR, Esq., Member
Administrative Judge
Atomic Safety and Licensing Board

APPEARANCES

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WITNESS	DX	CX	BD	RDX	RCX
DONALD F. LANDERS					
By Williams	7608				
By Stamiris		7621			
By Harbour			7696		
By Cowan			7704		
By Bechhoefer			7716		
By Williams				7732	
By Stamiris					7733
By Blume					7739
By Stamiris					7741
DONALD F. LEWIS					
By Williams	7611				
By Marshall		7687			
By Harbour			7693		
By Cowan			7704		
By Decker			7705		
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Prepared Testimony of Donald F. Landers, Donald F. Lewis and James Meisenheimer follows: 7619

Afternoon Session: 7689

Prepared Testimony of Joseph Kane: 7752

Prepared Testimony of W. P. Chen: 7762

C O N T E N T S (Continued)

E X H I B I T S

P R O C E E D I N G S

CHAIRMAN BECHHOEFER: Good morning, ladies and gentlemen. We are going to go off the record and discuss some scheduling matters. We will resume in a few minutes.

(Discussion off the record.)

MR. PATON: Mr. Chairman, I discussed with the NRC witnesses last night the matter involving their inspection involving QC inspector, the electrical QC inspectors. They advise me that the Applicant has in their over-inspections discovered a number of non-conforming conditions. As a result of these non-conforming conditions, the NRC has decided to require that the Applicant do a 100 percent over-inspection and that work will not be able to be finished this week, so it is our position that we would not be able to give the Board a final assessment of this matter this week. We can certainly give the Board a status report, but frankly I do not think it would be productive until the 100 percent over-inspection has been completed.

MR. ZAMARIN: As I indicated during the off-the-record discussion, the only knowledge that I have with regard to this change to 100 percent over-inspection and the potential impact that that would have on completing the inspection and being able to provide testimony here is from Mr. Paton. But no one that I am aware of in the organization at the site knew about it, at least as of an hour ago, and apparently at a meeting this morning.

What I suggest is that by noon they should be in a position to let me know so that I can tell you more about what our position is as to in fact whether we agree to this week or not.

CHAIRMAN BECHHOEFER: Ms. Stamiris.

MS. STAMIRIS: Yes. I was just going to say that I have some strong feelings about the testimony of the QA that was scheduled for this week and the situation which Mr. Paton and Mr. Zamarin have just discussed. My feeling is that we should go ahead and have the testimony this week, whether it is in the form of what Mr. Paton calls a status report, because some resolution hasn't been reached yet and because the over-inspection hasn't been done.

Be that as it may, it seems like what continually happens in this proceeding is that Consumers is asked to do something or even if not asked, it is just expected that they are going to do something on their own. For instance, on this subject, the electrical work, it came up in the 8112 inspection and they were to perform an audit. They performed that audit in July and then in the October inspection report the NRC found the results of that audit to be -- I can't remember what word they used -- unsatisfactory at any rate, and so now we have come back and Consumers has readdressed this issue. Now NRC came in. Well, we weren't ready for it last time, so it was put off, and now the NRC came in ready to inspect it and found that there were problems significant enough to require a 100 percent over-inspection on this work at this point in time.

So the proposal is to put it off for approximately a third time, and it seems like we will perhaps just keep putting it off until some resolution is reached and the NRC and Consumers can come in and agree that everything is all right now. I think, as opposed to doing that, the NRC should come in and tell what they found out, what has happened, and if it is not all right right now, we should hear about that. Maybe that should be -- I mean, we have talked about closing out the QA matters and it seems like this would be one way to deal with it, is just to take the status report of what we have today and what the situation is and deal with it this week.

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MR. PATON: Mr. Chairman, since her remarks were addressed to something that the NRC should do, I would like to respond first. I'm sure Mr. Zamarin has something to say.

We could take up a lot of this Board's time giving the Board the status of where we are, but I don't think it's productive. The experts that are out there performing this inspection say we think it's necessary for the Applicant to do some more work. Then we are going to take that information back to Region III and assess it and get the assessments of our leaders and come back and report to the Board.

I don't see the merits of Mrs. Stamiris' position at all. Absolutely we can take a lot of time explaining to this Board where we are now, but we are not going to have a conclusion. So I don't see that it's productive to come in and spend a lot of time on this matter now. We are absolutely going to have to come back later. If the Board wants the Staff conclusion, we are going to have to come back and do it again.

MR. ZAMARIN: I agree with Mr. Paton and I would like to add also that I disagree with Mrs. Stamiris' characterization that there is a problem. It may well be there isn't a problem. That is what the 100 percent over-inspection is going to determine. I think that's a better reason -- well, the 100 percent over-inspection if, in fact, that is what they are going to be doing. I couldn't agree more with Mr. Paton, the rarity that that is.

It just doesn't seem to make a good deal of sense timewise and resourcewise to be coming in with, in fact, no conclusion and a progress report. If we are going to do that, we might be at the site and watch what is going on and I don't think that is productive at all.

At this point I don't think it's true there is a problem. If there has been a change after the 100 percent over-inspection, then there can be an evaluation, if that is what the staff is now inquiring. I think that is what is going on out there. It is not that they have problems at this point.

CHAIRMAN BECHHOEFER: Is the 100 percent over-inspection designed to ascertain in part whether the QC inspectors in question were qualified or were not qualified?

MR. PATON: I think only in small part. He has prepared testimony on the program for the qualification of the QC inspectors and is satisfied in that regard. But he has gone back to check work performed by these QC inspectors in the past and that is where the difficulty lies. He has discovered a number of non-conforming conditions and such the numbers -- or the Applicant has in their--

MR. ZAMARIN: Yes, that's right.

MR. PATON: They have discovered this information and that number has caused us to require the 100 percent over-inspection.

CHAIRMAN BECHHOEFER: My inquiry is really will the results of this tend to indicate whether the problem was with the qualification of the inspectors or the paper work which records their qualifications, because there is a difference. If 75 percent of the inspectors or 100 percent of the --

MR. PATON: I heard the information, Judge Bechhoefer, and it's obviously going to mean a lot of different things to a lot of different people. You are going to the conclusion and it doesn't say two plus two is four. You have to interpret it yourself, does this mean that these people who on paper are qualified. It raises the question of why were these non-conforming conditions -- how did they come about with people who are apparently qualified. It raises that question and what the answer to that is subject to interpretation.

MS. STAMIRIS: It's a question that is almost impossible to answer because it goes back to the basic question is it that they are unable or unwilling. When you have something that goes wrong, you can't look at a piece of paper and say it happened because he was unqualified or it happened because he didn't care or he didn't understand. You will never be able to answer that question.

question.

MR. PATON: I think Ms. Stamiris is pretty close to the mark.

MR. ZAMARIN: If I may.

JUDGE DECKER: Excuse me

(Brief interruption.)

MR. ZAMARIN: My understanding of what has occurred is there are literally thousands and thousands of things to be looked at. I can't even tell you what they are. Again I think we are experiencing one of the problems coming in with information and not being able to tell you about it.

My understanding is there are literally thousands and thousands of things to look at, that there has been absolutely no problem at all, and that once an area was looked at where apparently there were problems, that in proportion to the number of things that didn't have problems, it's a very, very small proportion. But apparently, from what Bill Paton has told us this morning, it's sufficient to warrant -- for the Staff to want to look at all of them. That is where we are right now.

I think that is what is happening is that this is becoming a horror movie and it's being talked about in terms of a great problem. I think it may well be -- and I certainly would hope that after whatever inspection is required to satisfy whatever these concerns is done, that it isn't a problem. I think at this point it's appropriate for it to be looked at.

If, in fact, they are in the process of finding out what is going on, I think it's a little premature to be talking about it.

MR. MARSHALL: You are minimizing it, aren't you?

MR. PATON: Judge Bechhoefer, to put it in perspective, there have been somewhere between 1,300 and 1,400 over-inspections to be performed and there are about 500 to go. I didn't want to make it sound like we are just beginning to do the work. I mean I think it's something that can be accomplished within a week or ten days. I am not precisely sure, but there is not that much farther to go.

CHAIRMAN BECHHOEFER: Well, during this week will you be able to tell us how many non-conforming conditions exist?

MR. PATON: I can tell you right now, 68.

MR. ZAMARIN: Not in combination that I understand. It went into thousands and thousands.

MR. PATON: This may be -- depending on how you want to word it -- this will take testimony -- but the Staff would say this is out of 1,368, and I think the Applicant would say this is out of 17,000. It depends on how you do your numbers.

MR. ZAMARIN: That is fine.

CHAIRMAN BECHHOEFER: My question is what we wanted to handle this week was the question of whether the QC inspectors are qualified or whether their record keeping system is adequate to indicate they are qualified, whether there is adequate documentation of their qualifications. And we were trying to figure out why we would need the 100 percent -- the close-out of the entire item.

The record someday has to reflect, should reflect, whether or not the item is closed out. But why in terms of the issue we have to decide in our earliest decision wouldn't the testimony of Mr. Gardner -- as long as it still remains accurate -- why would not that be useful? That is the question that has to be resolved in conjunction with the first QA decision.

MR. ZAMARIN: I agree. That is precisely what I had in mind when I told you that over the noon break I would find out whether I agree with Mr. Paton that even if this 100 percent over-inspection was done, that we couldn't provide testimony and close it out.

The next point is that I didn't know the problem the Staff has with it, I simply don't know. And it may well be that our position, after the noon break, is that, in fact, we believe we can provide sufficient testimony to close the matter out this week. But I simply don't know that yet.

I suggest that after the lunch break, that we can address it and I will tell you what our position is at that time.

CHAIRMAN BECHHOEFER: The Board would strongly prefer to be able to take testimony on that item this week. We might have to supplement it later on to determine whether everything was closed out, but I would do that as more like a corrective action rather than two decisions.

MR. ZAMARIN: I think it depends what they have out there.

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there

MR. PATON: Judge Bechhoefer, perhaps we could proceed this way: We may allow testimony from January 22nd that accepts the first of two questions that Mr. Gardner addressed. The testimony states that he is satisfied that their certification of QC inspectors meets the Midland Project requirement and NRC requirement. That is his testimony. He is satisfied to that.

Then his last question and answer indicates he is waiting for the results of the over-inspection. I agree that perhaps this over-inspection, the results of this over-inspection, like a lot of other QA matters as Judge Cowan referred to this morning, we are going to have to have these continuously. Maybe the way to look at this is to allow us to complete our work, then we can come in and report to the Board at some later session; and if the Board thinks there is somewhere between all the parties and the Board enough to reopen the record, we can do it.

CHAIRMAN BECHHOEFER: Well, what I was thinking is that we should present Mr. Gardner this week.

MR. ZAMARIN: Before we resolve this, could I at least --

CHAIRMAN BECHHOEFER: With the open question still of the results of the over-inspection. The only thing that I would think is that the over-inspection would show, for our purposes, the extent to which there was a need for corrective action. The number of non-conformances could seem to me to be relevant.

MR. ZAMARIN: Before this is resolved, I would appreciate the courtesy of having the opportunity to find out what is going on. That is why I simply suggested we do it immediately after the lunch break. I can't see that that will cause a scheduling problem. So far I haven't the faintest idea of what is going on.

CHAIRMAN BECHHOEFER: We can wait until after the lunch break to decide that, but our inclination at least is to try to at least take testimony on what I believe is relevant to the first partial initial decision that we have to make. And then the closeout will be a follow-up item perhaps.

MR. PATON: Judge Bechhoefer, I realize we are going to put this off until the Applicant has an opportunity to look into the matter, and I'm sure that we are moving on the correct path and we should do this. The only thing I thought I would like to put on the record is that Mr. Gardner is not going to want to take a position. He thinks he doesn't have enough information to take a position.

And I would think it would be better to, if we can, figure out a way to do this. If we get into this over-inspection, it's going to be discovery process and it's going to go on for a long time. If that is what we want to do, it's okay. But I am afraid it's going to go on a long time with no conclusion. At least our staff is not going to have a conclusion.

I don't think it would be productive to get into this subject today. But I can just see us spending a lot of time on it with no results, at least no conclusion from the Staff. Because the Staff's position now is we need more information to reach a conclusion. We can address it, it's fine with the Staff. But I am not sure how far we will get with it, and I don't think we need to address it to close the QA record.

JUDGE COWAN: Are you saying that there will be a change in his conclusion in his testimony in regard to the training only in regard to the over-inspection?

MR. PATON: I don't think so, Judge Cowan.

JUDGE COWAN: That is what we were all looking for.

MR. PATON: That is up to him, but I don't think there will be a change in this conclusion.

JUDGE COWAN: That is fine.

MR. PATON: That is his conclusion, not mine. I doubt if it will change. And I do think we can close the QA record without going into this over-inspection matter, if we understand that if something very important comes out of it, the Board can obviously reopen the record.

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JUDGE COWAN: But when you say close the record, I would interpret that that you are merely closing the record for this first preliminary decision.

MR. PATON: Yes.

JUDGE COWAN: Because the whole business will continue to come up, and if there is any change, it may be changed around.

MR. PATON: I agree. We address QA issues and there has got to become a time when we close the record,and I agree exactly with what you are saying.

CHAIRMAN BECHHOEFER: And for the purposes of first decision, the first question that Mr. Gardner is asked will be the crucial one and, of course, can be asked whether, given the results of the over-inspection, they are likely to change that, and that is one of the things that we can explore. We can ask that witness that.

MS. STAMIRIS: Your Honor, may I make some comments?

CHAIRMAN BECHHOEFER: All right.

MS. STAMIRIS: I feel very strongly that I do not want to write up supplemental findings if I cannot deal with this whole issue, because, after all, it came out of the 8112 inspection and the whole thing that we are talking about in this proceeding, and the main part of my findings that I have submitted deals with.

When Mr. Paton says he thinks we can close the QA record without having the resolution of this 100 percent over-inspection, I just do not like the idea of separating things out. I mean, what is the point? It seems another artificial distinction.

My position was that to separate the QA and have it be a separate initial decision was an artificial distinction in the first place. But it seems like we are making further artificial distinctions if we can take it on the record to have Mr. Gardner come in and say, "Yes, these men in my opinion meet the qualifications," and the QA qualifications are there, but then we do not even look at how they use those qualifications or what they do with them or what happened with them in the real construction and situations that are going on out at the plant.

To say that we somehow should look at that part of it but put the rest of it off and, you know, just wait and see if it merits re-opening the record, I think the difficult issues that we should try to deal with regarding attitude towards QA are something that is tied to this whole issue, and it is tied not only to the ultimate resolution or the ultimate outcome of the over-inspection, but with the whole process of how they have dealt with the problem in the first place and how many attempts it has taken Consumers to get to a point of -- I mean, I think we have to look at the whole picture and not just separate things out. If we can't do that --

CHAIRMAN BECHHOEFER: I think what they plan to-- well, we are thinking perhaps it could be held off, not the number of non-conforming positions that were found, but how they went around correcting it.

MS. STAMIRIS: Yes.

CHAIRMAN BECHHOEFER: And that is a little different.

MS. STAMIRIS: Well, I would prefer, if we are going to await the final results of the 100 percent over-inspection, which really I am not against as far as that goes --

CHAIRMAN BECHHOEFER: I have stated our inclination to. I had thought we were more or less adopting your earlier suggestion.

MS. STAMIRIS: Well, I guess what I am trying to say, and I should say more concisely, is I do not mind -- if we are going -- I do not want to have supplemental findings and have it be just on that one part just on the QA qualifications, but not on the final results and the whole process. If they are going to come back at some later time and tell us what the final results of this over-inspection were, then I would much rather wait and do the supplemental findings after that so the whole picture can be included. I do not want to put off the supplemental findings, but they have to be to get the whole picture.

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picture.

CHAIRMAN BECHHOEFER: I would prefer that to supplemental findings on not only the QC written matters, but the organizational matters and some other things. That is the kind of thing we would like to be able to wind up and then hold the corrective action. Corrective actions would be the final set of findings.

But we will talk about it more after lunch when we know a little more about what we have it.

MR. PATON: Judge Bechhoefer, a question.

MR. ZAMARIN: Go ahead.

MR. PATON: A question. I don't think you ruled, or have you ruled --

CHAIRMAN BECHHOEFER: I have not ruled on anything yet.

MR. PATON: That you are going to specifically address the over-inspections. Is that still under advisement?

MR. ZAMARIN: That is what I asked to be left until after lunch.

CHAIRMAN BECHHOEFER: We have not decided.

MR. PATON: Okay.

CHAIRMAN BECHHOEFER: In fact, we haven't decided if we will ask you to bring Mr. Gardner up here to deal with the first part of this testimony on the qualifications.

MR. ZAMARIN: One other matter. After my question for clarification from the Board yesterday morning as to what it was that they wanted to be informed of, I did relay that information to my client, and I wanted to let you know that a directive is going to be prepared to have any information that would have significant impact on issues before this hearing to be provided to the Board. At this point I would anticipate it may well be more than this Board wants. For example, I know I was asked by my client, "Well, what are you talking about?" I quite frankly had to tell him, "I'm not sure."

It is rather open-ended and I find it very difficult to deal with and it is something that obviously the lawyers are not going to be looking at everything that goes on in every piece of paper in order to make better judgments. One of the examples that I mentioned yesterday was an NCR. For example, there was an NCR that has been written with regard to a hole that has been drilled. I have told them those are the kinds of things that this directive should include and I think the best way to do this is if, after this thing gets going, that we would then like some further guidance from the Board. I don't know whether this is going to fill up your mailboxes so you cannot get any other mail or exactly what it is going to mean. But in discussing it with my client and with me being unable to give them a definition of what it is that they are supposed to be providing now as the matter of routine -- and again, it may well be no different than information we have been providing in the past. We do not know that and I just want to let you know that I did talk to them, that they are going to prepare a directive to provide this information.

I would then request some kind of further guidance from the Board after you do get, you know, our first package of materials as to whether that is really what you have in mind, because quite frankly I find it very difficult in the abstract and I think it is unworkable for me as counsel to the Applicant to be involved in everything and make independent judgments for them. At the risk of not doing that, though, in light of what guidance the Board gave me yesterday morning, is I think rather grave. So that is what we will do and we are doing the best we can, but I am not sure what we are doing.

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doing

CHAIRMAN BECHHOEFER: Well, we will look that over. You might ask Mr. Paton how it works out when lawyers have to look at everything that is sent to the Board. I think they dropped --

MR. ZAMARIN: I do not have a problem looking over everything that is sent to the Board, although I do have to admit that the amount of mail that I get from the NRC on this case, and, of course, this is the first proceeding I have been involved in, but it is just incredible, it really is. I mean, it is tremendous.

But really I think that I have no problem with that with the routine things. It is simply a matter that from Mr. Paton, from a discussion we had the first morning here where I had indicated that I thought things were preliminary and just because something comes up; for example, an allegation, that is not something that normally I would feel an obligation to bring before the Board until I found out what it was about. Apparently my view on that was not shared by the Board, and that is why yesterday I asked for some further guidance.

So really what I am talking about is things that would not or may not otherwise be directed particularly to the Board will now I think perhaps be directed and it may well be that the cut is that everything is being brought to the attention of the Board now. I do not know.

MR. PATON: Mr. Chairman, I have been resisting this, but I think when I get back, I am going to call Mr. Zamarin and give him the citation of that footnote.

MR. ZAMARIN: Oh, I am aware of that footnote and I have expressed my opinion as to how workable that thing is.

MR. PATON: Well, there it is.

MR. ZAMARIN: But I do not see everything. That is a little different. I am talking about things now that I do not see. Things that I see, I have no problem in making a judgment. I am saying that that goes beyond that and heretofore things that had not been routinely provided to the Board now ought to be, and since I do not review or intend to review every piece of paper, it is something that I have to tell my client now that things that I -- maybe you ought to have some kind of directive, and the real rub came when they said, "Well, what is it they want," and I said, "I don't know."

I suggested that we do what I am doing now and just tell you what we are doing and then that we would appreciate some feedback.

CHAIRMAN BECHHOEFER: What you are doing sounds about right. We will go into it. If you present too much, we will let you know.

MR. PATON: Judge Bechhoefer, I think right in the middle of this discussion about 20 minutes ago, I think I had asked when we might get together with Judge Harbour. Maybe after lunch when we get back to discussing this again Judge Harbour can indicate some time that would be convenient that we could have this --

JUDGE HARBOUR: Yes. I want to wait and see what the scheduling of the witnesses and the issues is.

MR. PATON: Oh, for this witness?

JUDGE HARBOUR: Yes.

MR. ZAMARIN: It is a good idea to wait until this afternoon.

MR. PATON: Fine.

MR. ZAMARIN: Our witness is here and we are ready.

CHAIRMAN BECHHOEFER: I think before we start we ought to take a short break.

MR. ZAMARIN: Fine, good.

(Brief recess.)

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CHAIRMAN BECHHOEFER: Back on the record.

MR. WILLIAMS: Mr. Chairman, the Applicant is presenting three witnesses: Donald F. Landers, Donald F. Lewis and James Meisenheimer. These witnesses have not been sworn and I would ask you do that at this time.

Whereupon, DONALD F. LANDERS

DONALD F. LEWIS

JAMES MEISENHEIMER

were called as witnesses by Counsel for the Applicant, having been first duly sworn by the Chairman, were examined and testified as follows:

DIRECT EXAMINATION

BY MR. WILLIAMS:

Q Mr. Landers, would you state your name and your position and your relationship to the Midland Project for the record, please.

A (WITNESS LANDERS) Donald F. Landers, Senior Vice President of Teledyne Engineering Services. I have been put under contract by Consumers to develop a ovalization criterion for piping.

Q Do you have before you a copy of a document entitled "Testimony of Donald F. Landers, Donald F. Lewis and James Meisenheimer"on behalf of the Applicant regarding underground piping and tanks at the Midland plant?

A (WITNESS LANDERS) Yes.

Q Did you prepare a portion of this testimony?

A (WITNESS LANDERS) Yes.

Q Could you state what that portion is?

A (WITNESS LANDERS) Section 3.5 relating to ovalization criterion.

Q Did you cause to be filed with this testimony an affidavit stating that that testimony was true and correct at the time it was filed?

A (WITNESS LANDERS) Yes.

Q I would like to ask you if you have any corrections to the portion of the testimony for which you are responsible.

A (WITNESS LANDERS) Yes, I do.

Q Would you state those corrections, please?

A (WITNESS LANDERS) On Page 25 there appears a table. The last two tables of that table require changing. The column entitled "Reduction in Flow Area of 4 percent Ovality," all the numbers in that column require changing. Beginning at the top, I will give you the new numbers only: .00134, .01156, .031, .20, and .39.

In the next column "Percent Reduction" all of those numbers change to .04 in every case.

JUDGE COWAN: .0 what?

A (WITNESS LANDERS) .04 in every case. That is the only change I have to the testimony as presented.

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CHAIRMAN BECHHOEFER: I take it the last column--the last line, the 36-inch pipe size, is not changed?

A (WITNESS LANDERS) Right.

BY MR. WILLIAMS:

Q Mr. Lewis, would you also state your name for the record and your position and your relationship to the Midland project?

A (WITNESS LEWIS) My name is Donald F. Lewis. I am employed by Bechtel Associates Professional Corporation. I am the engineering group supervisor and acting assistant project engineer for the licensing and safety in Midland project.

Q Do you have before you the same document, "Testimony of Donald F. Landers, Donald F. Lewis and James Meisenheimer on behalf of the Applicant regarding underground piping and tanks at the Midland plant"?

A (WITNESS LEWIS) Yes, I do.

Q Did you prepare a portion of that document?

A (WITNESS LEWIS) Yes, I did.

Q Could you state for the record what portion of this document you are responsible for?

A (WITNESS LEWIS) I am responsible for the testimony in the Sections 2.1, 2.2 and 3.5.

Q Did you file an affidavit stating that as of the time of filing that the sections for which you are responsible were true and correct to the best of your knowledge?

A (WITNESS LEWIS) Yes, I did.

Q Do you have corrections to make to that document?

A (WITNESS LEWIS) Yes, I do. On page 11, on the last line of the first paragraph where it reads "ASME Code (Reference 1)" I would like to clarify. "Reference 1" refers to the 1971 edition of the code. The allowable stress referred to in that sentence is based on part of the code that came into existence in 1977.

JUDGE HARBOUR: I didn't understand the clarification.

A (WITNESS LEWIS) The clarification, sir, is that rather than referring to the 1971 edition to the code as is the case by the existing text, the reference should be to the 1977 edition of the code.

JUDGE HARBOUR: Thank you.

A (WITNESS LEWIS) On page 13, on the second line of the second full paragraph, the paragraph starting "The pipe profile measurement technique is based on the manometer principle," insert a figure referred to UP-10. On page 15 in the second full paragraph on that page, the paragraph starting off "The ovalization data was collected," after the second sentence insert refer to Figure UP-11.

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11.

JUDGE HARBOUR: After the word "piping"?

A (WITNESS LEWIS) Yes, sir. On Page 34, the last line of the first paragraph following the numbered paragraphs near the top of the page -- let me read it: "These locations are indicated on the profile and ovalization plots, Figures UP-2 through 7, and on the monitoring location diagram, Figure UP-11." The correction is change Figure UP-11 to UP-13.

That is all the corrections that I have.

Q Now, in addition to corrections, do you have a substantive change in testimony to make as a result of events which have taken place during the last ten days?

A (WITNESS LEWIS) Yes, I do.

Q Could you state what that is, please.

A (WITNESS LEWIS) As a result of our inability to reach agreement with the Staff on the demonstration of the 36-inch diameter service water piping, I have been authorized by Consumers Power to say that we will replace that 36 diameter piping.

In my testimony I refer to Figure UP-13 which is a large fold-out drawing. The piping in question can be shown coming out of the service water pump structure. There are four lines coming out of that structure. These are the 36-inch diameter lines that I am referring to.

The legend -- or that drawing now shows that a portion of those lines will be redotted. The correction is that those lines should be annotated to show that they will be replaced.

The 36-inch portion is from the point at which the lines leave the structure to the point at which they make -- they tee off into two lines. In two cases it's about 30 feet from the structure, and in the other two cases, it's about 80 feet from the structure.

Q You are referring to the lines which are marked "36-inch OHBC 19, 36-inch OHBC 20, 36-inch OHBC 15 and 36-inch OHBC 16," is that not correct?

A (WITNESS LEWIS) That is correct. In addition, the drawing shows that anchor points will be monitored for those lines inside the service water pump structure. Those anchor point monitors should be deleted from the drawing.

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drawing

Q Are there any other monitoring points which should be deleted from the drawing as a result of this drawing?

A (WITNESS LEWIS) Yes, there are. It also shows strain gauge monitoring in 36-inch portion lines. They should be deleted from the drawing also.

Q Now, is there another -- does that complete your testimony on this subject of change?

A (WITNESS LEWIS) No, it does not. On Page 34, Point No. 4 on the upper part of the page, where it states that "The first anchor point of all the piping systems will be monitored as the piping enters a building," the statement should be added "with the exception of the 36-inch diameter piping entering the service water pump structure."

That completes my corrections with respect to the replacement of the 36-inch pipe.

Q Do you have an additional change in the testimony to make with respect to the settlement monitoring?

A (WITNESS LEWIS) Yes, I do. On Page 33 in Section 5, there is a discussion of our monitoring program. It presently does not include any discussion of settlement monitors on the pipe. We have agreed with the Staff to incorporate level monitors on the pipe. The number and location of these monitors are still being discussed and have not yet been agreed upon.

Q Does that complete the changes you wish to make in your portion of this testimony?

A (WITNESS LEWIS) Yes, it does.

Q Mr. Meisenheimer, I would like to ask you the same set of questions: Would you state for the record your name, your position and your relationship to the Midland Project?

A (WITNESS MEISENHEIMER) Yes, I am James Meisenheimer. I am the Supervisor of Geotechnical Engineering with Gilbert Commonwealth. I am presently on loan to Consumers Power to coordinate geotechnical activities related to the remedial soils work at Midland.

Q Now, do you have before you a copy of the document entitled "Testimony of Donald F. Landers, Donald F. Lewis and James Meisenheimer on behalf of the Applicant regarding underground piping and tanks at the Midland plant"?

A (WITNESS MEISENHEIMER) Yes, I do.

Q Did you prepare a portion of this document?

A (WITNESS MEISENHEIMER) Yes, I prepared Section 2.1 and 2.2.

Q Did you cause an affidavit to be filed that states this testimony was true and correct at the time to the best of your knowledge at the time of filing?

A (WITNESS MEISENHEIMER) Yes.

Q Do you have corrections to make which you have become aware of subsequently?

A (WITNESS MEISENHEIMER) Yes, I do. On Page 9 on the second paragraph, third line, the sentence should be corrected to read: "No consistent correlations can be established between lower profile areas and softer underlying fill soils or between higher profiles and stiffer underlying fill soils." Just add the word "consistent."

A second correction on that page: First paragraph in Section 2.2, the third line, "Borros anchors have been installed at nine locations," instead of eight.

Q Do you have further corrections?

A (WITNESS MEISENHEIMER) That is all.

Q Thank you. Now, I would like to ask all three of you if you all state that this testimony at the present time as corrected is true and correct to the best of your knowledge?

A (WITNESS LANDERS) Yes.

A (WITNESS LEWIS) Yes.

A (WITNESS MEISENHEIMER) Yes.

MR. WILLIAMS: Mr. Chairman, I move that the testimony be admitted into evidence and bound in the record as if read.

MR. BLUME: No objection.

MS. STAMIRIS: No objection.

MR. MARSHALL: No objection.

CHAIRMAN BECHHOEFER: Without objection, the testimony will be admitted into the record and bound in the record as if read.

(Prepared testimony of Donald F. Landers, Donald F. Lewi~ and James Meisenheimer follows:)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	Docket Nos. 50-329 OM
	)	50-330 OM
CONSUMERS POWER COMPANY	)	
	)	Docket Nos. 50-329 OL
(Midland Plant, Units 1 and 2)	)	50-330 OL

TESTIMONY

OF

DONALD F. LANDERS, DONALD F. LEWIS, AND JAMES MEISENHEIMER

ON BEHALF OF THE APPLICANT

REGARDING UNDERGROUND PIPING AND TANKS
AT THE MIDLAND PLANT

Midland Plant
Public Hearing Testimony

UNDERGROUND PIPING AND TANKS

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UNDERGROUND PIPING AND TANKS

1.0 BACKGROUND

1.1 SCOPE OF TESTIMONY

This testimony sets forth evidence regarding the present condition of the underground Seismic Category I piping and tanks at the Midland plant, regarding the ability of the piping and tanks to withstand postulated design conditions, including design basis safe shutdown earthquake forces, over the life of the plant, and regarding the ability to monitor the piping over the life of the plant to provide continued assurance of its capability.

1.2 DESCRIPTION OF PIPING

Four categories of buried Seismic Category I piping, ranging in size from 1½ inches in diameter to 36 inches in diameter, serve safety functions at the Midland Plant. The first category consists of the diesel fuel oil lines, which serve the emergency diesel generators. In this category are eight small-bore pipes, of which four are 1½ inches in diameter and four are two inches in diameter. These pipes provide fuel oil supply and return between the emergency diesel generators and four diesel fuel oil storage tanks buried in the vicinity of the diesel generator building.

The second category of piping consists of borated water lines, which provide borated water for emergency volume and reactivity control from the borated water storage tanks for normal functions and for such postulated accidents as a pipe break in the reactor coolant system. Four 18-inch pipes are included in this category.

The third category consists of piping in the service water system which supplies water to various systems needed under normal and accident conditions. Twenty-two lines, ranging from 8 inches in diameter to 36 inches in diameter, are included in this category.

The last category consists of piping and tanks in the control room pressurization system, which supply overpressurization air to the main control room from two tanks buried in the vicinity of the auxiliary building during postulated accidents such as releases of hazardous gases from offsite storage areas. One 4-inch pipe, one 1-inch, and 2 tanks are included in this category.

Table UP-1 contains a detailed listing of the Seismic Category I piping which is included in the scope of this discussion. Figure UP-1 indicates the locations of the buried piping and tanks. The diesel fuel lines run from the buried diesel fuel oil storage tanks northerly and then westerly to the diesel generator building. The borated water lines run a short distance in a generally southerly direction from the borated water storage tanks to the auxiliary building. The service water lines have the longest lengths, running from the service water pump structure to the auxiliary building and to the diesel generator building. The control room pressurization piping runs from the buried pressurization tanks westerly to the auxiliary building.

The diesel fuel oil lines, service water lines, and one of the control room pressurization lines are of carbon steel. The borated water lines and one of the control room pressurization lines are of stainless steel. The 18 inch and larger diameter pipes are seam welded, while the smaller lines are seamless. The pipes are fabricated in nominal lengths ranging approximately from 4 to 40 feet, fitted up, and welded. The welds are inspected and hydrostatically tested to assure integrity.

As has been previously indicated in this hearing, the construction excavations between the major power block buildings were filled with heterogeneous backfill material. Because of the location of the piping discussed herein and because of the depth at which it is buried, all of the pipes and associated tanks within the scope of this testimony rest on compacted backfill material.

As a result of the detection of insufficiently compacted fill material at a number of locations in the power block area, the Applicant initiated investigations to evaluate fill material contitions. Based on the results of the investigation the Applicant has undertaken a program of measurement, analysis and monitoring to assure that the buried piping and tanks can perform their intended functions throughout the life of the plant under both normal and accident conditions.

2.0 SOILS CONDITIONS AND PREDICTED FUTURE SETTLEMENT

2.1 RESULTS OF TEST BORINGS

As part of the investigation of the compaction of fill material conditions, extensive soil borings were taken throughout the power block area. Logs of exploration borings along the pipelines indicate that subsurface soil consists of heterogeneous compacted fill from ground surface at elevation 634 down to approximately elevation 600. The fill material rests on naturally occuring very dense sands and gravels or hard silty clays.

The heterogeneous compacted fill is primarily composed of silty clays and sandy clays that were excavated from on-site borrow areas. Contained within the site fill are pockets of sand and lean concrete placed during filling operations or during subsequent excavation and backfilling activities.

The records of exploration borings indicate that the consistency of the fill at the location of buried utilities, including piping, varies from soft to hard for silty clays and loose to dense for sands. Generally, the fill soils can be classified as medium stiff or medium dense below invert elevations of buried piping and other utilities. Exploration boring logs also indicate that the consistency of fill material can vary considerably in a vertical direction within a boring and also laterally, as evidenced by closely spaced borings.

Settlements that have been observed at buried utilities are primarily a result of the fill settling under its own weight. Areas that have been subjected to surcharge loading, such as the diesel generator building area and the borated water storage tank area, exhibit additional settlement from surcharging. The buried utilities add little, if any, weight to the fill and therefore have very little impact on present and future settlement below their invert elevations.

Depth profiles along pipelines were compared with subsurface conditions projected from adjacent exploration borings. No correlation could be established between lower profile areas and softer underlying fill soils or between higher profiles and stiffer underlying fill soils. In areas where closely spaced borings indicate stiffer soils and softer soils adjacent to one another, no abrupt differential variations were observed in the pipeline profiles.

2.2 PREDICTION OF MAXIMUM FUTURE PIPE SETTLEMENT

Records of monitored settlement within the fill have been utilized to predict future settlement for buried utilites. Borros anchors have been installed at eight locations in the vicinity of buried utilities not influenced by surcharge loadings. Settlement readings for anchors that have been established at depths of 7 feet to 12 feet below the surface were used in the analysis, since this depth is representative of the depth of most buried utilities. Soil conditions at these locations are representative of the variable soil conditions encountered throughout the fill.

Borros anchors BA 13, BA 14, and BA 34 were installed in December 1978. Settlement data have been taken on these anchors for over three years. Borros anchors BA 100 through BA 106 were installed in September 1979, and over two years of settlement data exist for these anchors. The plots of settlement verus log-time for each of these anchors form straight lines which extrapolate to 2.0 to 2.5 inches of additional settlement to occur over the next 40 years of anticipated plant life. Based on these projections, a conservative estimate of future maximum settlement of buried utilities is for not more than 3 inches of additional settlement to occur at any pipe location.

The maximum differential settlement along the longitudinal axis of buried utilities is anticipated to occur at anchor points, which may be at or near building entry. The maximum critical differential settlement expected along buried piping will be the difference between the future projected settlement of the building entered at the anchor locations and the maximum estimated settlement of the fill in which the pipeline is buried.

3.0 ASSURANCE OF SERVICEABILITY

The serviceability of the buried piping over the life of the plant will be assured by existing measurements and analysis coupled with a program of long-term monitoring, or by excavation, rebedding and rewelding particular piping as appropriate.

3.1 DIESEL FUEL PIPING AND STORAGE TANKS

The diesel fuel oil lines were installed in June 1980 after completion of the diesel generator building surcharge program. The small diameter flexible pipe in these lines can accept the predicted future plant fill settlement without exceeding allowable limits. The maximum settlement stress has been calculated assuming that the maximum value of three inches of predicted settlement was apportioned over a 40-foot span of pipe corresponding to the spacing between pipe footings. The highest stress value was 18 ksi. This value is well within the allowable stress of 45 ksi for these lines based on ASME Code (Reference 1).

The diesel fuel oil storage tanks were installed approximately two years after the fill was placed. This isolated the tanks from the effects of the initial settlement of the fill. The tanks were filled with water and the settlement monitored for approximately 8 months. The settlement of the tanks during this period was minimal (less than 0.2"). It has been estimated that the tanks will experience long-term settlement on the order of 1¼" during plant life. These buried tanks will settle with the surrounding soil. The connecting pipes will also settle with the tanks in the surrounding soil. Thus, the differential settlement between the pipes and tanks will be small. Nozzle loads due to settlement will be insignificant.

3.2 BORATED WATER PIPING

The borated water lines will be rebedded from the borated water storage tank valve pits to the dike around the outdoor tanks. These lines have been cut loose from the valve pits to isolate them from the settlement caused by the surcharge of the valve pits. This partial rebedding in conjunction with the existing program to monitor future settlement of the borated water storage tank and the auxiliary building will provide sufficient assurance of the continued serviceability of this piping.

3.3 CONTROL ROOM PRESSURIZATION LINES AND TANKS

This system was installed in early 1981 in a manner equivalent to that utilized for rebedding other piping. The late installation after the occurrence of major fill settlement in a manner equivalent to rebedding provides sufficient assurance of continued serviceability of the pipes and tanks in this system.

3.4 SERVICE WATER PIPING

3.4.1 Locations and Alignment

Extensive measurement data have been taken to define the present settled condition of the piping. The original position immediately after installation is less well defined. It is difficult to ascertain precisely how much of the current profile originated from settlement since installation and how much of it was due to the position of pipe after backfilling the pipe trench. For the purpose of assuring serviceability, it has been conservatively assumed that all deviations from design location are due to settlement.

In 1979 elevation or profile data were taken for one pipe line in each pipe trench. In June 1981 the Applicant retained Southwest Research Institute to develop a more accurate measurement technique and to reprofile all the service water piping which is 26 inches and larger in diameter using the new technique. The measurement technique uses pressure and ultrasonic tranducers and is accurate to 1/16 inch. The current location of the piping is very well defined from these accurately measured profile data taken at five foot intervals along the pipe length. The measurements have also identified the pipe spool weld joints. The pipe profiles for the large pipes are shown in Figs. UP-2 to UP-7.

The pipe profile measurement technique is based on the manometer principle. The technique measures changes in elevation by measuring the change in height of a reference water column. The instrumentation system maintains the reference water column constant and measures the change in pressure required to maintain the reference column of water at a constant elevation.

The components of the system consist of a water hose, water syringe, water level indicater, pressure transducer, ultrasonic transducer and several voltage readout devices. The pressure transducer is connected to the end of the water hose and the change in pressure is recorded as a change in voltage at the readout device. The ultrasonic transducer is used to monitor the reference column of water which is held constant by adding or removing water from the level indicator with the syringe. This reference is maintained very accurately by monitoring an electronic signal from this device.

The measurement procedure consisted of a series of steps. The piping was cleaned and the measurement locations were marked and the pipe spool length welds were identified. The measurement locations were chosen to be two inches on either side of the circumferential weld and at approximately five foot intervals along the pipe spool. At pipe fittings, measurements were taken at closer intervals. A datum point was then established for the particular piping run to be measured and the instrument system was calibrated to this datum elevation. Once the datum was established the water hose and pressure transducer was manually positioned on the marked measurement locations inside the piping. The change in elevation was recorded by reading the change in voltage at the pressure transducer readout meter. The results of these measurements show that the service water pipe is 8 to 12 inches from the design elevation in some extreme locations and the majority of the piping is on average approximately 5 inches from its design location.

3.4.2 Ovalization Measurements

The serviceability of the piping is indicated by out-of-roundness/ovalization measurement data. Measurement of ovalization is an indirect measurement of the stressed condition of the piping because ovalization of the installed piping is a function of the bending curvature of the piping. (See Section 3.5 below.) These ovalization measurements were taken internally at the same locations as the profile points of the piping.

A measurement arm and jig was fabricated by Southwest Research Institute to record the maximum and minimum diameters of the piping at a given cross-section. From this data the percent ovality can be calculated according to the ASME code equation: $(D_{max} - D_{min})/D_{nominal} \times 100$.

The ovalization data was collected at the same measurement locations identified for the 1981 profile data collection. The measurement instrument consisted of a sliding arm mechanism spring loaded to expand or contract to conform to the internal diameter of the piping. This measurement arm has a scale mounted onto it with two sliding blocks which indicate the maximum and minimum diameter. There is also an azimuth scale used to indicate angular position of the maximum and minimum diameters of a given cross-section of pipe. This measurement arm was mounted on a supporting jig designed to maintain the measurement arm perpendicular to the meridional axis of the pipe. At the fittings the arm had to be manually positioned at circumferential locations for a given pipe cross-section to obtain accurate data perpendicular to the meridional axis of the fitting.

The measurement procedure consisted of locating the longitudinal weld seam of the pipe and positioning the measurement arm against that seam. The measurement arm was then rotated around the internal circumference of the pipe cross-section and spring action of the arm maintained contact with the pipe wall. The sliding blocks on the diameter scale move to the maximum and minumum diameters of the cross-section. These diameters were recorded as data along with their azimuth position. Plots of ovalization measurements are also shown in Figs. UP-2 through 7.

The results indicate general ovalizations of 1 to 1.5% with some locations of 2% and greater. The maximum ovalization recorded was 3% in one 36 inch diameter pipe where the pipe enters the service water pump structure.

3.5 OVALIZATION CRITERION

3.5.1 General

When circular pipe is deflected from its normal linear configuration a change in the cross-sectional shape of the pipe accompanies the longitudinal deflection. As the pipe bends, the cross section changes from a circular to a generally elliptical or oval shape, with the minor axis parallel to the direction of bending. The change from circular to elliptical or oval shape is referred to herein as ovalization or ovality. A convenient numerical measure of ovalization is obtained by the formula $(D_{max} - D_{min})/D_o$, where Dmax is the length of the major axis, Dmin is the length of the minor axis, and Do is the nominal diameter.

It is known that if pipe becomes sufficiently bent (deflected), inward collapse of the pipe will eventually result. During such deflection, the pipe becomes increasingly ovalized. It is possible to relate deflection to impending collapse, but ovalization is a more sensitive and direct indicator.

The Applicant has available extensive data on actual ovalization values of the buried 26 inch and 36 inch pipe at the Midland site. This data allows direct assessment of the actual pipe condition as it relates to the possibility of collapse. With the ovalization data in hand, the next step is to develop a criterion whereby observed ovalization can be judged acceptable or unacceptable from an engineering standpoint.

3.5.2 Flow Preservation

The major point of concern with respect to pipe deformation is whether sufficient flow will be maintained in the piping systems to perform safety functions under all anticipated conditions. The amount of flow through any given pipe is a function of the flow area. As a pipe deforms and ovalizes, the flow area is reduced and ultimately may reach the point where sufficient margin does not exist on the design flow to assure the safety function.

The piping at Midland has ample margin to withstand minor diminution in area due to ovalization. However, actual collapse of the pipe must be prevented.

3.5.3 Collapse Phenomena

Ovalization leading ultimately to collapse can come about through either of two mechanisms: first, the application of a specific continuous load (moment) to the pipe, and second, the imposition of a specific deflection on the pipe. There is a significant difference between these mechanisms with respect to the implications of a critical point in the ovalized condition indicating impending collapse.

Fig. UP-8 illustrates the difference in behavior depending on whether load or deflection is applied. A simple hollow-cylindrical beam is clamped on one end and a load (F) applied. In the process of applying the load (F) a continuous measurement of ovalization and deflection (δ_1) is made so that the value of the deflection at which the ovality in the pipe reaches a critical point can be ascertained (Fig. UP-8(a)). If the load (F) is still applied after this point, the pipe will continue to deform and ovalize with no load increase and will collapse rapidly, essentially shutting off flow completely (Fig. UP-8(b)). This is commonly referred to as "load controlled" deflection and collapse.

The second mechanism, deflection, is represented in Figs. UP-8(c) and UP-8(d). In Fig. UP-8(c), the deflection (δ_1) measured in Fig. UP-8(a) at the critical ovalization is applied. Since the end of the pipe is deflection limited, the critical ovality is reached, but uncontrolled collapse will not occur, since the end of the pipe is, by assumption, not forced to deflect further. Should subsequent deflections be applied (δ_2, δ_3), the critical ovality will be exceeded but uncontrolled collapse will still not occur since the motion of the end of the pipe is controlled. This is commonly referred to as a "deflection controlled" phenomenon. The above distinction is essential, since the situation at Midland involves a "deflection controlled" phenomenon. In this situation, piping will not proceed to collapse unless substantial additional deflection is brought about.

The term "collapse" is frequently used to describe different phenomena. As indicated above, in a "load controlled" situation the inability of the specimen to maintain the level of applied load is often referred to as "collapse." The discussion above indicates that, for the buried pipe at Midland, this is an inappropriate definition since the concern is deflection rather than load. A pipe which has reached the point of maximum load capacity can still be deflected further without seriously diminishing its ability to carry required flow. Furthermore, in some "load controlled" tests the applied load decreases at the time of bifurcation but then can be increased again after this phenomenon occurs.

For large (D/t) ratios (pipe diameter divided by wall thickness) (in the range of that of the 36" pipe at Midland) another phenomenon occurs which is also often referred to as "collapse." This phenomenon is more correctly defined as wrinkling or bifurcation. In this phenomenon, the pipe wall in the compression zone of the bending field develops wrinkles and eventually bifurcates in the local region. This bifurcation occurs as a result of the high compressive membrane stress in the local region. It should be recognized that this effect is local and has a minimal effect on the flow area. For a pipe which has developed a local bifurcation, substantial further deflection can be applied and the ovalization process can continue. That is, the pipe has not "failed" with respect to serving its intended function. Thus wrinkling is also an inappropriate definition of "failure."

3.5.4 Data Review

In order to develop a criterion for an allowable value of ovalization for piping at Midland a literature survey was performed. A summary of the critical ovalization data obtained from that survey is presented in Table UP-2. A plot of all data presently available to the Applicant is shown in Fig. UP-8A.

It should be recognized that all of the data are for "load controlled" tests and the distinctions made in Section 3.5.3 with respect to "deflection controlled" test data are applicable. Since "load controlled" critical ovalization is a more conservative measurement than "deflection controlled" collapse, use of a safety factor of as 1.5 between estimated "failure" point and the allowable is appropriate.

Additionally, significant information was uncovered which is not in the form of data but addresses the occurrence of ovalization in buried pipe and provides design guidance. This information supports the data in Table UP-2 and indicates that ovalization of less than 5% are of no concern. These sources suggest that there is no need to consider the collapse phenomenon at all at these values. A list of these sources is given in Reference 3.

3.5.5 Ovalization Criterion

The data exhibited in Table UP-2 and plotted in Fig. UP-8A show considerable scatter. However, an approximate best fit line would indicate a minimum critical ovalization of about 8% for the largest piping at Midland. Application of a conservative safety factor of two would suggest appropriate acceptance ovalization of approximately 4%.

In order to incorporate additional conservatism, however, the Applicant has also conducted an analysis based on the lowest data points. As the following analysis will indicate, these data, excerpted from the work of Merwin and others (Ref. 3 to Table UP-2), must be corrected for yield strength of pipe wall material to be valid. In addition, because of the conservatism already built into the data selection and the testing procedure, a safety factor of 1.5 is appropriate. On the basis of the analysis described below, the Applicant believes that acceptance criteria of 4% for 26-inch pipe and 3% for 36-inch pipe are extremely conservative but are acceptable at this time.

(1) General

The distinction established in Subsection 3.5.3 between the two uses of the term "collapse" is significant in establishing an appropriate ovalization criterion. It appears that bifurcation rather than true collapse occurred in tests reported by Merwin (Reference 3 to Table UP-2). This is substantiated by the data reviewed above. Further, other data available to Merwin indicate that two other tests at a (D/t) ratio of 96 resulted in 6.6% and 5.6% ovality values respectively. Merwin has indicated that in all cases ripples developed in the compression zone during loading. These ripples were approximately 1/16" to 1/8" in magnitude. At the point at which failure on a load carrying basis was reported, one of the ripples would predominate and form a wrinkle (bifurcation) of approximately 1/2" depth. Additional curvature was recorded and the pipe was deflected further without collapse after the bifurcation was produced.

Bouwkamp tested seven specimens of 48-inch diameter pipe with a (D/t) ratio of about 100. The tests were performed under combined bending and axial compression and also included internal pressurization. That author reported longitudinal bending strains prior to buckling (Specimens 1 to 4) in the range of 0.31% to 0.68%, which for a 48-inch diameter pipe represent ovalities of 4.8% to 22.8% respectively. For the remaining specimens (e.g., 5, 6 and 7) Bouwkamp did not clearly indicate the buckling point. In addition, Specimen 5 underwent an atypical two-part loading sequence. Specimen 6 was 0.10 inches in thickness, thicker (D/t = 85) than all others and Specimen 7 was of spiral-weld design.

Three of Sorenson's tests were identified as "not good tests" in his report since failure occurred at a support, indicating improper loading.

(2) Comparison with Code Criteria

Paragraph ND-3552.3(b) of the current ASME Code addresses th` problem of a single deflection of a pipe as follows:

> the effects of any single nonrepeated anchor movements shall meet the requirements of Equation (10a):
>
> $$\frac{i\,M_D}{Z} \leq 3.0\,S_c \qquad (10a)$$
>
> Terms same as in ND-3652.1 except:
>
> M_D = resultant moment due to any single nonrepeated anchor movement (such as predicted building settlement), in lb.

Using Equation (10a) of the Code an equivalent ovalization criterion can be developed. Collapse is a yield strength phenomenon, and the equation:

$S_c = 2/3\ S_y$ (2/3 yield strength)

applies.

The measured yield strength of the 36" pipe is 50,000 PSI. Using $2\,S_y$ = 100,000 PSI and Young's Modulus (E) = 30×10^6, strain at yield can be calculated as follows:

$$\epsilon = \frac{2\ S_y}{E} = \frac{100,000}{30 \times 10^6} = 0.0033$$

Using the relationship between strain and ovalization set forth in Subsection 3.5.7 and Fig. UP-9, the corresponding ovality for this strain is 4.6%.

(3) Yield Strength vs. Ovality

Professor Merwin's data support the conclusion that ovalization at bifurcation is a strong function of material yield strength. Computer modeling analyses of pipe collapse also indicate that as the yield strength of the material increases bifurcation will occur at lower ovalities.

Using Merwin's data, a curve of ovality versus yield strength plots as a straight line, as shown in Figure UP-8B. This plot indicates that for material at approximately 64 KSI yield strength, zero ovality would result in failure. This is not a physically meaningful result; the curve should properly become asymptotic to zero ovality. However, interpolation rather than extrapolation should be accurate on a straight line basis.

In Figure UP-8C the yield strength values of the 26-inch (45 KSI) and 36-inch (50 KSI) buried pipes at Midland have been shown on the "Design Curve." These values are shown as 6.25% and 4.6% ovality respectively. Using a safety factor of 1.5 based on the above-described difference between load controlled testing and deflection controlled application, the design curve figures must be multiplied by 2/3 to obtain safe limits. Figure UP-8C indicates that two-thirds of the "Design

Curve" value for 26-inch pipe results in an ovality limit of 4.17%. Taking two-thirds of the "Design Curve" value for 36-inch pipe results in an ovality limit of 3.06%. These values provide a margin of 1.5 on the lowest meaningful data points available.

3.5.6 Ovalization vs. Flow Area

Since the real concern is sufficient flow to assure safety function, it is necessary to compare the criterion with reduction in flow area to determine if it is significant.

Pipe Size	Nominal Flow Area (in^2)	Reduction In Flow Area of 4% Ovality (in^2)	Percent Reduction
2	3.356	.00174	.05
6	28.9	.0213	.07
10	78.9	.0773	.10
26	501	.46	.09
36	976	.39	.04

Based on the foregoing, the reduction in flow area at 4% ovalization is shown to be insignificant.

3.5.7 Conversion to Strain Criterion for Monitoring

Since in actual operation the piping under discussion will be filled with fluid, direct internal measurement of ovalization will be impossible. However, ovalization is related simply to longitudinal strain in the pipe, and sensitive and durable instrumentation (see section 5.2 below) is available to measure longitudinal strain. As a result, longitudinal strain will be monitored and converted to ovalization for comparison to the foregoing ovalization criterion.

The theory relating longitudinal strain to ovalization is developed in Reference 4. The equation relating strain to ovalization is

$$\text{Oval.} = \frac{D_{max} - D_{min}}{D_0} = \frac{D_0 - 2W_{90}) - (D_0 - 2W_0)}{D_0}$$

$$= \frac{2(W_0 - W_{90})}{D_0}$$

where

$$W_0 = \varepsilon \frac{\nu a}{2} + \frac{a\varepsilon^2(1 - \nu^2)}{(t/a)^2} \left[1 - \frac{\varepsilon\nu}{16}\right] \qquad W_{90} = - \frac{a\varepsilon^2(1 - \nu^2)}{(t/a)^2}$$

In these equations

a = mean radius
t = thickness
ε = longitudinal strain
ν = Poisson's ratio

A graph of these equations using values appropriate for the 26-inch and 36-inch service water pipe is shown in Fig. UP-9. These curves will be used to convert strain measurement to ovalization.

4.0 STRESS ANALYSIS OF BURIED PIPE

4.1 SEISMIC LOADS

Earthquakes can in principle exert two kinds of influences on buried pipes: faulting and shaking. Faulting is the direct shearing displacement of bedrock which may carry through to the ground surface. However, surface faulting is not a factor in the design of a nuclear power facility at the Midland site (Reference 2). Therefore, faulting was excluded from consideration in the seismic analysis of the buried piping which supports this testimony.

The effects of ground shaking on buried piping are:

1) Axial tension and compression due to traveling seismic wave

2) Shear and bending due to traveling seismic wave

3) Strain caused by dynamic differential movement at connections.

For very long, straight pipes the analysis is based on the assumption that there is no relative motion between the pipe and the surrounding soil. Seismic stresses in the pipe are calculated from the maximum soil strain in the surrounding soil due to the passage of seismic waves. For short pipes, slippage may occur between the pipe and soil and the calculated axial stresses will be proportionately less than those assuming the pipe strain equal to the soil strain. The effects of bends or tees and differential displacements at connections to buildings are analyzed using procedures based on equations for beams on elastic foundations.

The calculated seismic stresses are combined with stresses from other loading conditions according to the recommended appropriate ASME code equations for the final design.

4.1.1 Maximum Soil Strain

To determine the maximum soil strain, the maximum axial and bending strains due to the different types of seismic waves were calculated. The seismic waves considered were:

1) Compression wave
2) Shear wave
3) Surface (Rayleigh) wave

The maximum axial and bending strains for each wave type were based on the wave propagation velocity, maximum particle velocity and maximum particle acceleration corresponding to each wave type. For example, the maximum axial strain due to a compression wave is calculated by:

$$\varepsilon_{ap} = \pm \frac{V_{mp}}{C_p} \cos^2\theta$$

where:

ε_a = maximum axial strain due to a compression wave

C_p = compression wave propagation velocity

V_{mp} = maximum compression wave particle velocity

θ = angle of incidence of the propagating wave measured from the longitudinal axis of the pipe. The maximum axial strain will occur when $\theta = 0$.

The value of wave propagation velocity used was the effective velocity of the ground motion disturbance past the pipe. For the Midland site, the effective velocity of the ground motion disturbance is the wave velocity of the underlying bedrock. (For further explanation of this point, see Reference 5.) The wave propagation velocities of the underlying bedrock at the Midland site were determined from on site tests conducted by Weston Geophysical Engineers, Inc. The bedrock wave velocities are:

Compression wave	10,000 fps
Shear wave	5,000 fps
Surface wave	4,675 fps*

The values of maximum particle velocity and acceleration for each wave type were conservatively assumed to be equal to the maximum site acceleration and velocity for the particular earthquake under consideration, either Operating Basis Earthquake (OBE) or Safe Shutdown Earthquake (SSE).

The maximum axial and bending strains for each type of seismic wave were combined by the square root of the sum of the squares method. The maximum combined axial and bending strains were added to find the maximum soil strain.

4.1.2 <u>Bends and Tees</u>

In the case of a long straight pipe buried in the soil, the transfer of soil strain as axial strain into the pipe depends on the end bearing of the pipe against the soil and the frictional resistance between the pipe surface and the

*Calculated from the compression and shear wave velocities.

soil. Portions of the pipe far from the ends are assumed to move and deform with the soil. At the ends, frictional resistance will develop for some length along which the pipe will displace relative to the surrounding soil due to strain incompatibility between the soil and the pipe.

In the case of a bend, the transverse leg is assumed to deform as a beam on an elastic foundation due to the axial force in the longitudinal leg (the leg parallel to the direction of maximum soil strain.) The pipe bends were analyzed as flexible bends with the flexibility coefficients calculated in accordance with Reference 1. Each bend was analyzed twice (once for maximum soil strain parallel to each leg). The results from the two analyses were combined by the square root of the sum of the squares method.

The modulus of subgrade reaction (spring value for the elastic foundation) was based on the shear modulus (G) of the soil. The shear modulus is calculated as follows:

$$G = \rho C_s^2 (\alpha)$$

where:

ρ = Mass density of the soil

C_s = Shear wave velocity of the soil

α = Ratio of soil shear modulus at seismic strain to the shear modulus at low shear strain (10^{-4}%)

The value of shear wave velocity used was 500 fps and was determined by onsite testing. This value is the shear wave velocity in the fill at the level of the pipe and is not the same as the value used in the calculation of the maximum soil strain. The value of the ratio is determined from a relationship developed by Seed and Idriss for sands and depends upon the soil shear strain due to the deflection of the pipe through the soil.

Since the soil prope.ties depend upon the deflection of the pipe and the deflection of the pipe depends upon he soil properties, an iterative procedure must be used to arrive at the final solution. The steps of the procedure are as follows:

1) estimate deflection
2) calculate soil properties
3) calculate new deflection
4) compare deflections
   - if within required accuracy - stop
   - if not -- use new deflection as an estimate and go to step 2

The analysis of tees is the same as that for bends except for the equations used in calculating deflections.

4.1.3 Connections

The connections of all buried Seismic Category I piping, except some of the diesel fuel lines, to buildings at the Midland site are considered to be free connections. That is, there is no rigid attachment at the points where the pipes penetrate the buildings. The first anchors inside the buildings are normally several feet away from the penetration. Therefore, the seismic analysis of the pipes at the penetrations did not consider stresses. Instead, the maximum differential movements between the pipes and the buildings were calculated.

The differential movements between the pipes and buildings consist of two parts: the movements of the pipes relative to the soil and the movements of the buildings relative to the soil. The movements of the pipes in the soil are determined by calculating the axial slippage and rotation at the free ends due to he maximum soil strain. The movements of the buildings are determined independently from the building seismic analyses and are added directly to the pipe movements to arrive at the maximum differential movements. The maximum differential movements between the pipes and buildings are included in the seismic analyses of the piping systems inside the buildings from which pipes stresses at the penetrations are determined. For the lines that are fixed at the building penetrations, some of the diesel fuel lines, the analysis is performed by assuming the lines to act as beams on elastic foundations with the building displacements as input.

4.2 COMPARISON TO ASME CODE ALLOWABLES

The computed seismic loads have been combined with other loads in accordance with Reference 1. The following code equations were used:

1) Equation 8
2) Equation 9 (normal and upset condition)
3) Equation 10
4) Equation 11

Table UP-2 sets forth the preliminary results of the comparison of the computed loads to allowables. The stress allowables are taken from the ASME Code Appendix I (Reference

1) for the materials and operating temperature relevant to the piping under discussion. As the Table indicates, in all cases the code requirements are satisfied.

5.0 MONITORING

The effect of future soil settlement on the service water piping will be monitored using externally mounted strain gage instruments located at various points along the piping system. This technique will allow the Applicant to directly measure the change in internal energy of the pipe wall due to the settlement of the soil.

5.1 MEASUREMENT OF PIPE STRAIN

The measurement of pipe strain will be made using a strain gage attached directly to the surface of the pipe buried in the ground. Some local excavation at the selected monitoring stations will be necessary to attach the instruments. The piping and instrument would then be covered with soil. The strain gage selected is a reliable vibrating wire strain gage. It is used in geotechnical practice and in the mining industry and also has been used to measure the effect of subsidence on oil and gas piping systems. The instrument is a passive mechanical component which requires excitation at the critical frequency of the wire lengths only when a measurement is to be recorded.

5.2 MONITORING INSTRUMENTATION LOCATIONS AND MONITORING FREQUENCY

The criteria to determine where monitoring stations will be located were established from the ovalization measurement data collected on the piping system in the summer and fall of 1981. The following criteria were used:

1. Monitor all points in a pipeline with present ovalization measurements two percent or larger.

2. Four points would be the minimum number of selected points per pipeline if Item 1 was not fulfilled. The remaining points would be selected based on the highest magnitude of ovalization.

3. One monitoring point per pipeline was selected on the basis of highest seismic stress. This seismic point is inclusive in fulfilling the four-point minimum requirement.

4. The first anchor point of all the piping systems will be monitored as the pipe enters a building.

These locations are indicated on the profile and ovalization plots, Figs. UP-2 through 7, and on the monitoring location diagram, Fig. UP-11.

The monitoring frequency selected is consistent with the measurement program for future settlement readings to be taken at the various buildings on the plant site. We have selected the following monitoring schedule:

1. Monitor all 65 stations at 90-day intervals for the first 5 years of plant operation.

2. After the fifth year, monitor the 24 anchor stations on a yearly basis. The need to continue monitoring the field stations will be evaluated at this time from time history plots of the collected data.

3. In case of a seismic event, monitor all stations immediately to ensure the reliability of the service water piping.

4. If the technical specification limit (not yet defined) is reached at a monitoring station, the monitoring frequency shall be increased to a monthly basis at that point until remedial action is taken.

6.0 CONCLUSION

The Applicant has undertaken a program of measurement, analysis, and monitoring to assure that the seismic Category I buried piping and tanks at the Midland nuclear site can perform their intended functions throughout the life of the plant under both normal and accident conditions. The measurement programs have demonstrated that most of the piping and tanks are presently in an acceptable and functionally capable condition. Marginal lines are being modified. Analysis has demonstrated that the piping and tanks have substantial margins to allow for anticipated conditions during the life of the plant. These analyses considered the predicted fill settlement, piping ovality, and seismically induced stresses.

A monitoring program has been identified that utilizes strain gauges located at various points along the piping. The acceptance criteria for the monitoring have been established based on highly conservative considerations of acceptable ovality. This monitoring program assures that the piping condition will be known and acceptable throughout plant life.

REFERENCES

1. American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section III, Rules for Construction of Nuclear Power Plant Components, Division 1, Subsection ND (1971 ASME Code with addenda through Summer 1973).

2. Midland FSAR, Rev. 39, subsection 2.5.3.

3. Available Information:

   3.1 "Buried Pipelines - A Manual of Structural Design and Installation."

   3.2 R.E. Barnard, "Design and Deflection Control of Buried Steel Pipe Supporting Earth Loads and Live Loads."

   3.3 "Steel Pipe Design and Installation," American Water Works Association.

   3.4 G.G. Meyenkof and C.L. Fisher, "Composite Design of Underground Steel Structures."

   3.5 M.G. Spangler, "The Structural Design of Flexible Pipe Culverts."

   3.6 M.G. Spangler and Donovan, "Applications of the Modulus of Passive Resistance of Soil in the Design of Flexible Pipe Culverts."

   3.7 E.C. Rodabaugh, S.E. Moore, "Evaluation of the Plastic Characteristics of Piping Products in Relation to ASME Code Criteria," NUREG/CR-0261.

   3.8 J.G. Bouwkamp, R.M. Stephen, "Large Diameter Pipe Under Combined Loading," ASCE Journal of Transportation, Volume 99, 1973.

4. J.D. Wood, "The Flexure of a Uniformly Pressurized Circular, Cylindrical Shell," Journal of Applied Mechanics, December 1958, Pages 453-458.

5. M.J. O'Rourke, S. Singh, R. Pikul, <u>Seismic Behavior of Buried Pipelines</u>, Lifeline Earthquake Engineering -- Buried Pipelines, Seismic Risk, and Instrumentation. Third National Congress on Pressure Vessels and Piping (San Francisco, California, June 25-29, 1979).

TABLE UP-1

SEISMIC CATEGORY I LINES

A. Service Water Lines

8"-1HBC-310	26"-OHBC-53
8"-2HBC-81	26"-OHBC-54
8"-1HBC-81	26"-OHBC-55
8"-2HBC-310	26"-OHBC-56
8"-1HBC-311	26"-OHBC-15
8"-2HBC-82	26"-OHBC-16
8"-1HBC-82	26"-OHBC-19
8"-2HBC-311	26"-OHBC-20
10"-OHBC-27	36"-OHBC-15
10"-OHBC-28	36"-OHBC-16
	36"-OHBC-19
	36"-OHBC-20

B. Diesel Fuel Oil Lines

1-1/2"-1HBC-3	2"-1HBC-497
1-1/2"-1HBC-4	2"-1HBC-498
1-1/2"-2HBC-3	2"-2HBC-497
1-1/2"-2HBC-4	2"-2HBC-498

C. Borated Water Lines

18"-1HCB-1
18"-1HCB-2
18"-2HCB-1
18"-2HCB-2

D. Control Room Pressurization Lines

4"-ODBC-1
1"-OCCC-1

TABLE UP-2

CRITICAL OVALIZATION MEASUREMENTS

Investigator	Date	D/T	% Ovality at Collapse	Reference No.
Sorenson	1970	99.8	9.	2
		75.	6.	2
		54.6	3.2	2
		40.5	4.0	2
		62.	11.0	2
		55.3	6.0	2
		51.4	8.0	2
		48.6	10.0	2
		39.8	10.8	
Reddy (Steel)	1978	67	9.0	1
		51	11.8	1
Wilhoit & Merwin	1972	78	3.0	3
		62	8.0	3
		46	8.0	3
		31	no failure	3
Merwin		96	6.6	*
		96	5.6	*

Table References

1. B.D. Reddy, "An Experimental Study of the Plastic Buckling of Circular Cylinders in Pure Bending," International Journal of Solids and Structures, Volume 15, Pages 669-683.

2. J.E. Sorenson, et al, "Buckling Strength of Offshore Pipelines," Battelle Memorial Institute, July 13, 1970.

3. J.O. Jirsa, Fook-Hoy Lee, J.C. Wilhoit, and J.E. Merwin, "Ovaling of Pipelines Under Pure Bending," 4th Annual Offshore Technology Conference, May 1972.

*Private Communication.

TABLE UP-3

ASME CODE CHECK - PRELIMINARY STRESS SUMMARY FOR BURIED S.W. PIPING

Stresses in PSI

		Normal EQ. 8		Upset EQ. 9		Faulted Code Case 606		Thermal EQ. 10	
Line No.	Description	Actual Stress	Allowable Stress	Actual Stress	Allowable Stress	Actual Stress	Allowable Stress	Actual Stress	Allowabl Stress
36/26-OHBC-15	S.W. Supply	2442	17,500	6060	21,000	12,536	42,000	5,214	26,250
36/26-OHBC-16	S.W. Return	2442	17,500	7505	21,000	26,383	42,000	10,420	26,250
36/26-OHBC-19	S.W. Supply	2442	17,500	9190	21,000	26,953	42,000	10,814	26,250
36/26-OHBC-20	S.W. Return	2442	17,500	9190	21,000	27,232	42,000	21,613	26,250
26 -OHBC-53	S.W. Supply	1742	17,500	5438	21,000	17,378	42,000	12,513	26,250
26"-OHBC-54	S.W. Return	1742	17,500	5218	21,000	22,223	42,000	25,009	26,250
26"-OHBC-55	S.W. Supply	1742	17,500	4370	21,000	13,802	42,000	13,857	26,250
26"-OHBC-56	S.W. Return	1742	17,500	5296	21,000	13,582	42,000	--	--
10"-OHBC-27	S.W. Supply	695	15,000	5740	18,000	14,750	36,000	------- Not A	
8"-1HBC-81	S.W. Supply	695	15,000	5740	18,000	14,750	36,000	------- Not A	
8"-2HBC-310	S.W. Supply	695	15,000	5740	18,000	14,750	36,000	------- Not A	
8"-1HBC-310	S.W. Supply	625	15,000	2625	18,000	8,077	36,000	------- Not A	
8"-1HBC-311	S.W. Return	625	15,000	1297	18,000	9,875	36,000	------- Not A	
8"-2HBC-81	S.W. Supply	625	15,000	2625	18,000	5,462	36,000	------- Not A	
8"-2HBC-82	S.W. Return	625	15,000	1455	18,000	5,864	36,000	------- Not A	
10"-OHBC-28	S.W. Return	695	15,000	4403	18,000	12,155	36,000	------- Not A	
8"-1HBC-82	S.W. Return	695	15,000	4403	18,000	12,155	36,000	------- Not A	
8"-2HBC-311	S.W. Return	695	15,000	4403	18,000	12,155	36,000	------- Not A	

*Analyses are underway. These analyses will not affect the outcome of the settlement assessment.

e	EQ. 11 Actual Stress	EQ. 11 Allowable Stress
	--	--
	--	--
	--	--
	--	--
	--	--
	--	--
	--	--
	29,437	43,750
nalyzed*	-------	
nalyzed*	-------	
nalyzed*	-------	
nalyzed*	-------	
nalyzed*	-------	
nalyzed*	-------	
nalyzed*	-------	
nalyzed*	-------	
nalyzed*	-------	
nalyzed*	-------	

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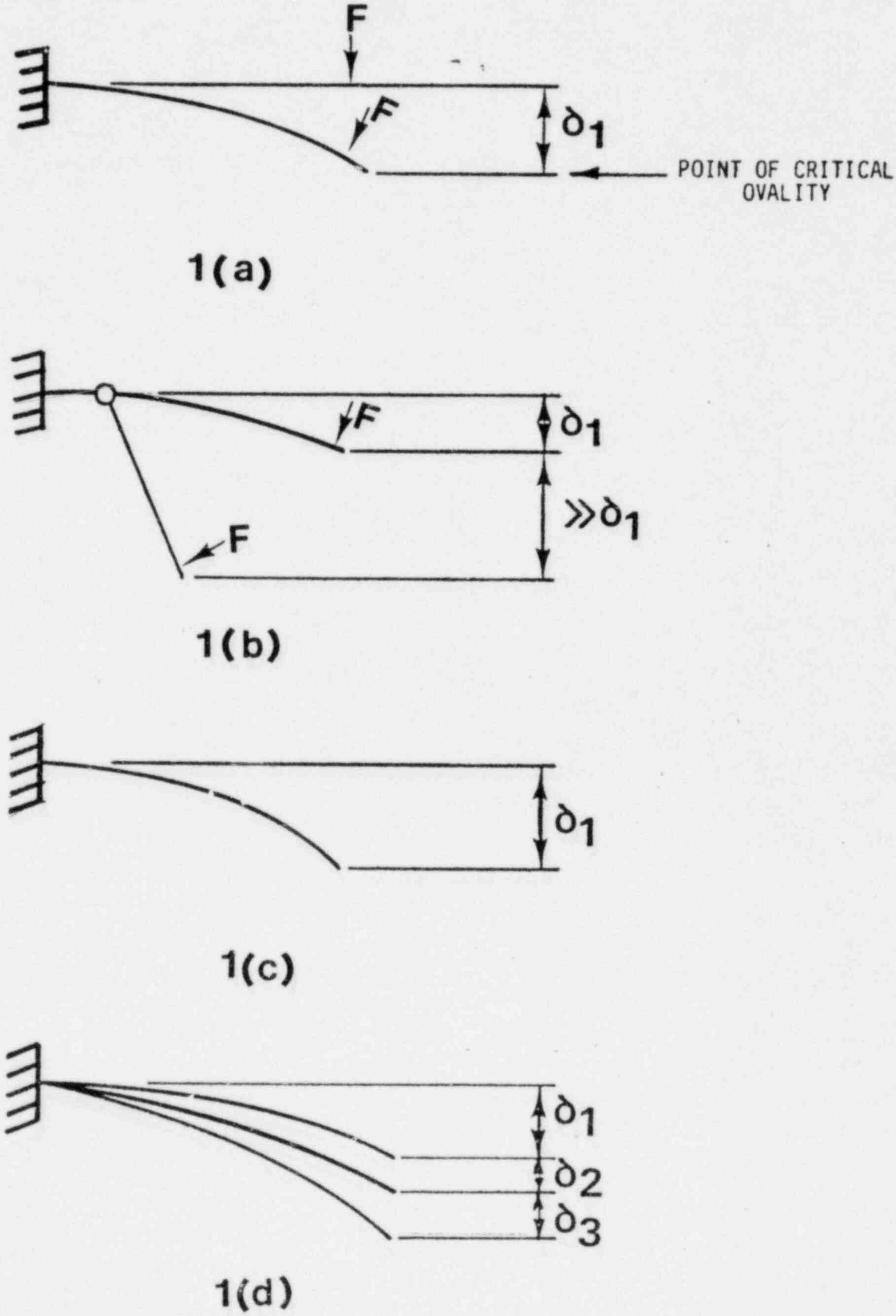
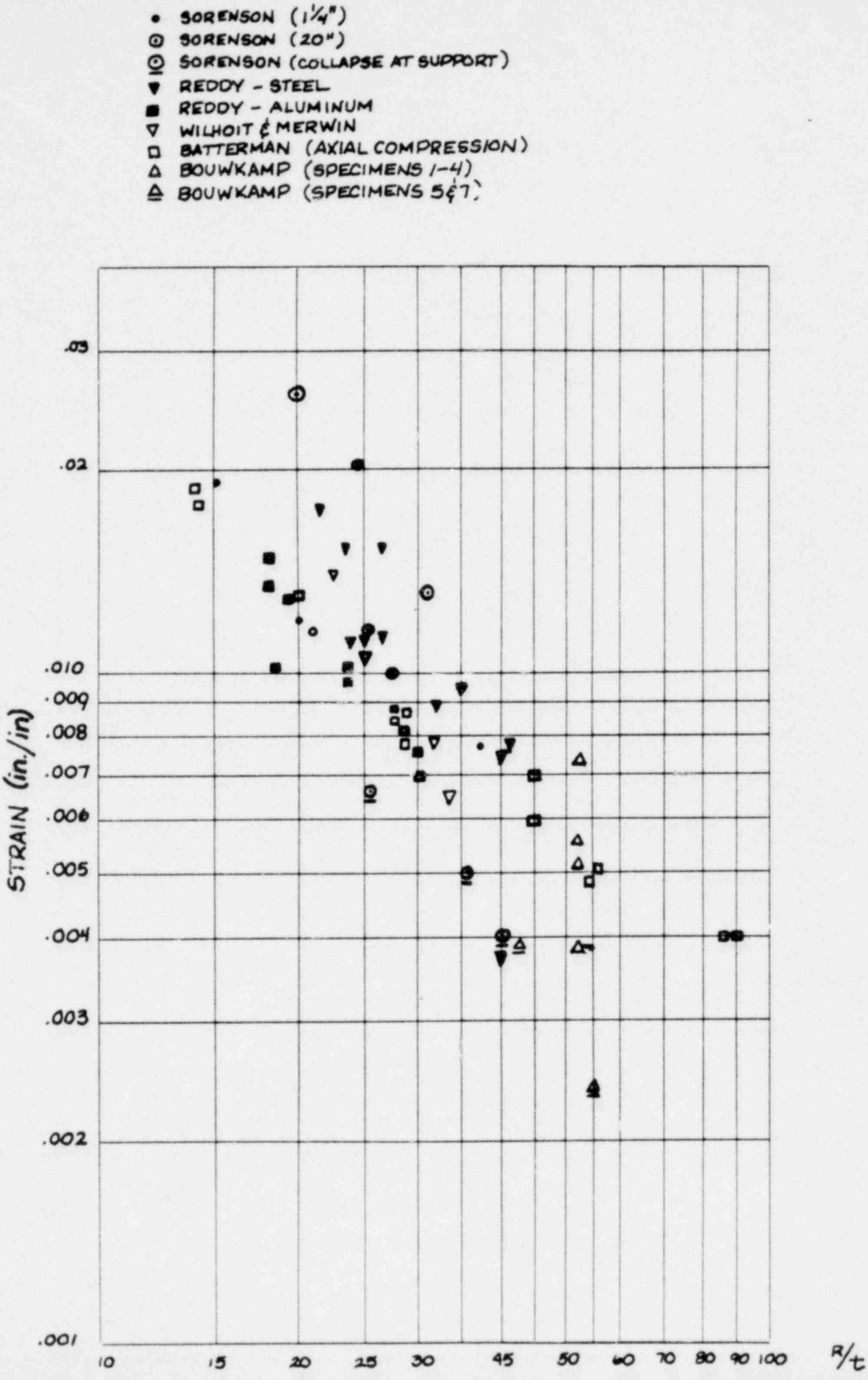
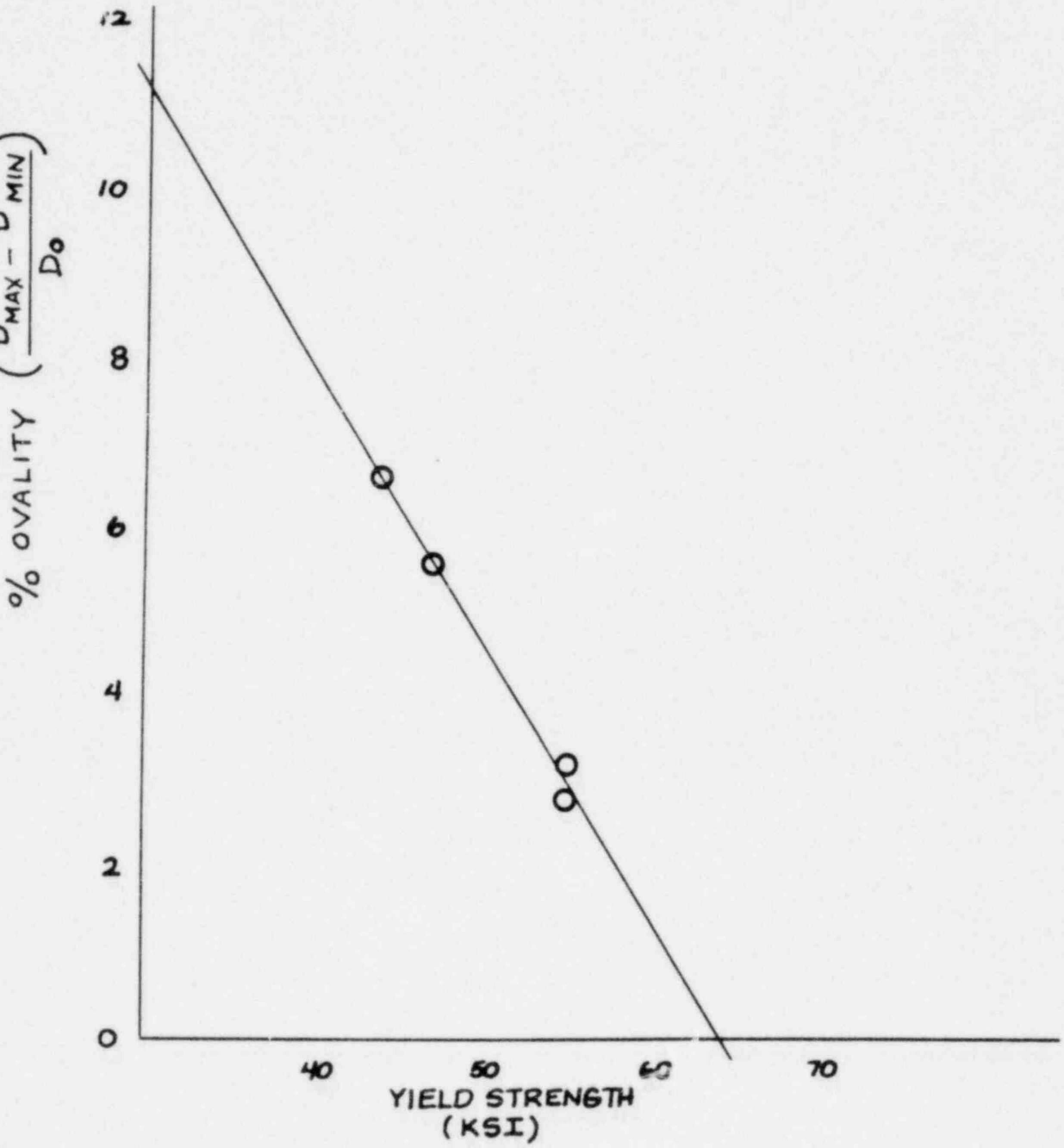

F
F
δ_1
POINT OF CRITICAL OVALITY
1(a)
F
δ_1
$\gg\delta_1$
F
1(b)
δ_1
1(c)
δ_1
δ_2
δ_3
1(d)

FIGURE UP-8



SORENSON (1¼")
SORENSON (20")
SORENSON (COLLAPSE AT SUPPORT)
REDDY - STEEL
REDDY - ALUMINUM
WILHOIT & MERWIN
BATTERMAN (AXIAL COMPRESSION)
BOUWKAMP (SPECIMENS 1-4)
BOUWKAMP (SPECIMENS 5&7)
STRAIN (in./in)
.03
.02
.010
.009
.008
.007
.006
.005
.004
.003
.002
.001
10
15
20
25
30
45
50
60
70
80
90
100
R/t

FIGURE UP-8A



% OVALITY $\left(\frac{D_{MAX} - D_{MIN}}{D_o}\right)$
12
10
8
6
4
2
0
40
50
60
70
YIELD STRENGTH
(KSI)

FIGURE UP-8B

TREND CURVE USING 2/3 OF DESIGN CURVE

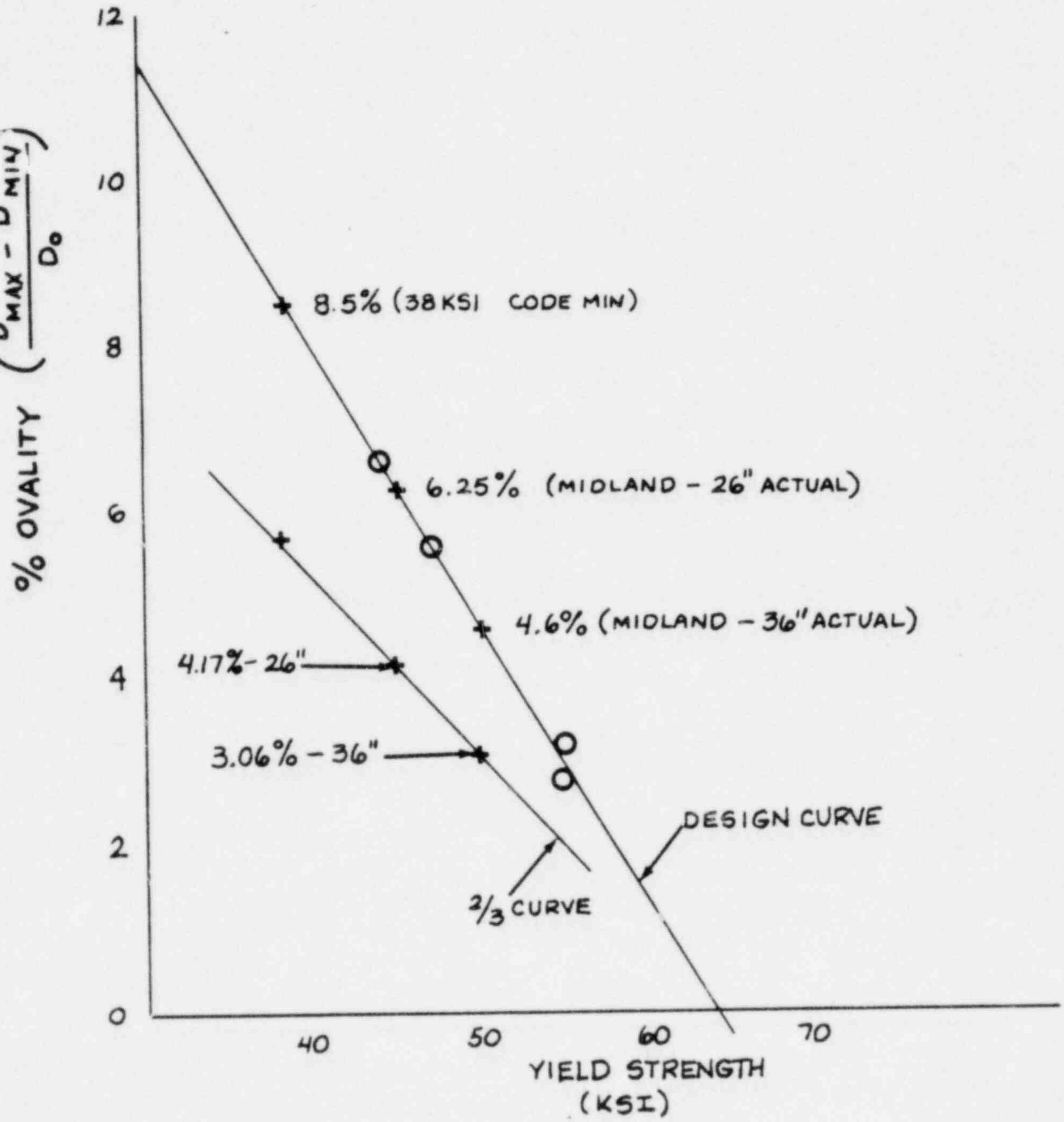


FIGURE UP-8C

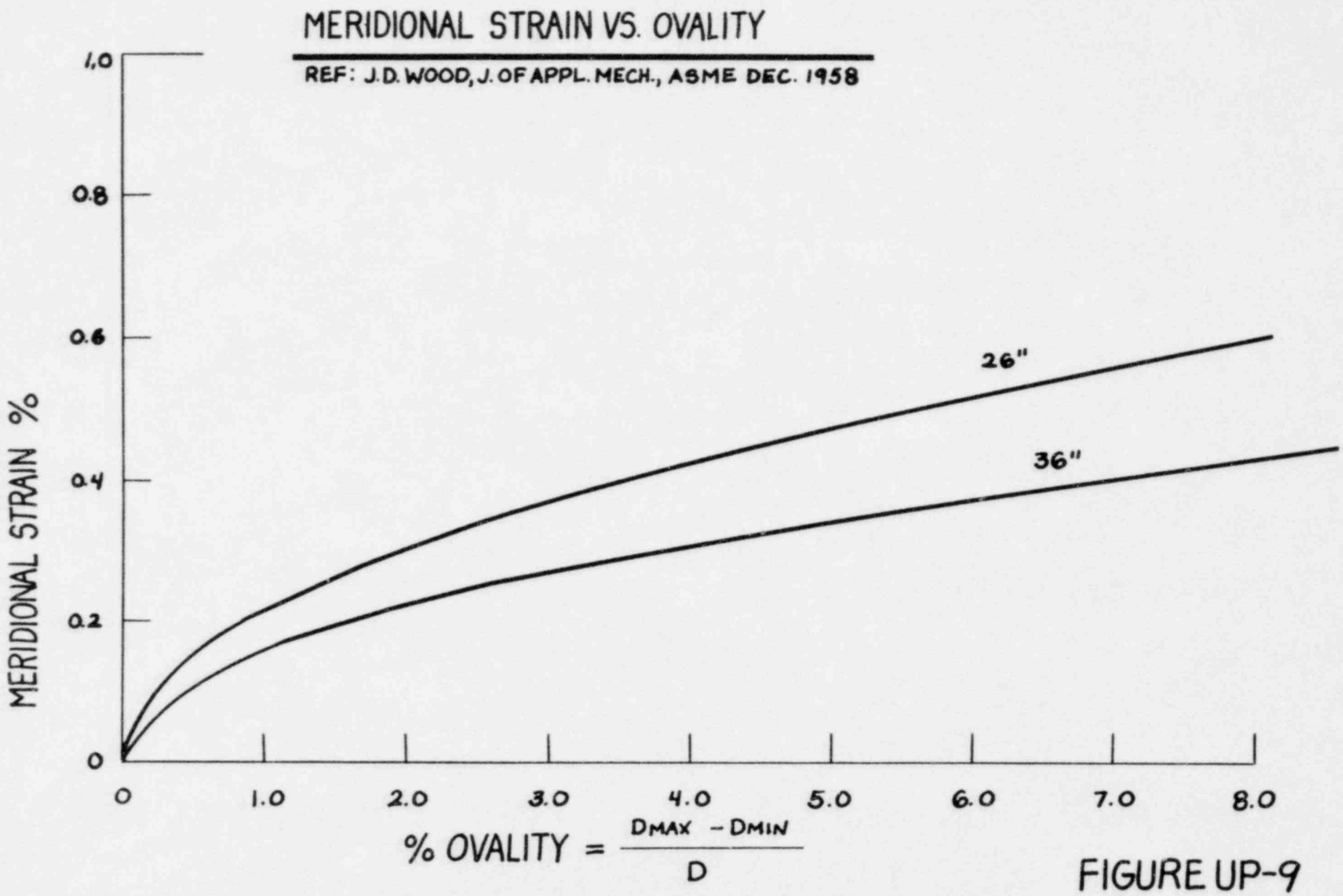
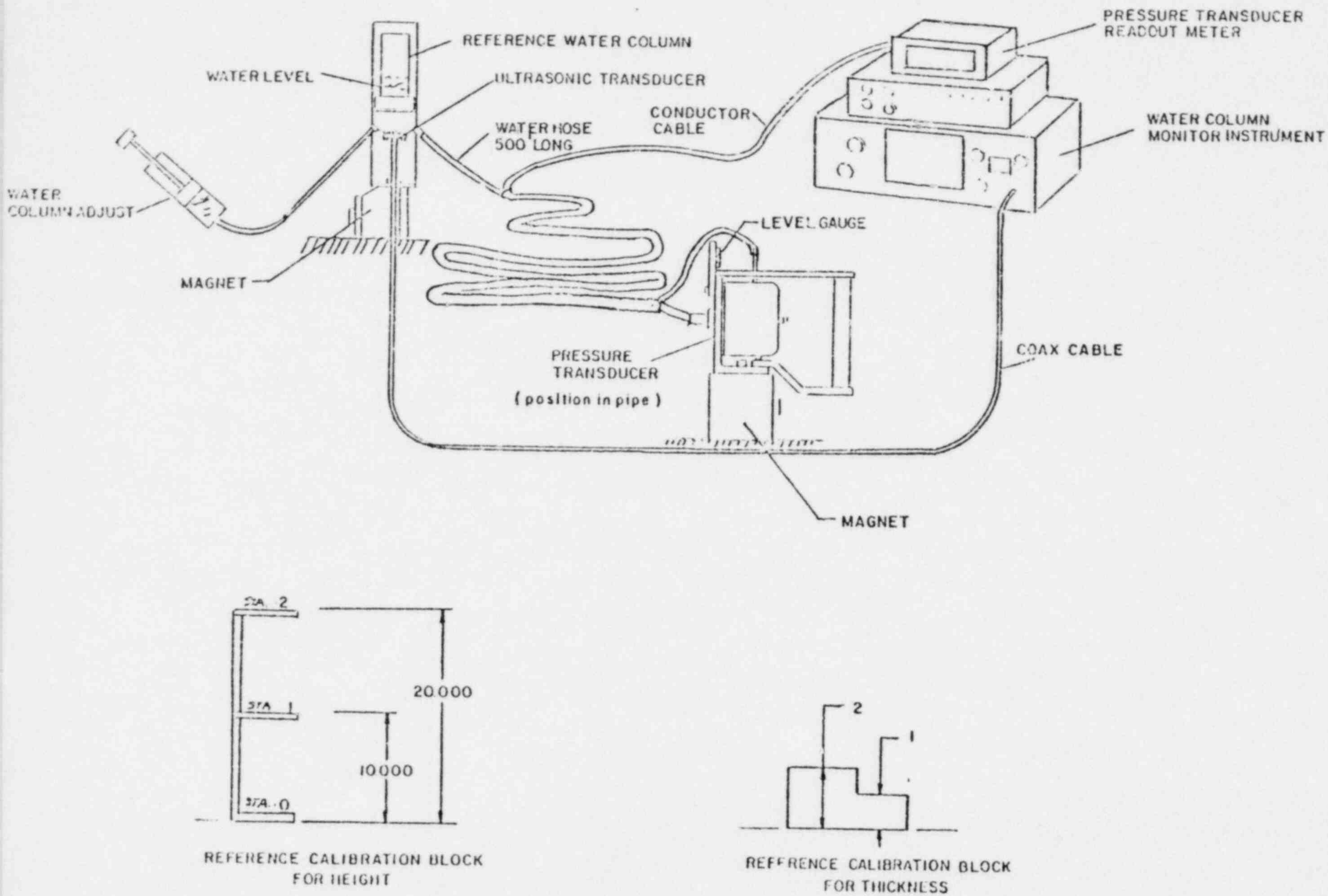

MERIDIONAL STRAIN VS. OVALITY
REF: J.D. WOOD, J. OF APPL. MECH., ASME DEC. 1958
1.0
0.8
0.6
0.4
0.2
0
MERIDIONAL STRAIN %
26"
36"
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
% OVALITY = DMAX - DMIN / D

FIGURE UP-9



SCHEMATIC - PIPE ELEVATION PROFILE MEASURMENT SYSTEM

FIGURE UP-10

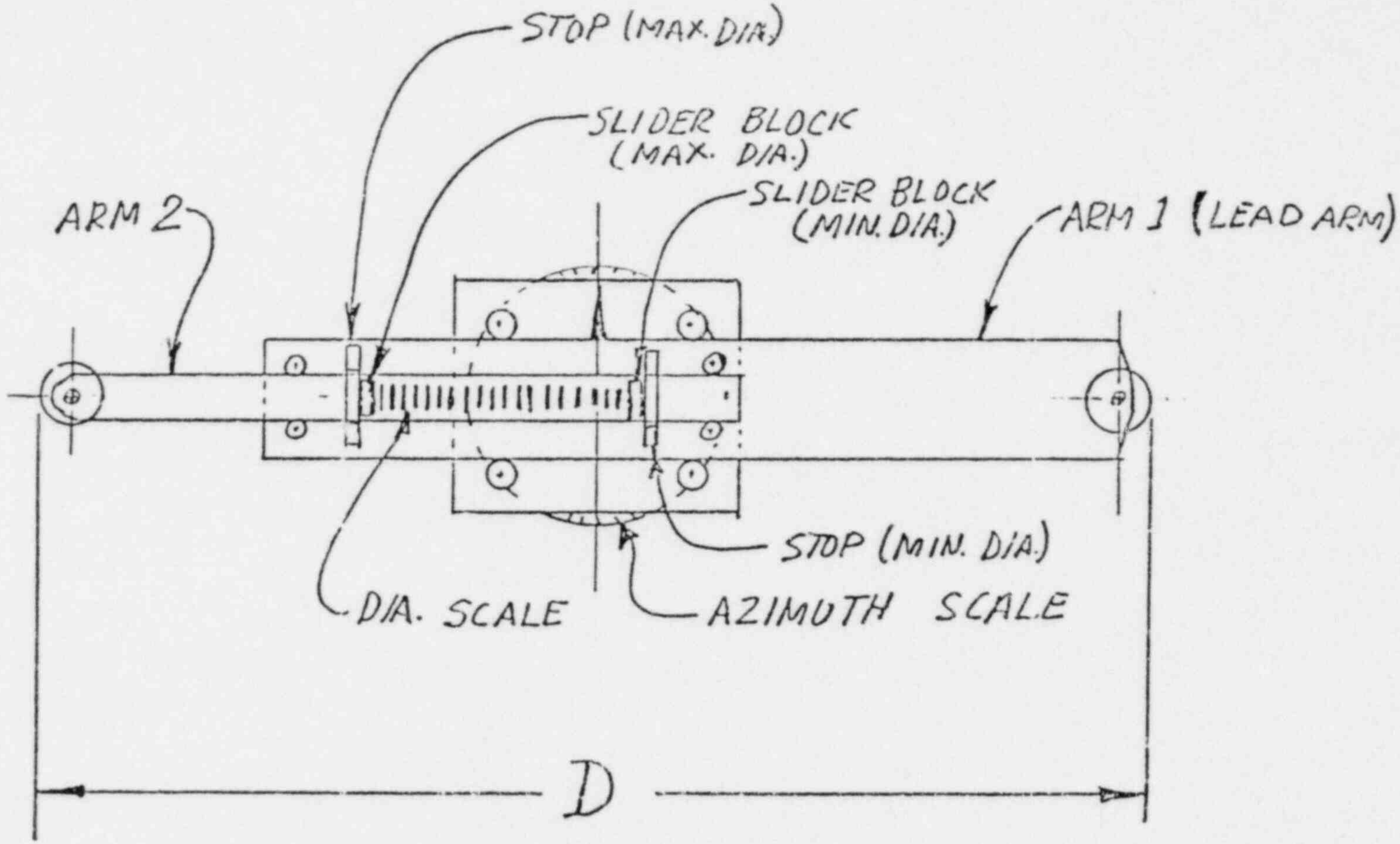
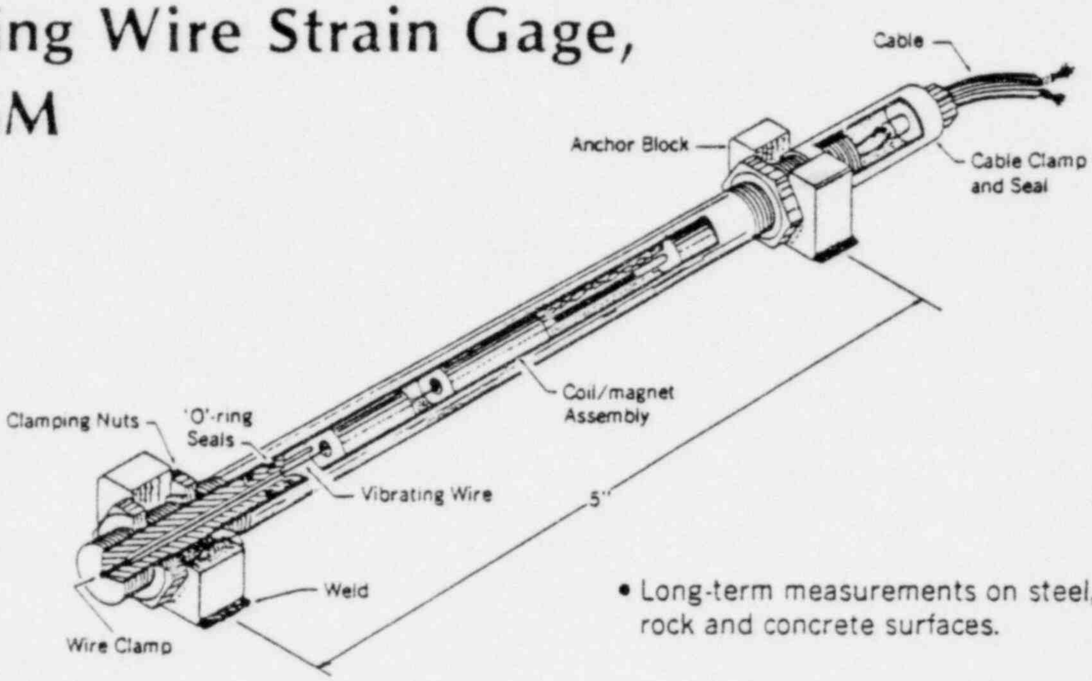


FIGURE UP-11

SKETCH- SwRI OUT-OF-ROUNDNESS MEASUREMENT INSTRUMENT

FIGURE UP-12

Vibrating Wire Strain Gage, Type SM



- Long-term measurements on steel, rock and concrete surfaces.

The IRAD GAGE Type SM Vibrating Wire Strain Gage has been designed to measure strains on structural steel work as well as on the surface of rock and concrete constructions. The gages are rigidly clamped by anchor blocks which are welded or bolted to the structure at predetermined spacing using a special jig. The initial wire tension is set to the required value by rotating the clamping nuts using a standard wrench.

The wire vibrations are measured using a coil/magnet assembly mounted inside the gage. The lead wires to this assembly are brought out through one of the ends. The period of the resonant frequency is easily read on the display of the IRAD GAGE Readout Box MB-6 (or MB-3).

Either tensions or compressions can be monitored and no loads other than those required to tension the vibrating wire are applied to the structure. As the coefficient of expansion of the wire is closely matched to that of the structural steel there are no temperature corrections. If temperature measurements are required they can be monitored by a thermistor (optional extra) mounted inside the gage.

Where gages are susceptible to impact damage such as in high traffic areas or during shotcreting, it is recommended that they be shielded by a metal cover (optional extra).

The gages are provided with heavy duty cable. Further cable protection can be provided by means of flex conduit coupled to the gage cover.

Calibration data are supplied with the gages to enable the observer to convert the period readings to strains.

Specifications

Model No.	SM-5
Active Gage Length (anchor block spacing)	5 inches (127 mm.)
Maximum Strain Range	2000 μ in./in.
Sensitivity	1 μ in./in.
Temperature Range	−40° to 150°F
Overall Length	7½ inches (190 mm.)
Tube Diameter	½ inch (12.7 mm.)
End Block Dimensions - (weldable)	1 x 1 x ½ inches
(bolted)	1½ x 1 x ½ inches
Weight with 10 ft. of cable	1 lb.

Essential Accessories

Setting Jig (bolting type).
Setting Jig (weldable type).
Wrench.
Model MB-3 (or MB-6) Readout Box.

Optional Extras

Thermistors.
Model MT-1 Thermistor Readout.
Gage Cover.
Flex Conduit.

Ordering Information - Model SM-5

Specify: 1. Cable Length.
2. End Block Type. (Weldable or Bolted).

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	Docket Nos. 50-329 OM
	)	50-330 OM
CONSUMERS POWER COMPANY	)	
	)	Docket Nos. 50-329 OL
(Midland Plant, Units 1 and 2)	)	50-330 OL

AFFIDAVIT OF DONALD F. LANDERS

My name is Donald F. Landers. I am Senior Vice President of Teledyne Engineering Services, a division of Teledyne Industries. Teledyne Engineering Services engages in the practice of consulting engineering with particular, though not exclusive, emphasis on the engineering problems of nuclear facilities. I am a mechanical engineer with specialization in the field of piping engineering. An outline of my education and professional qualifications is contained in the attached resume.

My experience includes over twenty years of engineering work, including design, fabrication, installation, and testing of commercial nuclear power plant piping systems as well as other categories of high-reliability piping, including fuel piping for Titan missile bases and piping for nuclear surface ships. I am chairman of the ASME Boiler and Pressure Vessel Code Section III, Nuclear Components SubGroup on Design, a member of the Section III Committee and of the Working Group on Piping Design. I am a member of the Pressure Vessel Research Committee of the Welding Research Council and currently chairman of the Technical Committee on Piping Systems. I have been a lecturer at more than 40 seminars throughout the world on the Design of piping systems and ASME Code criteria. A list of my publications relating to nuclear power plant component design is contained in the attached resume.

I am the author of Section 3.5, including all of Subsections 3.5.1 through 3.5.7, of the foregoing Underground Piping Testimony. I am not responsible for any other section of this testimony. I believe that, by virtue of the education and experience set forth in this affidavit and in the attached resume, and as a result of my review of the circumstances of the underground piping at the Midland Plant, I am qualified to testify as an expert with respect to the serviceability of the Midland Plant underground piping.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on February 2, 1982

Donald F. Landers

Donald F. Landers

DONALD F. LANDERS
Senior Vice President

Professional Resume

Education

Lincoln Technical Institute, A.S. in Mechanical Engineering, 1962
Northeastern University, B.B.A. in Engineering and Management, 1963

Experience

Teledyne Engineering Services, Teledyne Materials Research, and Lessells and Associates, Inc., since 1961: Engineering design, analysis and construction management for nuclear power and fossil power plant modifications; theoretical and experimental stress analysis of piping and pressure vessels; preparation of Design Reports; consulting on design criteria, design specifications, and pressure vessel and piping design and analysis; Design Review of nuclear and LNG piping systems including installation.

Arthur D. Little, 1959-1960: stress analysis and field engineering of fuel loading piping for Atlas and Titan missile bases.

Bethlehem Steel Co., Nuclear Power Section, Central Technical Dept., 1957-1959, 1960-1961: stress analysis of shipboard piping, pipe hanger design, supervision of nuclear piping installation.

Charles T. Main Co., 1955-1957: power plant and textile mill design.

U.S. Navy Weather Forecaster, 1951-1955

Membership

ASME, Boiler and Pressure Vessel Code, Section III Committee Member; Working Group on Piping Design Member; Subgroup on Design Chairman.

Welding Research Council, Pressure Vessel Research Committee

ANSI, B31.7 Code for Nuclear Piping, Member; Chairman, ANSI B31.7 Task Group on Design.

Registered Professional Engineer - Commonwealth of Massachusetts

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Authorship

"Specification Guidelines for Nuclear Pressure Vessels, " with W.E. Cooper, AEC Report NYO-3416-1, October 1964

"Nuclear Piping Design Guide," with R.D. Hookway, USAEC Division of Reactor Development and Technology RDT Standard.

"Effect of ANSI-B31. - 1969 on the General Piping Industry," Heating, Piping and Air Conditioning Magazine, June 1970.

Computer Software - Problems and Preferred Resolutions," ASME Booklet on Computer Software.

"Problems Occuring in Nuclear Piping System Analysis and Operation," Second International Conference on Structural Mechanics in Reactor Technology - Berlin, Germany, 1973.

"B31 Piping Design Philosphy," 1973 Annual Meeting, Mexican Society of Mechanical and Electrical Engineers.

"Design Specifications." ASME Philadelphia and Delaware Sections, 1973,1974 and 1975 Nuclear Power Plant Components Course and 1976 ASME Annual Meeting Short Course.

"Section III - Nuclear Piping Design," ASME 1975 and 1976 Annual Meeting Short Courses.

"Nuclear Piping Design - A Critique ", July 1978.

"Technical Program to Identify Signifigant Problems Related to Piping Systems in LWR Power Plants", August 1980 - Sandia Laboratories.

"Effects of Postulated Event Devices on Normal Operation of Piping Systems in Nuclear Power Plants" with R.D Hookway, TES, and K.D. Desai, USNRC - NUREG/CR-2136, May 1981.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	Docket Nos. 50-329 OM
	)	50-330 OM
CONSUMERS POWER COMPANY	)	
	)	Docket Nos. 50-329 OL
(Midland Plant, Units 1 and 2)	)	50-330 OL

AFFIDAVIT OF DONALD F. LEWIS

District of Columbia: SS:

My name is Donald F. Lewis. I am employed by Bechtel Associates Professional Corporation as the acting assistant project engineer and the engineering group supervisor for the Midland Nuclear Project. In this position, I am responsible for licensing activities, including evaluation of specific design issues with respect to licensing and technical requirements.

I have a total of fifteen years of experience in the nuclear power industry. Nine of these years have been in the design and construction of commercial nuclear power plants. The balance of my experience has been in the United States Navy as an officer in the Naval Nuclear Propulsion Program. I have a Bachelor of Science degree in Physics from Rensselaer Polytechnic Institute. In addition, during my service as a naval officer, I attended the United States Navy Nuclear Power School in Bainbridge, Maryland and the United States Navy Nuclear Power Training Prototype Unit in West Milton, New York.

In 1973, after leaving the Navy, I went to work for Bechtel Power Corporation as the nuclear steam supply system coordinator on Portland General Electric Company's Pebble Springs Nuclear Project and held the same position on Iowa Power Company's Central Iowa Nuclear Project. In these positions, I was responsible for incorporation of the reactor and reactor auxiliary systems into the plant design, schedule and licensing effort.

Beginning in 1976, I served as a nuclear discipline specialist in Bechtel's Ann Arbor area office. In this position, I was responsible for providing technical assistance to projects on nuclear, environmental, and licensing matters. I have also held the position of mechanical nuclear design group supervisor for the American Electric Power Nuclear Plant studies. I am also the current Vice Chairman of the Michigan Section of the American Nuclear Society, and was a past member of the ANS 51 Standard Committee to develop PWR design criteria.

In connection with my current positions as assistant project engineer and engineering supervisor for the Midland nuclear project, I am responsible for licensing activities with respect to the underground safety related piping and tanks at the Midland Nuclear Plant, as well as evaluation of specific design issues with respect to licensing and technical requirements.

I am primarily responsible for the underground piping testimony, with the exception of Sections 2.1, 2.2, and 3.5, for which James Meisenheimer and Donald Landers are responsible. I affirm that the statements in this affidavit and in those portions of the underground piping testimony for which I am responsible are true and correct, to the best of my knowledge and belief.

Donald F. Lewis

Donald F. Lewis

Subscribed and sworn to before me this 3rd day of February, 1982.

Phyllis D. Macey

Notary Public, District of Columbia
My commission expires: 1-1-87.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
CONSUMERS POWER COMPANY	)	Midland Plant Units 1 & 2
Application for Reactor	)	Docket No 50-329
Construction Permit and	)	Docket 50-330
Operating License	)	

AFFIDAVIT OF JAMES K MEISENHEIMER

My name is James K Meisenheimer. I am presently employed by Consumers Power Company as the coordinator of geotechnical activities relating to soils remedial work for the Midland Project. I am on leave from my job as Supervisor of Geotechnical Services at Gilbert/Commonwealth which is an architectural and engineering firm specializing in power plant design. I have a BSCE and a MS in geological engineering from the University of Missouri at Rolla. I have over 12 years of professional experience in geotechnical engineering. My resume is attached.

I am the author of that portion enclosed testimony which deals with subsurface soil conditions and future predicted settlement (Section 2.0). My testimony is based on my review of all pertinent data furnished by Consumers Power Company and Bechtel. Based on this review and on my professional experience and training, I believe I am qualified to give this testimony.

I swear that the statements made in this Affidavit, the attached resume and three portions of testimony for which I am responsible are true and correct to the best of my knowledge and belief.

Sworn and subscribed to before me this 1st day of February 1982.

James K. Meisenheimer
James K Meisenheimer
Coordinator of Geotechnical Activities

Barbara R. Hansen
Notary Public, Jackson County
My Commission Expires September 8, 1984

CC: State of Michigan
County of Jackson

mi0182-0017a100

JAMES K. MEISENHEIMER
Supervisor – Geotechnical Services

Background of over twelve years of professional experience in civil/geological engineering including studies, analyses, cost estimating and construction management of geotechnical phases of dams and cooling systems, power generation projects, highways, subsurface and surface mines, and waste treatment systems with special emphasis on soil and rock mechanics, foundations engineering, and siting studies.

EXPERIENCE: 1977 to Present	**Gilbert/Commonwealth since 1977** Supervisor – Geotechnical Services Section of the Environmental Systems Division responsible for directing the activities of a group of geotechnical engineers and geologists and a soils testing laboratory, involved in site investigations, foundation studies, mining and hydrogeological studies and environmental reports.
1971-77	**Dames & Moore, Park Ridge, Illinois** Project Engineer/Project Manager/Principal Investigator on studies, analysis, design, cost estimating and construction management for geotechnical phases of earth, gravity and tailing dams and cooling systems including construction surveillance of foundation preparation and treatment, geologic mapping and earthwork operations, instrumentation, design of controlled and production blasting, grouting for foundations and grout curtains, rock anchors, dewatering, borrow area development, and selection and development of quarries for riprap materials. Also responsible for exploration, testing and analysis to evaluate static and dynamic stability for existing hydraulic filled dam embankments. Exploration, testing analysis and design for open pit and underground mining to include slope stability, room and pillar and long wall mining, shaft sinking, rock bolting and instrumentation. Construction surveillance of nuclear power plant foundations; site development of cooling water and waste treatment systems.
1969-70	**U.S. Army** One year as Engineering Construction Officer involved in development, design and analysis of military construction of 75 miles of South Vietnam national highway. One year as Instructor in soil analysis and construction engineering at the U.S. Army School in Ft. Belvoir, Virgina.
1969 (3 months)	**U.S. Army Corps of Engineers, Kansas City District** Civil Engineer/consultant on $1 million troop housing and facilities project.
1967 (summer) 1965 (summer) 1964 (summer)	**Illinois Department of Transportation, Paris, Illinois** Assistant Resident Engineer on two miles of state highway and storm sewers; quality control and construction inspection of concrete and asphalt mix for highway repair work.

(Continued)

1962-63	Assistant Maintenance Field Engineer involved in design, management and maintenance of 600 miles of state highway.
EDUCATION:	B.S.C.E., University of Missouri at Rolla, 1967 M.S., Geological Engineering, University of Missouri at Rolla, 1969
REGISTRATION:	Professional Engineer in Illinois (1975)
SOCIETIES:	Association of Engineering Geologists American Society of Civil Engineers Earthquake Engineering Research Institute

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CHAIRMAN BECHHOEFER: Off the record a minute.

(Discussion off the record.)

MR. WILLIAMS: Your Honor, that concludes our direct testimony. The witnesses are available for cross examination at the present time.

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CHAIRMAN BECHHOEFER: Ms. Stamiris?

MS STAMIRIS: I have some questions. First of all, I would like to ask you, Judge Bechhoefer, some of the questions I have are just basic understanding. I did try and read through this and understand some of the terminology and things about the pipes. I wondered if perhaps I cross examined at the end, I might understand some of these things by listening and not having to go through it.

But if you want me to proceed, I will.

CHAIRMAN BECHHOEFER: Would the Staff have any objection to going first?

MR. BLUME: The Staff has no cross examination, Mr. Chairman.

CHAIRMAN BECHHOEFER: Well, you are there.

CROSS EXAMINATION

BY MS. STAMIRIS:

Q I am not sure to which of you I should even address this question, but on page 18 and 19 is a discussion about the end of the pipe being deflection limited and how that affects the critical ovality. I am wondering if whoever is responsible for this section could discuss it in lay terms.

MR. MARSHALL: Yes.

A (WITNESS LANDERS) Yes, I think if perhaps you look back at Figure UP-A, we can get a better understanding of what we are trying to discuss there. Okay. And if we think of this as a hollow -- as a piece of pipe with a clamp on one end and we apply a load to the end of the pipe and we continually increase the load, we are going to reach a point at which the pipe cannot carry anymore load and it collapses. That is one situation that we call a load control phenomenon.

Q Does the pipe actually have a clamp at one end?

A (WITNESS LANDERS) The pipe out in the field, yes, in some locations it does where it's anchored, absolutely.

Q And where it doesn't?

A (WITNESS LANDERS) Where it doesn't, in fact, the collapsed point in this figure would not occur at the clamp. It would occur away from the clamp, you see. The clamp would tend to hold the pipe round. So -- should I continue?

Q Yes.

A (WITNESS LANDERS) Okay. At the point at which collapse becomes imminent in Figure 1-A, if we measured the deflection of that at that time, that would be this Delta 1. So now we have the time at which collapse begins and an appropriate deflection.

If we take another pipe that is identical and clamp it and apply that same deflection, collapse would expect to be imminent but it doesn't occur because we have held the end of the pipe. We have only allowed it to deflect so far.

In one case we have applied a load, nothing is holding the pipe back; and as the load is increased, pipe will collapse. If we hold the end of the pipe and only deflected a certain amount, then it can't collapse because we have stopped it from moving.

That is we apply step by step for the deflections, even though we have gone by the collapse point, the pipe does not exhibit collapse, that is, it doesn't run away from us. Again because we have controlled the end of the pipe. That is the deflection control phenomena.

In the situation with the buried pipe at Midland is a deflection control situation, that is, we are deflecting the end of the pipe or all portions of the pipe.

Q This deflection control that you are referring to is a part of the remediation?

A (WITNESS LANDERS) No, it's a part of the problem, that is, the piping is deflecting. But it's important to distinguish between a deflection situation and a load situation, since a load situation can be uncontrollable. When the load reaches the point at which collapse will occur, then collapse occurs.

Q Maybe if I tell you what concerns me most. You can address yourself to that, and I read through here and read some justification for why the collapse would not be rapid in the case of the pipes at the Midland plant. That is what I am concerned with, is if the collapse can occur when it reaches a certain point of stress, if then the collapse can occur fairly rapidly, is it true that, are there any pipes at the Midland plant that you were involved with that could collapse fairly rapidly?

A (WITNESS LANDERS) I have not been involved with any pipes at Midland other than the development of this ovality criteria for the buried pipe, and with respect to the buried pipe, that cannot occur because it is a deflection control situation.

Q And you base that on your analysis and calculations?

A (WITNESS LANDERS) I base that on the understanding of the phenomena, ma'am, that it is deflection controlled.

JUDGE HARBOUR: Can you explain what limits the deflection, please?

A (WITNESS LANDERS) The settlement of the soil.

JUDGE HARBOUR: And the presence of the soil, does the presence of the soil then prevent furtner deflections?

WITNESS LANDERS: Yes, sir.

BY MS. STAMIRIS:

Q Can you explain any more to me about how you are assured that the collapse cannot be rapid?

MR. WILLIAMS: Your Honor, I would like to object to that question because it is unclear, first of all, what pipe is being referred to and secondly, there is a hypothesis that there is going to be a collapse and the witness just testified that the buried piping will not collapse under the circumstances.

Now, perhaps if Mrs. Stamiris could clarify the question so that it is more clear what it is exactly she is talking about, that a proper question could be framed, but I do not think the one that she actually placed was a proper question.

CHAIRMAN BECHHOEFER: Ms. Stamiris, could you refer to some particular part of the testimony or perhaps --

MS. STAMIRIS: Well, on Page 19 and then on Page 22 there were different definitions of the term "collapse" and I really cannot be more specific as to the pipes which I am -- I mean, I am just asking it in a general sense and I cannot address it to specific pipes.

MR. WILLIAMS: Well, may we ask if she is referring to hypothetical pipes in general or to specific pipes at the Midland plant?

MS. STAMIRIS: Well, I am referring to pipes at the Midland plant, but I cannot be specific as to which ones. I mean, I am not asking it in the purely hypothetical sense.

Well, I will just skip it. I really do not understand it well enough.

JUDGE HARBOUR: Would you like to have an explanation of why or what the term "collapse" means in the two different cases as given on Pages 19 and 22?

BY MS. STAMIRIS:

Q That would be helpful.

A (WITNESS LANDERS) Yes, that is a good question too.

As the term "collapse" is used to define a different number of modes of failure and the testimony essentially addresses two of those, one of those would be collapses related to a round pipe continually ovalizing until we are unable to get sufficient flow through. That is the area really of concern at Midland, is getting sufficient flow through the pipes.

Another use of the term "collapse" is related to taking a pipe and bending it until wrinkling occurs in the top surface of the pipe where compression exists, and after a while the wrinkling what we call bifurcates, that is also sometimes called collapse.

I am trying to distinguish here between the two of those because wrinkling is in fact not damaging with respect to flow transmission through the pipe, the reduction in flow area is essentially insignificant for wrinkling but the term "collapse" is used by investigators in both cases and our concern, of course, is getting sufficient flow through the pipe.

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Q When you are addressing the critical ovality and when the pipe reaches the point and you are trying to determine where it reaches the point of concern as to whether or not the pipe can perform its intended function, are you -- and this may not be the part that you are involved with, so I will ask it of any of you -- are you measuring a degree of ovality in itself or are you measuring the load through the pipe at that point in time?

A (WITNESS LEWIS) Are you referring to the future monitoring program?

Q Yes.

A (WITNESS LEWIS) What we will be measuring is the strain in the pipe which is related directly to the ovality in the pipe. Flow measurement is not part of the monitoring for the -- to assure the serviceability of the pipe in this context.

Q The reason I ask that is because Mr. Landers, in answering my first question or the last question, said that the important point -- and I hope this is correct -- that the important point is when the flow through that pipe cannot perform its intended function.

If you are measuring the degree of ovality by means of the stress, could that not truly answer the question of whether the flow through that particular pipe is affected at that point?

A (WITNESS LEWIS) In the testimony, there is the table that lists the reduction in the flow area for the 4 percent ovality, on page 25.

Now, we have accepted a 4 percent limit on our measurement on ovality, for ovality, and we will corrolate our strain measurement to that. The table shows the reduction in flow area for that ovality and, as you can see, the percent reduction in area of the pipe, cross sectional area, is only 4 percent, and that is totally insignificant. It is insignificant with respect to the cross sectional flow area for the system.

Q Am I correct then in understanding that when a pipe reaches, has its flow area reduced by 4 percent, that is the point at which you would do something about it or that is the point -- I cannot ask it any better than that. Do you understand that?

MR. WILLIAMS: Mr. Chairman, can I interject just one point here?

I think the witness made a misstatement as to percentage.

WITNESS LEWIS: Yes, I believe --

MR. WILLIAMS: I believe it should be .04 percent.

WITNESS LEWIS: That is correct. It is not 4 percent reduction area. It is .04.

BY THE WITNESS:

A (WITNESS LEWIS) Would you please restate the question?

BY MS. STAMIRIS:

Q My question is does that mean that when the flow area is reduced by .04, that that is the point at which -- is that the point at which you will want to do something about it or correct a problem?

A (WITNESS LEWIS) The question that you are asking, or as I understand your question, relates to the operating technical specifications for the plant, which have not yet been drawn up. It is my understanding they will be agreed upon as part of the operating license hearings.

So the exact action that would be taken really has not been determined at this time. It is true though that 4 percent ovality limit corresponding to an area reduction of on the order of .04 percent is what we have accepted as a limit for our monitoring program.

Q Okay.

JUDGE DECKER: Excuse me, but I do not think that answered the question. You say it is a limit for your monitoring program, but what are you going to do when you hit that number? I think that is the question.

WITNESS LEWIS: It has not yet been decided, sir, just what we will do. It will be defined as part of the technical specifications.

MR. WILLIAMS: Judge Decker, I think that is really properly an issue for the operating license proceeding. The testimony indicates that this is an acceptance criteria for the pipe and I think that the steps to be taken will be a matter of much discussion between the company and the staff.

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JUDGE DECKER: I do not understand. If it is an acceptance criteria for the pipe and you go beyond it that means the pipe is unacceptable and, therefore,you have got to do something. Do I misunderstand completely?

WITNESS LEWIS: Is that question to me?

JUDGE DECKER: Yes, I think you would be the proper man.

WITNESS LEWIS: Okay. That will have to be a basis for an action of some type. What the action is, whether it is a further investigation, further evaluation or direct impact on the plant operation just has not been decided yet.

JUDGE DECKER: Okay.

CHAIRMAN BECHHOEFER: I have one question along the same line while we are here.

WITNESS LEWIS: Yes, sir.

CHAIRMAN BECHHOEFER: Does the 4 percent acceptance criteria apply to the 36-inch piping as well as the other pipes?

WITNESS LEWIS: No, it does not, given that we are going to replace the 36-inch piping.

CHAIRMAN BECHHOEFER: Well, does this limit not apply to everything you are going to place or do you have different acceptance criteria for what you are going to replace?

WITNESS LEWIS: We are going to replace the 36-inch piping in accordance with design standards and in accordance with the ASME code, as though, in effect, it will be a new installation. It will consider settlement and as well as other design considerations. As such it will not have any special monitoring applied to it any more than any other piping systems in the plant have unique monitoring applied to them.

CHAIRMAN BECHHOEFER: Well, does the code have any acceptance criteria for the degree of ovality which might result?

WITNESS LEWIS: The ASME code does not directly address ovality of buried piping or of installed piping systems.

CHAIRMAN BECHHOEFER: So what does the 3.06 percent which is listed on the third line of Page 25, that I take it will no longer be applicable at all?

WITNESS LEWIS: That is correct. We would have applied that limit, would have been willing to apply that limit to the existing 36-inch diameter piping. That limit will not be applied given that we are now replacing that piping.

CHAIRMAN BECHHOEFER: I see. Thank you.

WITNESS LEWIS: May I make a clarifying statement?

MR. WILLIAMS: Mr. Chairman, is that acceptable?

I think the witness wants to clarify something he said earlier.

CHAIRMAN BECHHOEFER: Yes, that's fine.

WITNESS LEWIS: I am going to Judge Decker's question.

On Page 34 at the bottom of the page we state that the monitoring, if the technical specification is reached, the monitoring frequency will be increased to a monthly basis at that point until remedial action is taken.

Now, just exactly what the technical specification limit will be is not just defined. It may be four percent or if we can justify it to the Staff, it may be another value.

JUDGE DECKER: Thank you.

MR. WILLIAMS: I believe that it is also the case that the Staff will be notified if that technical specification is reached, so that whatever action is taken will be taken in concert between the Applicant and the Staff.

CHAIRMAN BECHHOEFER: I am not sure that the question is proper for this panel or the staff panel, but was there not an agreement that something would happen when 75 percent of a specification were reached?

MR. WILLIAMS: I think maybe it might be better to wait for the Staff panel and address that to them.

CHAIRMAN BECHHOEFER: Well, I was going to ask that same question in connection with Item 4 on Page 34 at the bottom of Page 34, and I may be confusing --

MR. WILLIAMS: Well, do you wish to address that question to Mr. Lewis at the present time?

CHAIRMAN BECHHOEFER: Well, whichever panel member is responsible for the last item on Page 34 at the bottom of the page.

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page.

WITNESS LEWIS: I can address it. Would you please restate the question?

CHAIRMAN BECHHOEFER: Well, it was my impression that in the Staff testimony, and I could dig it out, there was a requirement that when 75 percent of a technical specification limit was reached, certain action has to be taken, and my question in conjunction with this paragraph four on the bottom of page 34 is shouldn't there be some percentage under the point where the technical specification limit is reached when some further action should be taken?

WITNESS LEWIS: The technical specification limit that we are referring to would be the first action point. The four percent limit is not a failure point, and itself does incorporate a safety factor of 1.5. So that upon reaching a limit of 4 percent or whatever may be negotiated comparable to that, there is still a margin available that provides a time for further evaluation and definition of any corrective action. I do not believe that we have -- we have not talked about the technical specifications with the Staff in more than conceptual terms and I do not believe we have that specific an agreement with them.

MR. BLUME: Mr. Chairman, if I may be of assistance?

Mr. Kane's testimony for this hearing session on page 8 notes that the Applicant in a December 15th report suggested a 75 percent notification.

CHAIRMAN BECHHOEFER: That is what I was referring to.

MR. BLUME: There is no such requirement at this point suggested by the Staff, however.

CHAIRMAN BECHHOEFER: I see. Well, would that suggestion be somewhat different than this Item 4, this provision on the bottom of page 34? Would that suggestion indicate that something further, some action different than what is stated in this Item 4 should take place?

WITNESS LEWIS: I believe the two statements are generally consistent, that we are really talking two values: one that is an initial action, that is at some percentage of any critical value; and then the higher value which would take likely a stronger action, would require a stronger action. So I believe the two statements are consistent, although the ovality limits that are being discussed and the percentages that are being discussed are not resolved and are not at this open issues.

MS. STAMIRIS: Should I continue?

CHAIRMAN BECHHOEFER: You may continue.

BY MS. STAMIRIS:

Q Mr. Lewis, yesterday some witnesses we had were talking about a general phenomena of preferring to confirm analytical analyses with actual field observations, and would you agree that because of the, by definition, the pipe that is buried underground, that the analytical or the analytical evaluations might have to be even more precise or conservative than usual to compensate for the fact that there cannot be observations of these pipes?

A (WITNESS LEWIS) In the sense that we are taking direct measurements on the piping, we are making observations. We do intend to, during plant operation, make observations of the pipe, observations of the strain in the pipe as a direct measurement technique. We are not in fact relying primarily on analysis, but more on direct indication of the condition of the pipes throughout the plant life.

Q Well, it is not direct in the sense that you cannot actually see how oval the pipe is. You are reaching that determination by means of an equation which somehow computes the stress into the ovality figure, is that roughly correct?

A (WITNESS LEWIS) That is correct.

Q So the accuracy of the ovality reading that you obtain would be dependent on the accuracy of the instruments that were measuring that, wouldn 't they?

A (WITNESS LEWIS) Yes, the accuracy would be dependent upon the accuracy of the instruments, that's right.

Q And what else would it be dependent on?

A (WITNESS LEWIS) That is the primary one, the accuracy of the instrument that would be mounted on the pipe as well as the read-out indication.

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JUDGE DECKER: Excuse me, please, Ms. Stamiris. When you try to convert stress to ovality, you are talking about a perfect ellipse, I suppose, are you not?

WITNESS LANDERS: The equation is derived from experimental data. It is not the fact that someone has sat down and just derived an equation. It is really based on a number of experiments that were performed, so it is empirical in nature.

But the answer to your question is yes, that we are talking about a perfect ellipse, certainly.

JUDGE DECKER: Is that really what is expected? You cannot get other shapes? Some of these pipes go under roads, for example.

WITNESS LANDERS: If one looks at a pipe deflected at its end and concerned with collapse, then it is the development of the elliptical shape that first indicates that collapse is imminent, yes.

CHAIRMAN BECHHOEFER: And collapse in this sense means which?

WITNESS LANDERS: Collapse. I will always refer to the other thing as bifurcation.

CHAIRMAN BECHHOEFER: Okay.

BY MS. STAMIRIS:

Q Mr. Lewis, do you have any back-up system or second means of confirming the data that you gather in from the stress measurement devices?

A (WITNESS LEWIS) Let me answer that in two stages.

With respect to back-up to the strain gauges or establishing a sense of confidence in the strain gauges, we will have control gauges that will not be attached to the pipe that will be accessible and will be read periodically to maintain confidence in the adequacy of the installed gauges on the pipe.

In addition we will be doing level monitoring or, correction, settlement monitoring of the piping itself at various locations, and that also provides a backup.

Q Can you tell me on what basis did you justify doing that settlement monitoring only once a year after the fifth year, if I am correct in understanding the Point 2 on Page 34 at the bottom of Page 34?

A (WITNESS MEISENHEIMER) In relationship to the settlement monitoring, the majority of the settlement that we have seen in the fill at this time has already occurred. The future projection of the maximum amount of settlement that could occur in the future was conservatively estimated at 3 inches. Most of the Borros anchors or settlement points we have in the fill along this pipeline indicate less than that, but we are using that as a control factor.

Within the next five years, the amount of settlement such as on the order of three inches will diminish very rapidly and the amount of settlement we would see after that time would be very, very minor. We will look at the settlement monitoring data during this time and be able to tell how this is flattening out and would be able to make a prediction of what you would have after a five-year period.

But at the present time, after five years from now there should be very, very little settlement in the fill itself.

Q Can you tell me how often you will be monitoring for settlement at the time that the permanent dewatering system begins?

A Right now we are monitoring the Borros anchors and such throughout this whole area on a continuous basis. I am not exactly sure if it's on a daily basis or a weekly basis, but it is being monitored continuously. All the settlement points we have out there are being monitored throughout this dewatering process.

Q Can you give me a rough estimate of how much of the ultimate plant dewatering process is now underway?

A The dewatering process has been underway for several years, a couple of years, in different areas and different phases. The Borros settlement anchors which we do have and which were used in our analysis have included this information and predictions of future estimated settlement that will become part of the permanent dewatering system. So these settlements from dewatering are included in these estimates and have been part of the measured values that we have had in the last year.

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year.

Q Do you expect any significant differences from the readings you are getting now at this time to what you think will take place when the complete permanent plant dewatering system is in effect?

A No.

Q Mr. Lewis, are you aware of information that came from the NRC consultant ETEC in October of 1980 which said that ETEC analysis indicates that the maximum bending stress due to soil settlement for several of the pipe profiles already exceed the ASME code allowable stresses and material yield strength?

MR. **WILLIAMS:** I would like to object to the question. If Ms. Stamiris is going to question the witness on a document, I think he should be given the courtesy of being shown the document and have it identified for the record.

MS. STAMIRIS: I thought I asked it in a way of just asking him if he was aware of this statement from ETEC was really NRC, but the document that I was reading from -- and I didn't read a direct quote -- it is October 2, 1980, letter from Robert L. Tedesco of the NRC to Mr. Cook, Consumers Power Company.

MR. **WILLIAMS:** Could I see it, please, before you give it to him?

CHAIRMAN BECHHOEFER: Is that an exhibit?

MS. STAMIRIS: No, it is not.

CHAIRMAN BECHHOEFER: What was the date on that?

MS. STAMIRIS: October 20, 1980.

CHAIRMAN BECHHOEFER: Okay, let me see if I have it.

MR. WILLIAMS: I would ask that Ms. Stamiris show the witness that document and then proceed to question him on it.

MS. STAMIRIS: I will be happy to show it to him. I do not really intend to question him at length on the document. I just wanted to ask him his awareness of the situation, but if that will be helpful.

CHAIRMAN BECHHOEFER: I think we would like to see it too.

MR. BLUME: Perhaps we can get around the problem if Ms. Stamiris asks the witness if he is aware whether the pipe exceeds the ASME criteria regardless of what the letter says.

MS. STAMIRIS: It doesn't matter to me, whichever.

BY MS. STAMIRIS:

Q Would you like to see the document?

A (WITNESS LEWIS) May I, please? Thank you.

CHAIRMAN BECHHOEFER: Off the record.

(Discussion had off the record.)

BY MS. STAMIRIS:

Q Mr. Lewis, are you --

A (WITNESS LEWIS) As I understand your question, it is am I familiar with this concern, am I aware of this concern?

Yes, I am aware of the concern of the calculated pipe stresses in the buried piping compared to the ASME allowables. We have been discussing this actively with the NRC over the last year. I have been directly involved in those discussions since last October.

I refer in page 12 oi my testimony at the bottom of the page to the difficulty in knowing precisely the causes of the present condition of the piping. Due to the profiling measurements that have been taken, we know the present condition quite accurately. However, we do not, we have been unable to determine specifically the way in which that condition was established. Therefore, the analyses that we have done, the stress analyses that we have done all assume conservatively that the piping was exactly in accordance with its design configuration and then that the changes in that were due to settlement, and that leads to -- that assumption can lead to very high stress calculations.

Yes, I am aware of that. We have been working with the NRC on that.

Q Do you agree with Mr. Tedesco that the ASME code allowables have already been surpassed?

A (WITNESS LEWIS) I agree that when you calculate those stresses based on the present profile of the pipe and assume that that profile results from settlement conditions, that you calculate very high stresses in excess of the allowables. I do not, however, I do feel strongly that that is an artificial calculation and those stresses are not real, and that is the whole basis for which we have elected not to do an analytical solution --

Q Not to do a what? I am sorry.

A (WITNESS LEWIS) An analytical solution to this question or problem and have elected to go with the demonstration solution of measuring the profile of the pipe exactly, measuring the ovality of the pipe and then continuing to monitor the condition of the pipe to the plant life.

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Q Okay. When you said that you agreed that they had, those ASME codes had been exceeded, if you used the criteria that you set forth and those criteria that you set forth were indeed the criteria you did use --

MR. WILLIAMS: Mr. Chairman, I am going to have to object to that question. First of all, I do not think that the witness agreed that the ASME code had in fact been violated or whatever the word was. I think what he said was different from that.

Secondly, the remainder of the question, I just couldn't follow it. It didn't seem to make any sense.

CHAIRMAN BECHHOEFER: Well, I understood him to say that the code was allowable if you did the calculations in a particular way.

MS. STAMIRIS: It was violated, was allowable.

MR. BLUME: Code allowable was exceeded.

CHAIRMAN BECHHOEFER: Exceeded, yes.

MS. STAMIRIS: Yes.

CHAIRMAN BECHHOEFER: I did understand the witness to say that.

MS. STAMIRIS: All right.

CHAIRMAN BECHHOEFER: If he did not say that, please explain, because that is the way it came across to me at least.

WITNESS LEWIS: Let me clarify it then.

CHAIRMAN BECHHOEFER: All right.

WITNESS LEWIS: The code stress levels, the calculated stress levels in the piping, when the stress is calculated using the exact measured profile of the piping, give results that are greater than the code allowables.

The calculated stress levels in this case we feel quite strongly are not consistent with the physical condition of the pipe and are not in that sense or as a result real, that it is a function, the high stress levels are the function of the way in which the calculation is done and the modeling, the very precise modeling of the piping profile into the stress analysis. So, on the one hand, the calculation does show that the stresses are above allowable. On the other hand, I do not agree that the code has in any way been violated or that the actual stresses in the pipe are anywhere -- are greater than code.

BY MS. STAMIRIS:

Q Mr. Lewis, in the question just before the ones I asked on whether you agreed that they had been, the codes had been exceeded, you set forth the conditions that you were following that Consumers had elected to use regarding the pipes. Were those conditions not the same conditions that you set forth in your answer that you just gave regarding whether these codes had been exceeded?

A (WITNESS LEWIS) I made the assumption -- we made the assumption in the stress analysis that the piping was initially installed exactly in accordance with design and that any change in condition of the pipe was the result of settlement and was not a result of other factors such as fit up of the pipe during welding and that type of thing.

Yes, I believe I made that, stated that same assumption in two questions.

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Q And do you believe that?

A (WITNESS LEWIS) I believe --

Q What I want to know is are you taking that position because you believe it as opposed to, you know, any other reasons? Do you believe that the pipes were indeed installed at what they were said to be and that the situation we have now is due to settlement?

A (WITNESS LEWIS) No, I do not believe that the entire existing condition is due to settlement. Looking at the pipe profile, it appears clear that at least part of the profile configuration is due to the matter in which the pipes were fitted up and welded. Discontinuities occurred at the weld joints of the pipe. In our program and our stress analysis, we assumed that that pipe was initially straight across that weld area and that any present discontinuities would be as a result of settlement conditions where in fact it appears very strongly that that is not the case, that when the pipe was installed, there was a discontinuity at the weld location.

Q And how did you confirm that, that it was installed that way? Did you observe it at the time of the installation to be that way?

A (WITNESS LEWIS) That is our difficulty in that there is no absolute way to confirm it. That is, again, that is why we stopped attempting to do an analytical solution, because the questions,you know, initial condition as opposed to present condition, just do not have a good answer.

JUDGE COWAN: Isn't your work on profiling the pipes, doesn't that reveal some information about the degree to which t he original installation was proper?

WITNESS LEWIS: Sir, all that really tells us is what the present condition of the pipe is. We can infer previous conditions from it, but we in fact don't know. We don't know.

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JUDGE COWAN: But the offsets where the pipes are well welded, don't you get some information about the offsets where the pipes are welded in?

A (WITNESS LEWIS) We have not been able to establish those specific offsets at the time of the installation of the pipes. Is that responsive to your inquiry?

JUDGE COWAN: Yes, except I don't see how the offset is going to change much.

A (WITNESS LEWIS) We believe the same thing, that, in fact, the offset shown on the present profile are resulting from the **fit ups.**

CHAIRMAN BECHHOEFER: Do you think that is sort of a QA problem then? If there is not a soil settlement problem, is there a QA problem or was there?

A (WITNESS LEWIS) Not that we believe or conceive, no.

CHAIRMAN BECHHOEFER: I would think it has to be one or the other.

A (WITNESS LEWIS) Sir, Judge Bechhoefer, various things can affect the present condition of pipe both during the fit up and installation, during the backfill, and over the course -- since from the time after it's installed until now, we just don't know where -- for each specific point what the cause of the point was or that change in profile.

JUDGE DECKER: Rather than QA problem, have you determined whether or not the quality people have any records of their inspections of the welds as to whether they are offset or whether there is welded at some small angle as opposed to zero?

A (WITNESS LEWIS) I have looked at the QC records for one line and the records indicate that -- within the requirements and specifications piping was installed properly and the welds were performed properly.

JUDGE HARBOUR: Are the kinks that occurred near the joint within specifications?

A (WITNESS LEWIS) With some exceptions they are.

JUDGE HARBOUR: What are the exceptions?

WITNESS LEWIS: I don't have the specific definition of what they are.

JUDGE HARBOUR: Would you identify the lines for which you inspected the QC records?

A (WITNESS LEWIS) I did not inspect the records. I looked at them. I saw them. I saw what they were. I did not do any kind of reference check.

JUDGE HARBOUR:Can you identify that line, please?

A (WITNESS LEWIS) I cannot here. I can after the break.

CHAIRMAN BECHHOEFER: One follow-up question: If there were some problems in installation of the pipe --

we don't know that there were -- but either there were some problems or there wasn't some soil settlement problems I guess. In installing new pipe or rebedding old pipe, does the company plan to do anything differently?

JUDGE HARBOUR: The 36-inch line.

CHAIRMAN BECHHOEFER: The 36-inch lines or any others that you may be rebedding or reinstalling.

A (WITNESS LEWIS) We plan to install them in accordance with our specifications and in accordance with the code. One thing that perhaps should be cleared is that the high stress points we see were not just due to any points that were outside of any sit up tolerances, even within the tolerances, no further discontinuity to show this is an apparent very high stress. It's just, you know, you can't correlate anything that might have been out of tolerances to an overstressed load. So the answer to your question, sir, is no.

BY MS. STAMIRIS:

Q I am not sure who would be the best to address a question about the effect of soil settlement on the piping, Mr. Lewis or Mr. Meisenheimer.

A (WITNESS LEWIS) It would depend on the exact question. Would you please phrase it and we ca see.

Q Which one of you would be more a soils expert?

A (WITNESS MEISENHEIMER) I am.

Q Mr. Meisenheimer, would you agree that stress in the degree of ovality that would occur in piping would be in relation to soil properties to the extent that if there was a very soft localized pocket of soil, that that would be a point where high stress would be apt to occur in the pipe?

A (WITNESS MEISENHEIMER) You have combined a structural and a soils problem in your question. I can respond from the soil settlement standpoint to the pipe.

6-2

pipe

As the soil settles, so will the pipe because it is buried in the soil. The weight of the pipe and the foot of the pipe really don't have any influence on what the soil is settling. Basically the fill doesn't know it's really there because it weighs the same as the soil mass that would have been occupying that place.

What happens is the soil settles, so does the pipe. So if you have an area that is soft in one spot and an area that is harder, the softer area will settle more than the harder area. So what happens, that section of pipe in the softer area will go down more and the section of the pipe at a higher area or harder point will settle less.

What happens then is the pipe will deflect or bend to move with the fill that is settling, and that is reflected in the profile that we see on the site.

In some areas where we could see a lot of borings, we could see a correlation between the softer and the harder soils and the bending in the pipe as the soil consolidated.

What happens in soil is -- in the kind of soils, is we basically have silty clay materials below the pipe or the bottom of the pipeline, so we do not have abrupt changes at the pipeline where you have a hard spot and soft spot, where one part of the pipe will not move but the other part wants to move. The soil is a gradual change. So, therefore, we get a gradual bending in the pipeline.

As the soil --as the pipe tries to bend, and as it tries to ovalize, the soil on the sides of the pipe will try to push and keep it from bending and deflecting. The same way if you have a traffic load or something that goes over the top imposing a load on the top of the pipe and the pipe wants to deflect and ovalize the soil and the sides will try to resist that.

Going back to the analytical analysis that was done, this is one of the problems in trying to analyze stresses in varied pipelines. It is very difficult to model what actually goes on because of the variable soil properties. And most of the time you end up with stresses, calculated stresses, that are considerably much higher than the ones you actually had. Also because you are dealing with varied pipelines, you are dealing with confined pipe in controlled bending situation. That was explained earlier by Mr. Landers.

So the condition that we see out there -- I don't know if I have answered your question -- is one we do not see the stresses that have been analyzed analytically and the actual behavior and existing condition of the pipe.

JUDGE DECKER: I don't understand that. You say "We don't see the stresses." Can you tell me how You know that, what is the basis of that statement?

A (WITNESS MEISENHEIMER) Basically that is a structural situation. According to our criteria, if we had the stresses, we would see the ovalization of the pipe and we do not see that. So apparently we do not have the stresses in the pipe that analytically would calculate it.

JUDGE HARBOUR: Before you go on, you mentioned areas of traffic and you said something to the effect that the soil would prevent -- or would resist the ovalization. Rather than changes in ovality, are there changes in elevation as you go beneath the areas of traffic on the soil?

A (WITNESS MEISENHEIMER) We evaluated the location where pipelines cross underneath rural roads in the areas where we know we have brought material into the site and equipment into the site. We also evaluated where the roadways went over the top of the pipelines where we know we had a lot of traffic during construction, and we did not really see that we had settlement in those areas just related to those activities along in those loadings.

The Staff and I, Mr. Kane and I, reviewed that last week and looked at these areas in particular where there had been some possible -- we felt we saw some indications because we looked at the actual profiles and actual locations that were across those. There was no indication that traffic from railroad loadings or other types of equipment loadings at the site had impacted or caused deflections in the pipeline.

JUDGE HARBOUR: Thank you.

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you.

JUDGE DECKER: Mr. Meisenheimer, I accepted your answer to my last question but I don't know why I did. How did you know the ovality?

A (WITNESS MEISENHEIMER) The ovality was measured in each of the pipes. And Mr. Lewis can address t hat.

JUDGE DECKER: It was measured from the time it was installed?

A (WITNESS LEWIS) No, sir, in September -- in the fall of 1981 there was an extensive program conducted by Southwest Research Institute to measure not only the elevation of the piping but the ovality in the pipi ıg at that time. That is the basis for this statement.

JUDGE DECKER: How did they do that, please?

A (WITNESS LEWIS) The elevation measurement or the ovality?

JUDGE DECKER: No, the ovality.

A (WITNESS LEWIS) There is a figure in the testimony that shows the jig that was used. I am referring to measurement on the 26-inch and the 36-inch piping. That pipe is big enough for a man to crawl inside and a measurement device was created for that.

JUDGE DECKER: Thank you.

CHAIRMAN BECHHOEFER: What did you do about smaller pipes?

A (WITNESS LEWIS) 8-inch piping was checked with what we call a peg that was pulled through the pipe to verify that it was ovalized beyond the size of the peg, and that corresponded to approximately two and a half percent ovality. The remaining small piping has either been rebedded or has been installed recently since we did not feel the ovality measurements were necessary.

CHAIRMAN BECHHOEFER: Did you pull this peg through the entire length of pipe?

A (WITNESS LEWIS) These are several rather short sections of pipe that the peg was pulled through, yes. These are 8-inch service work lines, cutting into the diesel generator building.

JUDGE HARBOUR: Would the presence of tension in the pipe affect its ovality and would it also increase the stresses or decrease the stresses?

A (WITNESS LANDERS) The phenomena that we have used to develop criteria here is the bifurcation phenomena. The bifurcation phenomena is a function of an increased compressive stress, so that bifurcation and wrinkling results as a function of compressive stresses on the compressive side of the bending zone.

An applied tensile test would, of course, increase the general stress picture, but it would tend to reduce that compressive zone. So just intuitively I would say it would be of assistance to us.

JUDGE HARBOUR: How would it affect the ovality measurements?

A (WITNESS LANDERS) It wouldn't affect them.

JUDGE HARBOUR: If the soil settled between two points at which the pipe is anchored, that means then that the pipe goes through a curve path rather than a straight path; and, therefore, it must be longer. Would that not introduce tension settlement?

A (WITNESS LANDERS) Yes, but the predominant shape is bending and, in fact, what is being measured is strain in the axial or tensile direction. So when I displace two ends, I am going to produce bending which, in fact, is a tensile stress on one side on the pipe and compressive stress on the other side of the pipe. And what we are going to measure is the strain in that direction because that is a direct measure of bending in pipe.

JUDGE HARBOUR: All right, thank you.

BY MS. STAMIRIS:

Q Mr. Meisenheimer, when you spoke of the clay soil that tended to give a gradual bending, as you described them in my last question, can you conceive of other situations with variable fill such as we have at the Midland site where those clay soils might not be there to sort of insulate the gradual bending that you discussed?

MR. BRUNNER: Your Honor, I think the question needs to be more specific than that. Is she talking -- surely the witness can conceive of something. Is she asking him whether conditions might arise at the Midland site or what?

MS. STAMIRIS: Yes, I mean at the Midland site with the knowledge that he has of the subsoils at the Midland site.

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WITNESS MEISENHEIMER: Okay. I think I can answer your question. I think there are some misconceptions when we talk about variable soils at Midland. In reality what we are talking about are variable consistencies of the soil or variable densities of the soil. Basically the fill soils we are talking about, almost the entire length of pipeline, except adjacent to some structures where there have been some granular backfill placed, is the clay material that came out of the borrow pits on the site. The variability is not in the type of material as much as it is in the compaction of these materials, where some areas are compacted more than other areas as far as the lifts were placed.

We do not have, you know, cobbles and riprap and things like that that exist below the pipelines.

BY MS. STAMIRIS:

Q Maybe if I give you a specific example it will help you to understand the question better.

A (WITNESS MEISENHEIMER) Okay.

Q I remember in the NCR 7820 report when they were describing the conditions of the soils beneath the administration building when those soils were excavated after the settlement problem there, a description was given of soils which were compacted and placed to the same requirements as are placed at other Category I structures in the site. And I remember reading a description of voids of air and chunks of material that were unbroken I think. I certainly couldn't be exact but of up to three inches.

If you had conditions like this where there were voids of air or chunks of unbroken clay or whatever material it was, couldn't that affect piping in a way different than the clay soil that you had already described?

MR. BRUNNER: I'm going to have to object to this question. It seems to me that Mrs. Stamiris is testifying here as to stuff that is not in the record. If she wants to ask a question about whether there are voids or whether there are hard chunks of material, I think it would be proper. But I don't think the question as phrased was proper.

MS. STAMIRIS: The 7820 report is in the record; and if anyone happens to have it -- which I don't -- I could turn quickly to that section. If Consumers has it I could find it very quickly to read a description of the soil that were of the same.

CHAIRMAN BECHHOEFER: I think we will overrule the objection. As long as the witness can picture the situation. I remember the same thing in the record that you do.

BY MS. STAMIRIS:

Q Let me ask first, Mr. Meisenheimer, if you are familiar with the report, the 7820 report on soils that described the soils underneath the administration building?

A (WITNESS MEISENHEIMER) No, I am not.

Q Okay. Well, then, conceiving of that situation that I described, would that affect piping differently than the way that you described earlier?

A (WITNESS MEISENHEIMER) Could you be more explicit with what you are conceiving?

Q Voids of air and chunks of unbroken material up to three inches. I don't know if I should -- I will say that just to give you something to be specific with.

MR. **Williams:** Mr. Chairman, I am going to have to object again. Ms. Stamiris has pointed to no information in the record which indicates that there are voids or chunks or anything else in the vicinity of the buried piping.

The subject matter of this hearing is buried piping. If she wants to ask the witness if he knows of any voids or chunks in the vicinity of the buried piping, I would have no objection to that. But without her furnishing the 7820 report and pointing to specific indications in it that there are such conditions, I am going to object to her ensnaring the witness in this hypothetical question.

MR. MARSHALL: I take exception to this objection and say there is evidence to what she is saying in the record already.

CHAIRMAN BECHHOEFER: There was a description of a condition near the borated water storage tank, but I am not sure that is the same one you are referring to. That appears on Page 17 of the Staff testimony we heard yesterday. But I am not sure that that would meet your --

MS. STAMIRIS: I would have to look at it. That is not the reference that I had in mind. Maybe I could ask Mr. Meisenheimer whether he thinks it's possible that such conditions could exist around the buried piping.

WITNESS MEISENHEIMER: Okay.

6-5

okay.

CHAIRMAN BECHHOEFER: You can answer that one.

WITNESS MEISENHEIMER: Okay. The condition that you are describing I assume is that we might have some particles on the order of three inches in size in the fill material and where there might be voids around the pipeline, is that the condition that you are describing?

MS. STAMIRIS: Yes.

WITNESS MEISENHEIMER: Okay. As far as the situation where we might have particles that are on the order of three inches in size around the pipe or beneath the pipe in the clay fill, that would not present a problem, a stress problem, on the pipe or affect the bending in the pipe as such. The condition where we might have voids around the pipe,it's very unlikely that we would have voids around the pipe in the open areas.

The only possible places that we might have a void around the pipe -- and we don't know that for a fact-- could be where we are close to a building as such and we might have some of the fill settle away from the bottom of the pipe. In that case we would have bending in the Pipe that would reflect that kind of a condition.

BY MS. STAMIRIS:

Q If you take as a given that fill soils around the pipe were compacted to the same requirement as fill soils where such voids were found, then on what would you base your statement that it's very unlikely that such voids would occur around the pipes?

A (WITNESS MEISENHEIMER) I really don't know at what points they found voids in the fill in the reference you are referring to. I can only relate it to the conditions that would occur along the pipeline based on my own experience in working with pipelines and also the evidence that I have seen at the Midland site.

We are dealing with a clay soil. The pipes are buried on the order of seven to nine feet or such below grade. The larger diameter ones we are talking about. At this depth if -- there might have been a void at the backfill, it would have been consolidated by this time. So it's very unlikely that we would have voids around the pipe at this time at those depths.

Q Well, if -- would not the key question be if you had a void, not whether it was consolidated at this time, but whether it was consolidated prior to the installation of the piping? In other words, if there was a void and then the piping was installed, you know, the piping could have been over-stressed three years ago and that over-stress would still be there, wouldn't it?

MR. WILLIAMS: I am going to have to object to that. I don't know whether Mrs. Stamiris is testifying to these facts that she is stating or what. But I think it's not a proper question. There is too much hypothetical information in the question, if it is indeed a question.

JUDGE HARBOUR: I think the witness answered a question as to the possible affect of voids. Didn't you?

WITNESS MEISENHEIMER: Yes.

JUDGE HARBOUR: And would it make any difference whether those voids were in pre-existing or any backfill associated with burying the pipe? Would it make any difference?

WITNESS MEISENHEIMER: Not really. If you have to have a void underneath the pipe, it means that the load has to be carried by the soil on either side of that pipe or other side of that void.

JUDGE HARBOUR: Would a 3-inch void have any significant effect on the stresses in a pipe whose diameter was 26 inches or larger?

WITNESS MEISENHEIMER: No.

JUDGE HARBOUR: 12-inches or larger?

WITNESS MEISENHEIMER: You mean the size of the pipe?

JUDGE HARBOUR: No.

WITNESS MEISENHEIMER: Three inch, no.

BY MS. STAMIRIS:

Q I will try and get to what my basic concern is in a different way. What are the smallest pipes at the site?

A (WITNESS LEWIS) The smallest buried pipes at the site?

Q Yes.

A (WITNESS LEWIS) We have one line that is a one-inch line that has been recently installed. There is diesel fuel oil lines that are one and a half to two inches in size.

Q Would I be correct in assuming, Mr. Lewis, that the smallest pipes are the most subject to stresses due to soils?

A (WITNESS LEWIS) No, ma'am, I would say just the opposite, that the flexibility of the small pipes allows them to -- we really don't see the type of stresses that we are talking about.

Q What are the most -- can you answer what are the most critical pipes at the plant in terms of their response to soil settlement?

A (WITNESS LEWIS) That would be the larger pipes, the 26 and 36-inch pipes.

5-6

JUDGE HARBOUR: Is that because of their size or does their wall thickness also come into that?

WITNESS LANDERS: It very certainly is a function that deals with T Ridge.

JUDGE HARBOUR: Would you explain that ratio?

WITNESS LANDERS: The diameter of the pipe divided by the thickness.

BY MS. STAMIRIS:

Q So then it's a function of -- well, let me just ask, Mr. Meisenheimer, what would be a condition in the soils that would cause you concern for the piping? What is the acceptance criteria?

A (WITNESS MEISENHEIMER) The acceptance criteria to what?

Q To failure of the parts to over-stressing, ovality.

A (WITNESS MEISENHEIMER) That is a structural problem. I am not a pipe expert. I really can't answer that.

Q Okay.

A (WITNESS MEISENHEIMER) If you are concerned about what I consider a point that would be concerned as far as bending goes or something like that, is when you have a fixed condition such as in a building anchor which we have talked about versus the pipe, whereas in the soil, and those are the areas that we are monitoring.

Q Those don't concern me as much as the ones you can pinpoint. What I mean to ask is: When you are putting in stress measurement devices in the piping, assume that you are putting it at selected locations. What process did you use to select those locations?

A (WITNESS LEWIS) We addressed that in Page 34 of the testimony, I believe. We are selecting the strain monitoring locations based primarily on the points of highest ovalation of the pipe.

Q Okay. I don't want to focus then on the settlement monitoring but on the -- is it -- I also get strain and stress mixed up, the stress monitoring --

A (WITNESS LEWIS) Strain monitoring.

Q Strain monitoring, thank you. -- that you are determining the ovalation from, where are those strain monitors installed or do they monitor the length of the pipe?

A (WITNESS LEWIS) They will be installed at the points of highest ovality, measured ovality, in the pipes.

Q But if they are installed to determine ovality, how can you be sure you are installing them at points of highest ovality?

A (WITNESS LEWIS) The highest ovality based on the measurements taken this fall. And the purpose is to measure that ovality up to the limit.

Q What I am really concerned about is the fact that -- or how can you be sure -- would you say, Mr. Lewis, that it's true that because of the variable soil conditions, that you can't be sure of where the points of highest stress are due to soils?

A (WITNESS LEWIS) I would defer to Mr. Meisenheimer.

A (WITNESS MEISENHEIMER) Because of the soil condition, we can -- we do know where the points of highest stress will be in the future. We know right now, we are assuming that points of higher ovality or points of high stress at the present time in the future. What happens in the future with the soi onditions we have, and considering we are talking about buried pipelines, the place that will have the highest bending stress increase would be the point that we would expect the most differential settlement from one point to the other.

The only place that this will really occur will be where we move from a soil condition where the pipe is basically floating in the soil mass and settling with the soil mass. Because of the soil we have, we do not have abrupt differential settlement characteristics in the pipe because of the nature of the soils. The place that we can have a possible abrupt change is where we move from the soil to a point of anchorage. But that point of anchorage is not moving as much as the soil is settling.

So the difference of what a building or an anchorage point settles versus what the soil is settling outside that anchorage is our point of highest differential settlement and would be the point of future high stress increase.

Q I would like to show Mr. Lewis a document from Consumers Power Company that I received. It was contained in a document from the NRC, signed by Darl Hood, dated September 23rd, 1981. The Consumers Power Company document is a summary of a meeting with the NRC and ETEC on underground piping which took place on February 4th, 1981.

I would like to ask Mr. Lewis if he is familiar with this meeting summary.

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summary.

CHAIRMAN BECHHOEFER: Ms. Stamiris, unless I have got the wrong document, my document says "Summary of January 20, 1981 meeting" and it's dated September 23rd. Is that a different document?

MS. STAMIRIS: Perhaps the cover letter from Mr. Hood refers to that meeting. There is Consumers meeting notes inside, a few pages referring to the February meeting that I mentioned.

MR. BRUNNER: I don't think it does. I think it also refers to a January 22nd meeting.

CHAIRMAN BECHHOEFER: It's the document dated February 4.

MS. STAMIRIS: I was looking at the wrong date.

MR. BRUNNER: Yes, the meeting date is right here.

MS. STAMIRIS: Oh, I see.

BY MS. STAMIRIS:

Q Mr. Lewis, are you familiar with that meeting summary?

A (WITNESS LEWIS) I'm generally familiar with the meeting that took place. I'm not familiar with the summary.

Q I do not have another copy. I believe it was Point 6. In Point 6 of that meeting, is there a statement of Consumers position that they believe that ETEC was being too conservative on something?

A (WITNESS LEWIS) You referred me to Point G when you handed it.

Q Point G, yes.

A (WITNESS LEWIS) This concern refers to rota-tional flexibility and during the surcharge; is that correct?

A (WITNESS LEWIS) Yes. I have read the paragraph. What is the question?

Q Are you familiar with Consumers position on that point in the meeting?

A (WITNESS LEWIS) No, I am not.

MS. STAMIRIS: I don't have any other questions at this point --well, wait a minute, I am sorry. I am looking at my notes. I may have a couple more.

BY MS. STAMIRIS:

Q Mr. Lewis, are there any pipes at the plant where something other than pure water flows through those pipes? Well, I should -- I don't mean to ask that, but is there any liquid that flows through the pipes that has some debris or something in it?

A (WITNESS LEWIS) I understand the question to be limited to safety grade pipes buried; is that correct?

Q Yes.

A (WITNESS LEWIS) Other than water pipes, we are talking two lines, two small lines, carrying air and one set of small lines carries fuel oil for the diesel generator.

Q What I was really thinking of is are there any water pipes that come from the cooling pond area that might have debris in them of some kind in the water that could get blocked in the pipe?

A (WITNESS LEWIS) There are no safety grade pipes, pipes that have a safety function of that nature. There are non-safety grade pipes associated between I believe the service water pump structure and cooling tower.

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Q Well,are these non-safety grade pipes being measured in any way, monitored?

A (WITNESS LEWIS) Not to my knowledge.

Q Well, what if one of the non-safety pipes collapsed?

A (WITNESS LEWIS) Pardon me?

Q What if one of the non-safety pipes collapsed?

MR. WILLIAMS: Mr. Chairman, I believe the subject of this hearing is the seismic Category I piping. I think the question is outside the scope of the hearing.

CHAIRMAN BECHHOEFER: To the extent the piping, that non-safety piping might have an impact on the safety structures, it would be in, so maybe the questioning could lead to that.

MR. WILLIAMS: Well, perhaps if she would ask that question it would be proper, but that is not the question she asked.

CHAIRMAN BECHHOEFER: Well, I think she is getting there.

MR. WILLIAMS: Well, it is taking quite a while.

CHAIRMAN BECHHOEFER: I think I will allow the question.

BY MS. STAMIRIS:

Q Mr. Lewis, can you conceive of a situation where a failure of a non-safety pipe could impact a safety condition at the plant?

A (WITNESS LEWIS) We have looked at that and reviewed cases where non-safety piping passes beneath safety grade piping and have done, performed evaluation of failure of the non-safety grade piping and potential impact it could have on the safety grade piping, specifically supported safety grade piping, and we have concluded that the unsupported lengths of pipe that could occur in safety piping would not result in undue stress. There would not be a problem with the functioning of the safety grade pipes.

Q And aside from this supporting or non-supporting condition that you were referring to with the non-safety piping, did you analyze situations where failure of non-safety piping would then lead to failure of a system that might lead to failure of another system which could be safety related? I mean, did you go down a sequence or a chain of possible events that started with a non-safety pipe failure?

A (WITNESS LEWIS) The specific analysis I referred to was limited to non-safety pipes passing under safety pipes. The broader question as I understand you are asking it really relates to the whole manner in which we designed the system, and we attempted to consider that within our design guidelines.

Q So are you saying that when the design guidelines were set and certain pipelines were determined to be non-safety piping in the first place, that a complete run-through of the failure of that piping and what could happen in a chain of events from that was considered in setting those criteria?

MR. WILLIAMS: Mr. Chairman, I think we are wandering pretty far afield here.

CHAIRMAN BECHHOEFER: I think that one we will have to sustain. It is a little broad, a little far afield from what we are talking about here.

MS. STAMIRIS: Okay.

BY MS. STAMIRIS:

Q Mr. Lewis, did you, in analyzing the safety of Category I piping, consider the combined effect of corrosion of piping which caused air leaks in that piping in the area of the borated water storage tanks in combination with stressing of soil settlement?

A (WITNESS LEWIS) Any analyses that we have done with respect to the borated piping and soil settlement have considered minimal allowable wall thicknesses --

Q Have considered what, I am sorry?

A The minimum allowable wall thicknesses of the piping which includes a corrosion allowance. So to that extent, yes, we have.

Q Are you aware of the corrosion that occurred in the piping near the borated water storage tank in 1979?

A I am aware of some corrosion problems that did occur in -- yes, I am.

Q Well, are you concerned that the pipes were corroded and leaking before, you know, some good many years before the plant is even operating?

A (WITNESS LEWIS) As a project, yes, we were concerned about it. My understanding of it is that we have taken and are taking corrective action both to repair pipes that have been unacceptably corroded and they have the cathodic protection system in place to prevent undue further corrosion.

Again, this was not specifically in the context of the settlement issues. This was a different type of concern.

7-2

concern

Q Well, has that protection extended to all the piping at the plant?

A (WITNESS LEWIS) I do not know.

Q Do you know how far, have you analyzed the corrosion problem as to how widespread its effect or potential effect is on all the piping at the plant?

A (WITNESS LEWIS) That specific problem has not been an area of my responsibility and I am not specifically familiar with it beyond the fact that in preparation for this testimony I looked at what the problems had been and satisfied myself that they did not relate to the settlement issues as such of the buried piping. Beyond that, I'm not familiar with the specific actions that were taken.

Q Well, if you had unusual corrosion for some reason in the piping at the Midland plant, do you not consider that you should take that into account along with the soil settlement stresses when you are measuring the -- whether the pipes will perform their intended safety function over the life of the plant?

A (WITNESS LEWIS) If we had an indication that the piping was corroded to lessen its design thickness, wall thickness or condition, that would have to be considered in our analysis and in our monitoring. We do not have that indication at this point.

Q Well, have you looked into it? I mean, how far did you look into that situation of corrosion after the experiences in 1979?

A (WITNESS LEWIS) I'm aware that there was substantial review done of the plant piping systems for the corrosion. I did not have direct involvement in it, so I do not know exactly what it was. I looked at a brief summary of it a few days ago and it was very limited scope of corrosion, so it was of no further -- I did not feel that it was a further concern in the context of the settlement of buried piping.

MS. STAMIRIS: I do not have any more questions.

CHAIRMAN BECHHOEFER: Okay, Mr. Marshall.

MR. MARSHALL: I have two questions, and I hope they are within the scope.

CROSS EXAMINATION

BY MR. MARSHALL:

Q Some questions she has stated here and answers I have heard lead me to ask this question of any one that can answer it.

What are the possibilities of installing piping down there of any size which has imperfections coming from the fabricator,defects?

A (WITNESS LEWIS) The piping, safety grade piping buried in the plant is fabricated to the ASME 3 code and that does require inspection and records of inspection.

To that extent, those requirements and those inspections give us confidence that the piping that is in the ground as installed is fabricated and installed acceptibly.

Q Well, I have been reading things lately that indicates that some people, despite all these inspections, are not infallible, and we are having defects creeping into these pipes. I think you are aware of what I am trying to say, but anyway, going on. Forget that. I will accept that as an answer and go on.

I would like to ask you at what -- we have a lot of piping around this county. This is undermined with piping everywhere. I would like to ask you what season of the year are you likely to have more problems down there with underground piping, one season is greater than another?

A (WITNESS LEWIS) The piping to my knowledge -- Jim, you can support me -- the piping to my knowledge is all below the frost line, and the problems I would expect to be independent of seasonal variations.

Q Well, does ground motion have anything to do with them?

A (WITNESS MEISENHEIMER) What kind of ground motion are you talking about?

Q Well, I understand that we have a situation around nuclear plants where we have ground motion, different types of ground motion from one time or another, like maybe not really -- it wouldn't -- I wouldn't say that it would be -- maybe a tremor something like that?

A (WITNESS MEISENHEIMER) You're talking about an earthquake?

Q Not exactly an earthquake, but from running machinery or something like that that is in the near area in close proximity to these pipes.

A (WITNESS MEISENHEIMER) Vibrations from construction?

Q That is what I am talking about.

A (WITNESS MEISENHEIMER) Vibrations from construction machinery would not affect the pipes as they are right now.

Q That's what I am getting at, yes. Not what he was thinking.

MR. MARSHALL: That's all. That's all the questions I have.

CHAIRMAN BECHHOEFER: I think at this point we will adjourn for lunch and come back for further questions. About 1:30.

(Luncheon recess to 1:30 p.m.)

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

Whereupon,   1:45 p.m.

DONALD F. LANDERS

DONALD F. LEWIS

JAMES MEISENHEIMER

called as witnesses by counsel for the Applicant, having previously been duly sworn by the Chairman, were examined and testified further as follows:

CHAIRMAN BECHHOEFER: Back on the record. I assume we will finish this panel before we will get into our discussion of some of the matters involving the QC inspectors.

MR. WILLIAMS: Yes, I would like to proceed that way if possible. I believe Mr. Zamarin is still on the telephone obtaining information he had promised to you, and I think it would be more efficient if we proceeded that way.

CHAIRMAN BECHHOEFER: I take it there is no objection to proceeding before Mr. Zamarin gets back?

MR. WILLIAMS: No, we will proceed.

MR. ZAMARIN: I was wondering, before we start with the panel, if it would be possible to get some indication -- this may not be physically possible -- of the amount of time that might be taken. Really what I am wondering is if we should plan on having other witnesses here this afternoon on a different subject. Do you have any feel for that?

CHAIRMAN BECHHOEFER: The Staff has two panels.

MR. BLUME: Mr. Chairman, I don't know if it will -- it should be more efficient, and we would like to present just one panel on piping, Mr. Kane, Dr. Chen, and Mr. Hood together. I think it would be more efficient.

MR. ZAMARIN: I am sorry, I am off by a factor of one panel. I apologize. I have been more concerned with the scheduling than what has been going on. I had forgotten that the Staff panel still had to go on. So I am sorry.

CHAIRMAN BECHHOEFER: We should finish with the staff panel fairly early. I don't think we have an exceedingly large number of questions of any of the panels as far as we are concerned. I don't know what other parties have.

MR. ZAMARIN: I think we may then assume that we will finish early and plan on having someone available on some subject today.

CHAIRMAN BECHHOEFER: Is Mr. Boos going to respond to the question by Judge Harbour?

MR. ZAMARIN: I think that we have intended that to be tomorrow,again because of his avilability. We have all the information but it's really just a scheduling matter.

MR. PATON: Mr. Chairman, I have been talking to Mr. Zamarin about what is going on at the site, and I think we are getting conflicting sequence. But anyway there seems to be some remote possibility that Mr. Gardner would testify today.

Could we ask the applicant if he has any idea how long this cross examination will take of the staff panel?

MR. WILLIAMS: Of your panel on piping?

MR. PATON: Yes, because if there is any possibility that it looks like we might want to hear from Mr. Gardner today, I would want to get him here so I can talk to him before he goes on the witness stand.

MR. ZAMARIN: That is what I was referring to putting someone on. I had Mr. Gardner in mind. And we will be getting a phone call soon that will tell us.

MR. PATON: I have no desire to push the program. If it's going to take all afternoon on pipes, it's fine. But if there is any likelihood of Gardner testifying, I want to get him here.

MS. STAMIRIS: Are you talking about just on the QC qualifications?

MR. WILLIAMS: To answer your question, it appears there are some small clean-up matters on the order of ten minutes, fifteen minutes perhaps at the outset.

CHAIRMAN BECHHOEFER: Miss Stamiris, about how long do you have for the Staff?

MR. BLUME: Mr. Chairman, can we go off the record for this discussion?

(Discussion off the record.)

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CHAIRMAN BECHHOEFER: Before the Board starts, did the Staff want to ask any questions of this panel as a result of cross examination thus far or would you prefer to wait until we go around to recross?

MR. BLUME: I think we would prefer to wait until recross, Mr. Chairman.

CHAIRMAN BECHHOEFER: All right.

EXAMINATION BY THE BOARD

BY JUDGE HARBOUR:

Q With regard to the elevation of the seismic Category I piping as they were, as the elevations were measured, what was the specified tolerance in the design elevations for this underground Category I piping?

A (WITNESS LEWIS) The elevation tolerance is plus or minus two inches for the design elevation.

Q And what were the maximum variations that were found as a result of the measurements?

A (WITNESS LEWIS) The extreme measurement was approximately 12 inches, somewhat less than 12 inches below the design elevation. I am referring now to the 26 and 36-inch piping.

Most of the elevations were in the 4 to 6 inch range from the design elevation.

Q Are those Category I pipes Q listed pipe?

A (WITNESS LEWIS) Yes, they are.

Q Does the quality control system extend to their installation and placement?

A (WITNESS LEWIS) Yes, it does.

Q Were there any non-conformance reports filed on the deviation of the actual elevation from the design elevation of the Category I borated piping?

A (WITNESS LEWIS) To my knowledge, they were not.

Q Do you know why not?

A (WITNESS LEWIS) I don't know that there should have been.

Q Well, what is the purpose of the two-inch tolerance to design elevation?

A (WITNESS LEWIS) That is a construction tolerance used widely on the site.

Q Did anyone ever check to see if the buried pipes meet that tolerance?

A (WITNESS LEWIS) At the time of the placement of the pipes in the trench, yes.

Q Was that done in the case of these pipes?

A (WITNESS LEWIS) The records indicate that the pipes were in accordance with the specification.

Q Is there QC documentation on the elevations of these pipes as laid?

A (WITNESS LEWIS) There is not quantification. There is not the dimension elevation points in the QC records. There are indications. The records do indicate that installation was in accordance with the specification, but numbers as to actual elevations do not exist.

Q You stated that you did not know whether a non-conformance report should or should not have been filed on these deviations up to 600 percent from the specified tolerance. Can you explain why you think a non-conformance report should not have been filed?

A (WITNESS LEWIS) I will attempt to. The measurements that we are talking about were taken in the fall of 1981. From the time that the pipes were installed, which was generally in 1977, from the time that the pipes were placed in and location was checked, after that time the actual welding took place, the trench was backfilled and then time elapsed during which general plant settlement ocurred.

I have no basis whatsoever for saying or believing that the pipes were out of tolerance at the time that they were installed. Things have happened since then. There is no way of saying either exactly what did cause the change from the design elevation. It is an undefined quantity and we have no method to my knowledge of defining it.

-2

it

Q In relationship to the use of strain measurements to relate to ovality and buckling or failure of the pipes, as I understand it almost the entire body of experimental knowledge that exists anywhere is referenced in this report. Is that correct?

A (WITNESS LANDERS) To the best of my knowledge, that is not to say all of it that exists is referenced, but all of it that we could find.

Q Does that represent many many experiments or experimental series?

A (WITNESS LANDERS) Yes, it does. In fact, there is a plot in Figure UP-8 I think it is of all of the data, UP-8A of all of the data that we were able to find.

Now, this plot is a copy of a figure taken from one of the references, the so-called Reddy paper, as well as additions that we've added to it from further test data that we found.

Q I guess that your view of a lot of data and my view of a lot of data must not be quite the same because that looks like a rather sparse data set.

Is there an amount of scatter in that data set?

A (WITNESS LANDERS) Yes, there is scatter. I think one point that should be made is that investigators investigate problems. When the industry is having a problem in a certain area, then one finds investigators doing significant work in that area. So that perhaps the lack of data is the result of the fact that buried pipe has excellent experience.

Q Well, were these experiments conducted specifically with buried pipes as opposed to non-buried pipes?

A (WITNESS LANDERS) None of these experiments are buried pipe. These are all in air.

Q Would the results that you have applied here in obtaining the relationship between strain and ovality be particularly sensitive to the correctness of one, any one or two experimenters' data sets? That is, if one or two of the data sets were found to be inaccurate or inapplicable, would it significantly affect your strain and ovality relationships?

MR. WILLIAMS: Judge Harbour, I think that perhaps the witness created a misapprehension in your mind by something he said before lunch. I believe he stated that the relationship between ovality and strain was based on experimental data and I think he is prepared to correct that statement to some degree. I think maybe that might clear up part of the question you are asking about.

WITNESS LANDERS: Yes, you beat me to it.

A (WITNESS LANDERS) In answer to I think it was Judge Decker's question about the equations, my response may have indicated that the equation was empirical in nature. The equation is in fact theoretical in nature and based purely on theory.

What we have done is taken as much applicable data as we can and compared it with the derivation of that data, so that the equation itself is theoretical. It is not empirical.

MR. WILLIAMS: You are referring in that case to the equation on the graph --

WITNESS LANDERS: On Page 26.

MR. WILLIAMS: The equation on Page 26 and the graph which is set forth in Figure UP-8?

WITNESS LANDERS: UP-9.

MR. WILLIAMS: UP-9, excuse me.

WITNESS LANDERS: Yes, sir.

BY JUDGE HARBOUR:

Q Will you explain the relationship of the experimental data that are plotted on UP-8A to the curves that are presented on Figure UP-9?

A (WITNESS LANDERS) There is no relationship. The curves on UP-9 are curves that are representative of the 26 and 36-inch buried pipe at Midland using the equations presented on Page 26, the data on Figure UP-8A or the data presented in Figure UP-8A is just the data that we could find in the literature.

tk10

JUDGE HARBOUR: What is the relationship of those data then to the verification of the theoretical formula which you are using to relate strain to ovality?

A (WITNESS LANDERS) We have taken most of the data that is applicable on Figure UP-8A and calculated ovality from strain where both of those were presented in the paper, and using our equation compared the results taking strain, calculating an ovality, looking at the empirical ovality and coming up with a comparison. So that is how we have used the data to verify the equation.

MR. WILLIAMS: That verification is not what is shown in Figure UP-8A?

WITNESS LANDERS: No, Figure UP-8A is just a presentation of all of the data.

MR. WILLIAMS: Can you explain for Judge Harbour quantities that are shown in Figure UP-8A? I think perhaps if you do that, that would clear up some of this.

A (WITNESS LANDERS) Again that is taken from one of the references that appear in the testimony as well as the addition of other data that we have found. And essentially it plots the strain at bifurcation or collapse, depending upon what the investigator called failure versus ratio of the radius of the pipe divided by the wall thickness of the pipe.

JUDGE HARBOUR: Would you explain the strain dimension there in more physical terms than simply in inches? I mean where on the pipe is the strain measured?

A (WITNESS LANDERS) In many cases its the average reading of the number of strain gauges located on the pipe at the region that the investigator anticipated that failure to occur.

JUDGE HARBOUR: Around the entire circumference of the pipe?

WITNESS LANDERS: No, sir, in the region of wrinkling. For example, on the top of the pipe and the compression range.

JUDGE HARBOUR: In the inner radius of curvature of the pipes?

A (WITNESS LANDERS) Yes.

JUGE HARBOUR: Are the strain gauges being placed on the pipes at Midland being placed on what is believed to be the inner radius of curvature?

A (WITNESS LANDERS) Yes, sir.

JUDGE HARBOUR: In the calculation of the earthquake effects on the buried piping, the testimony starting around Page 27, I believe, and then continuing from thereon. What earthquake has been used in the seismic analysis of the pipes at the Midland site in this testimony?

A (WITNESS LEWIS) The analysis used the SSAR earthquake, zero point acceleration of .12 of G multiplied by factor of 1.5.

JUDGE HARBOUR: Does the acceptance criterion for ovality of pipe contain sufficient margin that the added loads due to earthquake will still insure that the integrity of the piping is still maintained?

A (WITNESS LEWIS) Yes, it does.

JUDGE HARBOUR: Does this include the longitudinal strain, the shear wave reflections and the loads that are -- the strain that is caused by differential movement at connection?

A (WITNESS LEWIS) Does the -- let me understand the question. Does the entire analysis consider those affects, is that your question?

JUDGE HARBOUR: Does the margin of strength in the pipe provided by the acceptance criterion for the ovality include effects from actual tension compression due to traveling waves, shear and bending due to traveling waves and strain caused by dynmaic differential movements at connections?

A (WITNESS LEWIS) Yes, it does.

JUDGE HARBOUR: And these cases were all analyzed?

A (WITNESS LEWIS) Yes, they were.

BY JUDGE COWAN:

Q Referring to Page 10 of the testimony, I guess possibly Mr. Lewis, this is for you. I notice that there is a reference to estimates of the net differential settlement expected along buried piping as a difference between future settlement of the building and settlement of the fill. Have such estimates been made?

A (WITNESS LEWIS) Mr. Meinseheimer will answer.

Q Be my guest.

A (WITNESS WEISENHEIMER) I will answer that. Right now we are -- have used the maximum settlement of three inches because we are uncertain what the total conditions are along the pipeline, and we feel this is the worst condition that would occur across the site based on the borings we have reviewed and the Borros anchor settlement, plots and conservatives thrown into that.

The maximum differential settlement that you are talking about would be -- we are talking about assuming that the worst condition at a building would be a soft soil at a building,so the differential settlement would be what the pipeline would be moving on the order of three inches versus what the building is going to settle in its predicted future. So if you know the buildings will settle half inch, and we are talking estimated maximum differential settlement two and a half inches at that location.

location

Q You are talking about the termination where the pipe is anchored?

A (WITNESS MEISENHEIMER) Where the pipe goes into the building, that's correct.

JUDGE COWAN: Okay. Turning to page 21, it refers to an additional significant information which addresses the occurrence of ovalization. Were you referring to any particular information or just the fact that you made a literature search and came up with some helpful information?

A (WITNESS LANDERS) We did make a literature search and that information is listed in reference 3. It wasn't data but rather guidance.

Q Page 33 seems to be the next reference that I have where you are talking about these strain gauges. I think I understand the principle of operation of the strain gauges. I wanted to ask how trouble-free they are over a long period of time. That would be the first question.

A (WITNESS LEWIS) Experience that we have are from the -- one of the designers of these gauges indicates that it's quite trouble-free for a period up to 20 years or more and potentially longer than that, although up as high as 40 years. Although the data base gets rather sparse at that point.

Q Would you expect the strain gauges performance down the road 15 or 20 years to be of any real importance?

A (WITNESS LEWIS) We would plan to use the strain gauges over the life of the plant. The proposed technical specifications have been -- not the proposed specifications but the ones as we would envision them now would leave open the question of whether monitoring would continue to be done after five years. However, the gauges we would install, we would consider to be necessary for the life of the plant.

Q Do you consider that the sensitivity of these gauges is adequate for the purpose you are using them for?

A (WITNESS LEWIS) Yes, sir, I do.

Q Well, I see some other questions here that involve possible resolution of disagreements with the Staff. I think perhaps those are properly held until the Staff testimony is brought forth.

BY JUDGE DECKER:

Q Can you summarize for me, please, what remedial actions with respect to piping have been done, are under-way, or as far as the project is concerned, will be undertaken?

A (WITNESS LEWIS) That is summarized on the large drawing, Figure UP-13, where we show piping that has been or will be rebedded. I will summarize it for you verbally. To date piping to the north of the diesel generator building, 8 inch service water piping has been rebedded. Piping associated with borated water storage tank is in the process of being rebedded partially in conjunction with the work on borated water storage tank.

In the future, as I stated earlier, we will replace the 36-inch service water piping in the vicinity of the service water pump structure and we will, in addition to the elevation and detailed elevation and profile, ovality data that we developed in the fall of 1981, we will continue to monitor the remaining installed piping ovality and settlement.

Q Have you sought and received concurrence from the Staff on any of these remedial actions?

A (WITNESS LEWIS) We have been discussing these actions extensively with the Staff. I believe that in concept we have their agreement. We are still discussing with them the exact point of monitoring, particularly the settlement monitor location.

Q You have nothing in writing as there have been for other remedial action in which the Staff concurs in a proposed remedial action ?

A (WITNESS LEWIS) Beyond what is in the Staff's testimony, that's correct.

JUDGE HARBOUR: I have a small question for clarification for my own information. It has to do with the lack of a legend on Figure UP-1.

A (WITNESS LEWIS) Yes, sir.

JUDGE HARBOUR: There are lines going from the emergency diesel fuel oil storage tanks near the bottom of that figure up to the diesel generator building, and then from the diesel generator building it's kind of like a snake pattern on there. Can you tell me what that symbol represents on this?

A (WITNESS LEWIS) That is underground duct bank.

JUDGE HARBOUR: And that symbol is used elsewhere?

A (WITNESS LEWIS) Yes, sir.

JUDGE HARBOUR: On that figure?

A (WITNESS LEWIS) On that figure, yes.

JUDGE HARBOUR: Thank you.

BY CHAIRMAN BECHHOEFER:

Q I would like to first start out with a fairly general question and exclude now your testimony on 36-inch piping. But with respect to other piping, is your testimony and the system described by it the same as that provided in the Staff on December 15 or are there differences.

A (WITNESS LEWIS) There are differences and we have discussed those differences -- have been discussing those differences with the Staff on two meetings, one meeting in January, '82 and another in February.

February

Q In general what areas are those differences in?

A (WITNESS LEWIS) In the December 15th submittal we had a different monitoring program than we now are discussing and are now doing. Our monitoring program at that point was based on some level monitoring and also flow verification measurement. We have been discussing -- decided to monitor ovality strain based on ovality in settlement. That I believe is the primary area of difference.

tkll

Q Does the listing of seismic Category I piping which you have provided in Table UP-1, does that include the non-seismic piping where there could be an effect on safety equipment?

A (WITNESS LEWIS) No, it does not.

Q I think in this wording that you mentioned that you had taken that into consideration. Where would the results of that appear? Has that been provided to either the staff or to us?

A (WITNESS LEWIS) It is not part of the testimony. At least it is not part of our testimony. We have discussed the analysis with the staff in meetings this year and late 1981.

Q There was some testimony this morning about I guess the effects of roads or railroads. Is it likely that there could be future roads installed or railroads installed which might have an impact on buried piping?

A (WITNESS LEWIS) We did an analysis -- to answer your question, I don't know what the plans are for new roads or railroads. There is a railroad that presently is in place, although I do not believe that it has been used yet for going into the north end of the auxiliary building, and that does cross some of this piping.

You know, what changes may be at hand, I'm not aware that there would be any. The evaluation, the analysis that we did for loads, specific rail loads, heavy loads that could go over the piping was of a generic nature and would apply to any future loads, road traffic or railroad traffic that may be put in the area.

Q So does that mean that you think that wherever a road or a railroad would be installed, it would not have a significant effect on piping?

A (WITNESS LEWIS) Yes, sir.

Q The piping to which you were addressing.

A (WITNESS LEWIS) Yes, sir, that is correct.

If there was a specific load that was going to be unusually heavy or something like that, it would have to be analyzed obviously, but the load that was analyzed was very large.

Q Well, can you give us some idea of when a load would become such that it should be analyzed, any type of --

A (WITNESS LEWIS) Yes, I think so. The question was addressed in response to Question 34 of the 5054(f) report. The load that was analyzed was a Cooper's E-80 railroad load with an impact factor of 1.5, producing a load of approximately 2,000 pounds per square foot. This load does involve a spent fuel cask, the heaviest construction crane, any expected truck loading. So we cannot anticipate any loads that would be heavier than those that are already enveloped.

Q How much heavier than that do you suppose a load would be before you would think a new analysis would be necessary?

A (WITNESS LEWIS) Some comparison perhaps. The construction crane has a load of approximately 1,000 pounds per square foot. The analyzed load was approximately 2,000 pounds per square foot, so twice the size of the largest construction crane used.

The truck loading is approximately 200 pounds per square foot, so the analyzed load is about ten times greater than the largest truck on site.

Q But do you think, for instance, if the load should turn out to be 3,000 or 4,000 -- at what point do you think further analysis might be warranted?

A (WITNESS LEWIS) I understand your question now.

The loads were from the heavy load and not counting now the soil above the piping, but just looking at the transient load, was less than half of the **allowable** load, which would imply that twice that load could be taken without substantial concern.

Q I see. On Page 10, the statement about the conservative estimate and future maximum settlement of varied utilities, you state that it is not more than three inches.

Would three inches constitute an acceptance criteria or criteria beyond which further studies or further action would have, should be taken?

A (WITNESS MEISENHEIMER) We haven't reached a concurrence on that with the staff. That is something that we will be discussing as we develop our monitoring program and the tech spec for that program, but that would be one of the factors that would be included in that evaluation.

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Q Do you think there should be some measure behond which some further action would have to be taken, either analysis or something else?

A (WITNESS MEISENHEIMER) I think if we approach this value we would definitely be concerned about what was happening. At the same time there would probably be an evaluation performed at that time to see what was causing it and if it was significant to the pipe as far as inducing bending to the pipe.

Q Well, vis-a-vis the staff, what has the company's position been on this, when you get two or three inches, do you do further analysis or something else?

A (WITNESS MEISENHEIMER) Well, I guess I get back to that would be part of the criteria in the monitoring program and that would be worked out with the staff so that we are both in concurrence as to which direction and any actions we should take.

Q I see. Have you made any proposals?

A (WITNESS MEISENHEIMER) No, we have not.

Q Thus far?

A (WITNESS MEISENHEIMER) No.

Q I see. Okay. Just for clarification, on Page 13, it is my understanding that in the top paragraph, it is my understanding that there are 22 lines of service water piping. How many of those are 26 inches or larger and thus included in the analysis?

A (WITNESS LEWIS) Let me refer to Table UP-1.

Including the 26 and the 36-inch piping and counting a line that goes from 26 to 36-inch size, that's two lines, that could be 12 lines.

If you count a line that changes size from 26 to 36-inch diameter as two lines, then that counts up to 12 lines.

Q So I take it you have not really profiled the other 10 lines?

A (WITNESS LEWIS) That's correct.

Q Do you think you have adequate data or information to predict what will happen to those other ten lines?

A (WITNESS LEWIS) Yes, we do, because the majority of the lines had been rebedded in the last year and the four lines that have not been rebedded are first, short lines that connect between the diesel building, diesel generator building and 26-inch line that has been profiled and, furthermore, those have had the pig put through them to confirm that they are not -- to give us some feeling, the best feeling that we could get that is valid.

A (WITNESS MEISENHEIMER) Could I add something to that?

Q Yes.

A (WITNESS MEISENHEIMER) These lines that we are talking about too, we have not only checked out their present ovality, but we have also looked at the soil conditions in each of these areas. In the area of the diesel generator building, this is an area that was surcharged in a surcharge loading area and we have forced a lot of consolidation and do not expect that much more consolidation in the fill in that area.

The lines in the borated water storage tank area, the soils, we reviewed the borings in there -- we had quite a few -- and the soils and area are generally very good, and we would expect very little settlement in that area.

So we have also included future settlement based on detailed boring information in both of these areas.

Q Now, in terms of the discussion of collapse that we have had this morning, is it conceivable or is it likely that the situation would come about where pipe would not have its, say its flow reduced, but would just start leaking and then -- or breaking?

A (WITNESS LANDERS) As a result of what, sir?

Q As the result of anything, seismic loads in particular, but anything else that might do that.

A (WITNESS LANDERS) Related to soils settlement and loadings associated with the site at Midland?

Q Yes.

A (WITNESS LANDERS) No, it's not conceivable.

Q Yes, I did want to relate it to Midland, yes.

A (WITNESS LANDERS) It's not conceivable.

conceivable

Q On page 31, Section 41.3, I wonder what the meaning of the words on line 3 of that paragraph are, the words "Are considered to be."

My question is, isn't it, aren't they either free connections or not free connections? What is the, "Are considered to be"?

A (WITNESS LEWIS) Where the piping comes through the building wall and leaves the soil, it is not fixed or anchored. It comes through an annulous spacing that provides for motion, so in that sense it is a free connection, and that is the way it was analyzed, as an unanchored point for the seismic analysis.

Q Turning to page 33, Mr. Cowan asked you a couple of questions about strain gauge instruments. Is there a degree of change in internal engergy which should be alluded before certain other actions are required? It says you are going to directly measure the change in internal energy. Is there some level or degree of change beyond which some further action ought to be triggered?

A (WITNESS LEWIS) The measure of the degree and change in internal energy will be the strain measurement and, yes, that will be tied to a specific limit in the technical specifications with a defined action.

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Q Have you developed anything along that line and recommended anything along that line at this point in time?

A (WITNESS LEWIS) No, we have not at this point.

Q On Page 32 in the criteria that appear at the top of the page, why is No.2 necessary at all; or to put it the other way, why would not Item 1 be fulfilled?

A (WITNESS LEWIS) Will you please repeat the page number?

Q Page 34.

A (WITNESS LEWIS) Please restate the question.

Q Why is Item 2 at the top of the page necessary at all. To put it the other way, why wouldn't Item 1 always be fulfilled?

A (WITNESS LEWIS) Item 2 covers the case where there are fewer than four points along a given line with ovality greater than two percent and if we did not hate criteria No. 2, then we would monitor fewer than four points on that line. And there are lines in that category. We felt that a minimum number of monitoring points on each line -- and again this refers to the 26 and 36-inch lines -- but we felt that a minimum of monitoring points on each line should be accomplished regardless of the ovality conditions in that line.

Q If that is so, then so Item 1 would never not be fulfilled, is that not correct? I mean --

A (WITNESS LEWIS) That is correct, we will monitor all points with ovalization measured based on the data of the fall of '81 2 percent or larger.

Q Perhaps Item 2 could be stated with somewhat more clarity. In other words, 4 points will be the minimum whether or not Item 1 were fulfilled?

A (WITNESS LEWIS) That is correct. I am trying to think the words to make it more clear. Yes, we will monitor all points two percent or larger ovality; and if there are fewer than four points of two percent ovality, we will still monitor at a minimum of four points.

Q Now, turning to the criteria for monitoring frequency which appear at the bottom of Page 35 in No. 3, I want to know what a seismic event is as used in that paragraph. Does this mean one one hundredth of a G or displacement? What defines event?

A (WITNESS LEWIS) The exact level would be defined in the technical specifications. It has not yet been decided.

Q I take it that does not mean every seismic occurrence.

A (WITNESS LEWIS) I would not expect it to, but at the same time, I could not give you a cutoff point below which we wouldn't want. But the actual values have not been defined and decided yet.

CHAIRMAN BECHHOEFER: That is all the questions we have at this time.

Do you have some redirect?

MR. WILLIAMS: I have a few items I would like to take up on redirect, yes, sir.

REDIRECT EXAMINATION

BY MR. WILLIAMS:

Q Mr. Lewis, this morning there was some discussion of the fit up tolerances and the meaning of fit up tolerances with respect to laying of this pipe. I would ask you, for the Board's benefit, to go through in as much detail as you can the process of laying of pipe of the type that is under discussion here, i.e. the large pipe wherein the process these tolerances are applied and measured and what happened subsequent to those measurements.

A (WITNESS LEWIS) The pipe, after placement in the trench, is fixed up to the adjoining pipe for weld. It is at that point prior to the welding operation that the location of the pipe is checked. After that check is performed, the welding is accomplished, construction takes place of the weld itself for the quality of the weld. And then following that, the pipe is backfilled, fully bedded and backfilled to complete the process.

The check points then are for locations prior to the welding process for welding integrity is doing the stress checks of the weld fit up preparation, but then of the weld itself after it is accomplished.

I think there may have been some confusion when we were looking at welding records.

12-2

records.

Q Is it also true fit up tolerances, that is to say the amount, not now design location I am talking about but the relative location of the end of the pipe, is that also done prior to welding or after welding?

A (WITNESS LEWIS) That is done prior to welding.

Q There is no recheck of those measurements, either design location or weld fit up, after welding?

A (WITNESS LEWIS) To my knowledge that is correct.

Q Now, have you seen anything in your review of the records that would indicate that these measurements of either the design location or fit up tolerance were done improperly or not documented properly?

A (WITNESS LEWIS) My very cursory review of the records plus my discussion with other people who have looked at them somewhat more closely do not indicate any non-conformances with the fit up or with the welding.

Q Is that compatible in your view with the subsequent measurement of the location of the pipe as it appears in the profile measurement?

A (WITNESS LEWIS) I believe generally, yes, it is compatible. There are some points on the elevation profile -- and let me clarify it further: The elevation profiles were taken, among other places, a short distance, about two and a half inches, on either side of each weld. There are some points where those two measurements on either side of each weld are outside of the fit up tolerance for the pipe.

However, again those measurements are taken after the weld process, and I do not feel that we can draw any conclusions as to how that relates to the fit up prior to the weld.

Q How far from the welds are those measurements?

A (WITNESS LEWIS) I believe they were two to two and a half inches either side of the weld.

Q So they do not indicate the actual mismatch at the weld; is that correct?

A (WITNESS LEWIS) That is correct.

Q Now, I think in response to a question from Judge -- I can't remember whether it was Judge Decker or Judge Harbour this morning -- but you indicate you have reviewed weld records of one of these lines and you were going to identify one of these lines this afternoon. Have you been able to review your records so that you can identify the line?

A (WITNESS LEWIS) I did not review the weld records. I did look at them briefly. I do not construe it a review per se. But the line I reviewed -- and this is in response to your question Judge Harbor -- was line

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JUDGE HARBOUR: OHBC --

A (WITNESS LEWIS) 56.

BY MR. WILLIAMS:

Q We had some considerable discussion in the course of the testimony this morning about the stress analysis leading to high stresses at local points on the piping. Could you explain, in slightly more detail than we have already, for the Board the nature of the analysis that was performed and what the meaning, if any, is of the pipe stress point which has been indicated by that analysis?

A (WITNESS LEWIS) These stressanalysis that we performed used the same method, procedure and technique of stress analysis performed for the design of pipe, with the exception that instead of utilizing a design profile, the actual measured profile was input into the calculation. The results of that analysis show that in general the stress levels were not excessive, were moderate, within the piping system certainly acceptable. And the locations of discontinuities, kinks, if you will, or discontinuities at the weld points for the piping, there were local high stresses, in some cases very high.

Q Now, the kinks you referred to, do you refer to some place where there were weld joints?

A (WITNESS LEWIS) Yes, I am.

Q Is that true in all cases that the kinks were at weld joints?

A (WITNESS LEWIS) Based on my recollection of the review, yes, that is true in all cases.

Q What is your opinion regarding the nature of the apparent high stress indicated by this analysis?

A (WITNESS LEWIS) My belief is that those high stresses are artificial. They are an artifical result of the method in which the piping system was calculated or was modeled in and do not -- did not take any recognition of the possibility that the kinks were a result of a fit up or, in fact, installation.

And on one line we did some smoothing of some points on the curve and found that with a very minor change in the assumed profile, less than one -- one-quarter inch or less, that very drastic reductions in the stress occur, which again supported I think the belief that the modeling is overly sensitive in this area.

12-3

area

Q This leads you to the conclusion that these high stress areas are an artificial factor of calculation?

A (WITNESS LEWIS) Yes, it does.

Q Could you explain briefly the difference between this analytical approach to the problem of the pipe in what we now call the demonstration approach to the pipe?

A (WITNESS LEWIS) Rather than attempt to make assumptions as to which portions of the profile were resulting from settlement and which portions of the profile from other cause, which assumptions we -- would have to be just assumptions based on judgment -- we have elected to justify the present condition of the pipe by direct inspection, which has been done, and to justify continued use of the piping operation with the pipe through the plant life by means of extensive direct monitoring program.

Q Thank you. I would like to direct this next question to Mr. Meisenheimer.

Mr. Meisenheimer, I think there was a little confusion this morning as to the placement of level or settlement monitoring instruments. Could you elaborate for the Board on what the criteria will be for the placement of settlement monitoring instruments along piping that is to be monitored for that purpose?

A (WITNESS WEISENHEIMER) Okay. The settlement locations -- and this has been discussed with the Staff -- are locations, one, that will give us the characteristics of overall area fill settlement. And, secondly, they will be located in areas where we suspect the soils are softer and we would anticipate having the most settlement in the future.

Secondly, there will be two locations which we will monitor either side of a strain gauge that is on the pipe, so we will have two affects of monitoring the bending of the pipe and correlating it to the strain gauge measurements.

Q There was some questioning this morning regarding the cutoff of monitoring after five years if everything appears to be normal, and I believe you made some -- there was some questioning about the relationship between taking action in settlement projections and the adequacy of these settlement projections. Can you explain how the settlement projections that you are relying on were made, what type of analysis was used to arrive at these settlement projections?

A (WITNESS MEISENHEIMER) The method of analysis used to come up with future predictions of settlement have been based on varied markers in the fill. And the markers that we use -- we call them Borros anchors. But basically they are stationary points buried in the fill and we measure the movement at that point, and that is, the elevation of these buried markers are relative or close proximity to the invert elevation or bottom elevation of pipelines. So the amount of settlement that we are measuring in these markers correlates to the kind of settlement that we would expect to occur underneath the buried pipeline.

Also we have correlated the borings at the settlement markers and they cover the complete range of soils that we have encountered in the areas of the pipelines, and we are using the worst or the softest soil condition to base our estimate of future settlement. And it turns out that this settlement marker that we are using to base our maximum amount of settlement is not along the pipeline but is in an area away from the pipeline.

The set markers in the vicinity of the pipeline are showing less projected settlements in the future. To calculate the estimated settlement in the future, the settlement plots or the settlement data is plotted on a long time scale, amount of settlement versus the log of time, and this creates a straight line slope. And projecting this slope is in the geotechnical work how you predict future settlements, and this is what we are using. Included in this settlement estimate is the settlement from dewatering as well as seismic shakedown.

Q Now, assuming that the conditions at a particular Borros anchor or settlement monitor was similar to what you have seen in the ones that have already been plotted, how much of the approximately anticipated settlement would you expect to see, what facts would you expect to see over five years as compared to total amount which might occur?

A (WITNESS MEISENHEIMER) I would have to go back and look at the settlement anchors. But reviewing the log time relationships, you use up your settlement real fast, and, in fact, most of these points, Borros anchors we are dealing with, have been in from the period of two years to three years.

The amount of settlement we are looking at in the future is probably considerably less than what has already been experienced at that location.

12-4

ocation.

Q So if anything untoward would happen, you would anticipate seeing it in the first five years; is that correct?

A (WITNESS MEISENHEIMER) Very definitely. These set markers will also be used to see whether the settlement at the location for monitoring are falling within less than our predicted values.

Q Thank you. Mr. Landers, a short while ago you indicated that the stress ovality relationship which appears in the testimony, as I think we cited Figure UP-9, was a theoretical relationship which had been well verified with the experimental data.

JUDGE HARBOUR: I have to object to your characterization. I think that we can say it was qualified but I don't think it was clear it was demonstrated that it was well qualified.

MR. WILLIAMS: Let me start over again.

BY MR. WILLIAMS:

Q You discuss this stress ovality relationship and indicate it as theoretical relationship but that you had verified it with experimental data that you had available -- or rather strain ovality. I think I made the same mistake Ms. Stamiris did this morning.

The instruments that will be monitoring the piping will be strain gauges, will they not, which is a more fundamental measurement of what is happening to the pipe, if either, is between the strain or ovality?

A (WITNESS LANDERS) Strain.

Q So it makes more sense to make a direct measurement of strain, does it not?

A (WITNESS LANDERS) Yes.

Q What is the purpose of having a conversation between ovalization or ovality in strain in the first place?

A (WITNESS LANDERS) Well, two reasons: One is that we are dealing with a situation existing ovalization and this allows us to reduce the amount of strain that we will allow in a strain gauge reading that we get over the life of a plant to account for the existing ovality.

Q So the fundamental reason for this conversation then is to compare the existing ovalization measurement with the future strain measurement; is that correct?

A (WITNESS LANDERS) Yes.

MR. WILLIAMS: That is all I have, Mr. Chairman.

CHAIRMAN BECHHOEFER: Ms. Stamiris?

RECROSS EXAMINATION

BY MS. STAMIRIS:

Q On that last point, your answer that strain is a more fundamental measurement and ovality and that was the reason that -- if I am understanding correctly -- that the strain was being measured and converted to a value; is that correct?

A (WITNESS LANDERS) The answer was that strain is a more direct measurement of what is going on.

Q Right. I thought the reason that strain was being measured instead of ovality was because ovality couldn't be measured by direct observation. Is that incorrect? I mean could you directly measure ovality first?

A (WITNESS LANDERS) The possibility exists that one could develop a technique to measure ovality first -- not first, but during the life of the plant.

Q Well, has such a technique ever been developed to your knowledge before?

A (WITNESS LANDERS) Not to my knowledge.

Q Then would you agree that -- well, I won't ask anymore questions about that.

Mr. Lewis, in response to a question from Dr. Cowan, you indicated that the vendor had assured you that the strain measurement devices were relative or -- I don't think you used the word -- you considered trouble-free basically over at least the first 20 years or so of their life; is that correct?

A (WITNESS LEWIS) Yes, it is.

Q To focus on the problem of accuracy of instrumentation, what assurance do we have that -- what assurances do you have beyond those statements from the vendor regarding the accuracy of those strain gauges so that if we are in the future faced with anomolous reading on one of these strain gauges, the temptation doesn't exist for you to say that something must have gone wrong with the instrumentation as opposed to reading that you are getting?

A (WITNESS LEWIS) Our confidence stems not just from the vendor, although that is what I stated earlier, but in addition, some of the people here -- and possibly Mr. Meisenheimer would like to address it -- do have direct experience with using this type of gauge.

Perhaps more to your point, the value mode of these gauges is such that essentially they work or they don't work; and that it would be highly unlikely to see a drift or off calculation, if you will, type of condition existing. However, to consider that possibility as well, we would use, what I referred to I believe earlier -- as control gauges that would be installed in a configuration where they would not be changing and where they could not change -- they could not see a change in strain, excuse me. And then their readings would be monitored over time.

These control gauges would come from the same plot if the gauge is installed on the piping, so that if something were to be wrong with those gauges on the piping, you'd expect also to see it on the control gauges.

12-5

Q You said it would come from the same lot, but will there be a control gauge at each point of strength measurement on the piping for each point?

A (WITNESS LEWIS) No, that is not anticipated.

Q Well, could I ask for your assurance that if you get a reading that says -- would you be willing to make any comments or statements about a fact that if -- or the possibility of obtaining a reading that because of the controls you have set up, that you would not then question the reading that was obtained because of the instruments that obtained that reading?

A (WITNESS LEWIS) Let me answer your question in two parts: First we will have a second gauge located at each location that is being monitored. There will be two gauges at each point. So one --

Q There will be two gauges measuring the strain on the pipe at each point?

A (WITNESS LEWIS) That is correct. I would not characterize the second gauge as control gauge because it will, in fact, be fastened on to the point. So they will both be reading strain at essentially the same location. So that substantially improves our confidence.

Secondly, if a -- again I have to refer to technical specifications which have not yet been written and are part of the OL hearing, however, if there is a reading that goes off the scale -- or wrong, exceeds the specification, then any evaluation done on that reading would have to have the Staff's approval and would not be just the operator's judgment.

Q Okay. When you say there are two gauges at each point of reading on the pipes, then I just want to make sure you mean there are two different instruments.

A (WITNESS LEWIS) That's correct.

Q That is what you mean?

A (WITNESS LEWIS) Yes, ma'am.

Q I just wanted to make sure it wasn't two readings from the same instrument.

A (WITNESS LEWIS) No, these are two gauges mounted on the pipe in close proximity to each other.

Q When you speak of the acceptance criteria which will -- am I correct in assuming that the NRC will have to concur on all of the technical specifications which are to be completed?

A (WITNESS LEWIS) Yes, that is correct.

Q 100 percent. Do you envision that these technical specifications will include a clear and definitive time limit for reporting any measurement?

A (WITNESS LEWIS) Yes, I would expect that to be the case.

MS. STAMIRIS: I have no further questions.

CHAIRMAN BECHHOEFER: Mr. Blume?

MR. BLUME: Thank you, Mr. Chairman. I know Applicant's counsel is anxious to finish with the examination. I would ask his indulgence because my examination arises in great part from the cross by the Board. It is more in the nature of cross than recross.

RECROSS EXAMINATION

BY MR. BLUME:

Q Mr. Lewis, is your confidence in the dependability of the strain gauges based on the use of their design for 20 years or on something else?

A (WITNESS LEWIS) The inherent nature of the design of the gauge is at the same time simple and strong. That fact plus the geotechnical applications experience of which we are aware, plus the limited test information available --and this is vendor information available from the vendor -- all support the same conclusion that the gauges are -- the type of gauges we are speaking of are both reliable and have a limited number of failure modes that we can predict and see if they do -- if they were to occur, we would be aware of them.

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Q Well, you are not testifying that the vendor has been in business for 20 years, are you?

A (WITNESS LEWIS) No, sir, I'm not. Not at all. This type of gauge has been in use for more than 20 years, but the specific vendor I'm talking about has not been in business for that long.

Q Mr. Landers, is it your testimony that it is inconceivable that there will be any cracking or leaking in any of the pipes at the Midland plant, the underground Category I seismic types?

A (WITNESS LANDERS) No, my testimony said that it is inconceivable to me that cracking in the underground pipes will occur as a result of settlement or seismic events.

Q What is the basis for that opinion, Mr. Landers?

A (WITNESS LANDERS) The ovalization criteria and strain criteria that we have developed.

Q For the 26 inch pipes, at what point would you expect them to crack, if at all?

A (WITNESS LANDERS) We have data which indicates a crack in one piping system or one pipe test that was I believe a 48-inch pipe. It was loaded until wrinkling occurred. It had internal pressure and an axial load applied at the same time. The specimen was then turned and deflected 42 inches in the other direction before cracking occurred.

So I do not anticipate cracking for three inches of deformation, three inches of deflection in the buried pipe at Midland.

Q And what was the ovalization of that pipe?

A (WITNESS LANDERS) What was the ovalization of that pipe?

Q Yes.

A (WITNESS LANDERS) There was no ovalization measurement at that time -- well, I shouldn't say that.

The author stated that the ovalization was 20 times approximately what he had measured at the point of wrinkling.

Q And was that pipe the same diameter to thickness ratio as the 26-inch pipe at the Midland site?

A (WITNESS LANDERS) Diameter to thickness ratio was about 100, which is higher than the 26-inch pipe.

Q Mr. Meisenheimer, it is your testimony, isn't it, that the most significant differential settlement effecting the pipe will occur near buildings, isn't it?

A (WITNESS MEISENHEIMER) I said at points of anchorage, which right now I think most of them are probably at buildings. I don't know of any locations where a pipe is sitting on top of a duct bank or something like that, but that would be a similar type situation. But right now I would say buildings where the pipe goes inside the building is anchored.

Q So at points away from buildings where underground seismic Category I pipes pass over duct banks or concrete encased pipes, there could also be significant differential settlement, true?

A (WITNESS MEISENHEIMER) At those locations, yes, it could be.

MR. BLUME: I have no further questions.

CHAIRMAN BECHHOEFER: We do not have any further questions. Do you have any?

MR. WILLIAMS: No, Mr. Chairman.

CHAIRMAN BECHHOEFER: Did you have any?

MS. STAMIRIS: I have one question based on what Mr. Blume just asked Mr. Landers.

RECROSS EXAMINATION

BY MS. STAMIRIS:

Q Mr. Landers, when you were asked at what point you would expect a 26-inch pipe to -- I think it was fail -- and you gave certain criteria based on your experience or from whatever it was based, you answered that question and I just would like to ask you if the pipe, if this pipe you were considering was also subject to corrosion, would that corrosion have an effect and need to be factored into whatever point it would fail due to these other stresses?

MR. WILLIAMS: Objection. I think the witness testified as to a pipe that would crack under certain circumstances. I do not think this recent cross examination of Mr. Blume mentioned failure exactly. There was a question that was directed to cracking.

MS.STAMIRIS: Well, I said I was not sure of the word "fail."

CHAIRMAN BECHHOEFER: Why don't you use "cracking"?

MS. STAMIRIS: I will have to.

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to.

BY MS. STAMIRIS:

Q Do you think that if this pipe were corroded, that that would affect the point at which it would crack?

A (WITNESS LANDERS) What type of corrosion?

Q I don't know.

A (WITNESS LANDERS) Without knowing the kind of corrosion that you are talking about and having no familiarity with any corrosion problems at Midland, I really can't answer the question.

Q I don't know if this will help at all, but if I said corrosion due to electrochemical attack? Does that make a difference?

A (WITNESS LANDERS) I think it muddies the water even more.

Unfortunately corrosion is more encompassing a word than collapse, and corrosion can occur from a whole lot of sources. I really cannot answer.

JUDGE HARBOUR: Could you try just plain rusting?

WITNESS LANDERS: Let me give an answer and establish the environment.

A (WITNESS LANDERS) If that thinning of the wall occurred as a result of rusting, would I expect cracking to occur sooner than what?

BY MS. STAMIRIS:

Q Than without that?

A (WITNESS LANDERS) I'm not sure because a number of things happen. You see, you get a larger DOT ratio which tends to produce wrinkling earlier, but you also have a more flexible pipe which tends to be able to handle deflection better. So I would say, given a length of pipe on the surface, if it were thinner and we load t and it wrinkled, I would anticipate that it would crack earlier, yes.

Q Would you make a general statement on your opinion of whether,do you think if there were questions regarding corrosion of piping, that when stresses on those pipes were being measured as to how it affects their ultimate ability to perform their function, that those questions as to the corrosion should be considered in conjunction with all other factors?

A (WITNESS LANDERS) Well, as I understand it, the pipe in question, the 26-inch pipe had a man inside of it and that man has not to my knowledge reported any corrosion problem with respect to the internals of the pipe.

Q I was trying to just ask it generally as a general rule of thumb. Do you know if it would be better to consider that and --

A (WITNESS LANDERS) Corrosion is considered in developing wall thickness of the pipe. That is usual practice. The code in fact specifies that you have to do that, depending on the type material that you are dealing with.

MS. STAMIRIS: I have no further questions.

CHAIRMAN BECHHOEFER: Do you have anything further?

MR. WILLIAMS: I have no further questions.

CHAIRMAN BECHHOEFER: I believe the panel may be excused.

JUDGE HARBOUR: Thank you, gentlemen.

(Panel excused.)

CHAIRMAN BECHHOEFER: Let's take a break, 15 minutes.

(Brief recess.)

CHAIRMAN BECHHOEFER: Mr.Blume.

MR. BLUME: Thank you, Mr. Chairman. We are presenting a panel for the Staff to testify on underground piping. The panel consists of Joseph Kane, Darl Hood and Dr. Paul Chen. Dr. Chen has not yet been sworn.

Whereupon,

PAUL CHEN,

called as a witness by Counsel for the Regulatory Staff, having been first duly sworn by the Chair man, was examined and testified as follows:

and Whereupon,

JOSEPH KANE

DARL HOOD

were called as witnesses by Counsel for the Regulatory Staff, having previously been duly sworn by the Chairman, were examined and testified further as follows:

DIRECT EXAMINATION

BY MR. BLUME:

Q Gentlemen, would you please identify yourselves for the record and state your positions.

A (WITNESS HOOD) My name is Darl Hood. I am the Project Manager for the Midland Project for the NRC Staff.

A (WITNESS KANE) My name is Joseph Kane. I am a geotechnical engineer with the U. S. Nuclear Regulatory Commission.

A (WITNESS CHEN) My name is Paul Chen. I am Manager of the Stress Analysis Unit at ETEC as a nuclear technology engineer and then consultant to the NRC Staff on the Midland plant.

13-3

plant.

Q Mr. Kane, did you write the document entitled "Testimony of Joseph Kane Regarding the Effects of a Plant Fill Problem on Foundation Support for the Seismic Category I Underground Piping"?

A (WITNESS KANE) Yes, I did.

Q And do you have any additions, corrections to deletions to that testimony?

A (WITNESS KANE) Yes, I do. My corrections are attempting to update it based on new information that we are receiving.

On page 3, in response to Question 5 (A)(5) I would ask that the first paragraph be deleted entirely and placed with the following sentence:

"Soil profiles along the alignments of two of the service water lines have been provided to the Staff subsequent to the submittal of this testimony dated February 5, 1982."

In the sentence following that addition where it reads, "The important to the staff in developing this information," I would ask that the word "profile" be inserted after "this."

Another change that I would like to make is at the end of the answer to Question No. 11 on page 9.

CHAIRMAN BECHHOEFER: Mr. Kane, let me ask you first. In answering, in substituting the answer

No. 5, do you plan to leave the question as it is stated? Because the answer, the new answer does not seem completely responsive to the question as worded, and I wonder whether any correction there had to be made.

MR. BLUME: I think that is a good suggestion, Mr. Chairman.

CHAIRMAN BECHHOEFER: The problem could be there are various piping systems and the answer talks about two service water lines, and those may not be co-extensive.

MR. BLUME: I think that is a good suggestion, Mr. Chairman.

WITNESS KANE: Rather than change the question, I think I would like to add an additional sentence to the one I have just added. The sentence that I would like to add after "February 5, 1982," is:

"The foundation conditions reflected on the submitted profile is presently under review by the Staff."

BY MR. BLUME:

Q Mr. Kane, do you have any further corrections of your testimony?

A (WITNESS KANE) Yes, I do.

On page 9, in answer to Question No. 11, I would like to make two changes.

In paragraph D, second line, I would like to change "decrease" to "increase."

At the conclusion of paragraph B, I would also like to add the following statement:

"As indicated in the change to the testimony of Donald Lewis, the Applicant's proposed plan for settlement monitoring of underground piping **is** being reviewed and details remain to be resolved with the NRC Staff."

Q That should be a new paragraph in answer to paragraph 11, Mr. Kane?

A (WITNESS KANE) That is correct.

I would like to make an additional change on page 12. The first sentence on page 12 beginning with "The Applicant." I would like to strike "has not responded," and in its place insert, "The Applicant provided information on February 11, 1982, to the Staff on this safety," on, and then continuing with "this safety review concern."

Q So that the sentence should read:

"The Applicant provided information on February 11, 1982, to the Staff on this safety review concern and it remains -- "

A (WITNESS KANE) No, and I was going to strike out -- excuse me, leave and cross out, "and remains an outstanding issue," and change it to, "this information requires evaluation by the Staff."

So the sentence should properly read:

"The Applicant provided information on February 11, 1982, to the Staff on the safety review concern and this information requires evaluation by the Staff."

13-4

13-4rtl

staff

Q Do you have any further additions, corrections or deletions to your testimony, Mr. Kane?

A (WITNESS KANE) I apologize for the attachments not being numbered, and so I should character them now.

Attachment 2 is the table that lists the seismic Category I lines to be addressed.

Attachment 3 is a figure entitled "Plan of Buried Q Listed Pipe Locations."

Attachment 4 is 19-1.

Attachment 5 is the page headed with variable soil properties.

Attachment 6 is entitled "Utility Crossings at Freezewall 1."

Attachment 7 has for a title "Crossing 3 Plan 6."

Attachment 8 is entitled "Crossing 3 Profile 7."

They are all the corrections that I have.

tk14

Q Now, with those corrections, is your testimony correct and true to the best of your knowledge, Mr. Kane?

A (WITNESS KANE) Yes.

MR. BLUME: Mr. Chairman, I offer into evidence the testimony of Joseph Kane regarding the effects of the plant fill problem on foundation support for the seismic Category I underground piping as well as the Attachments 1 through 8 to that testimony.

MR. WILLIAMS: No objection.

MS. STAMIRIS: No objection.

CHAIRMAN BECHHOEFER: That testimony will be admitted into evidence and bound into the record as if read.

MR. BLUME: Thank you.

(Prepared testimony of Mr. Joseph Kane follows:)

02/05/82

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CONSUMERS POWER COMPANY	)	Docket Nos. 50-329 OM & OL
	)	50-330 OM & OL
(Midland Plant, Units 1 and 2)	)	

TESTIMONY OF JOSEPH KANE REGARDING THE EFFECTS OF THE PLANT FILL PROBLEM ON FOUNDATION SUPPORT FOR THE SEISMIC CATEGORY 1 UNDERGROUND PIPING

Q.1 Please state your name and position.

A.1 My name is Joseph Kane. I am a Principal Geotechnical Engineer in the Hydrologic and Geotechnical Engineering Branch, Division of Engineering, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission.

Q.2 Have you prepared a statement of your professional qualifications?

A.2 Yes, Attachment 1 provides my professional qualifications.

Q.3 What are your responsibilities with respect to the Midland Plant?

A.3 My responsibilities have been set forth in prior testimony submitted to this Board, and also in the testimony of Hood, Singh and Kane for this hearing session.

Q.4 What is the purpose of this testimony?

A.4 This testimony addresses the foundation stability of seismic Category I underground (buried) piping placed in the fill at the Midland Plant. The concern for foundation stability of underground piping has arisen because the plant fill which supports these pipes has been shown to be inadequately compacted and is settling under its own weight. As a result, the piping buried in the plant fill is settling with the fill. The settlements which have been observed are not uniform because of the highly variable soil fill conditions, differences in actual loadings, and also due to the varying foundation elevations of structures that are connected with underground piping. This testimony will cover the following topics:

(a) Description of foundation conditions along the various piping systems (Emergency Core Cooling System, Service Water System and Diesel Fuel Oil System).
(b) Current settlement history.
(c) Future settlement predictions.
(d) Foundation soil parameters adopted in underground piping design.
(e) Effect of freeze wall.
(f) Future monitoring plans.
(g) Evaluation and conclusions.
(h) Status of outstanding design issues.

Separate testimony prepared by the NRC Mechanical Engineering Branch (MEB) and its consultants describes the history of the safety review events since 1978 relative to the effects of the problem plant fill on underground piping. The MEB testimony also discusses the technical studies which have been and are currently being performed to evaluate the effects of differential settlement on the structural integrity of the seismic Category I underground piping.

Q.5 What are the foundation conditions that exist along the various seismic Category I piping systems which are founded in the plant fill?

A.5 In spite of the extensive number of borings and explorations which have been completed at the Midland site, soil profiles along the alignments of the various piping systems have not yet been developed for Staff review which would permit actual foundation conditions to be evaluated in conjunction with observed settlements of the underground piping. It is our understanding that these soil profiles are currently being developed by the Applicant's Consultant.

The importance to the Staff in developing this information includes the following:

(a) The soil profiles would assist in determining whether the presently distorted pipe grades established by internal profiling of the buried pipes are the result of fill settlement or of an accumulation of as-built installation discontinuities as contended by the Applicant's Consultant.

(b) The combined soil and pipe deflection profiles would permit an evaluation of the extent to which observed pipe profiles were caused by settlement due to past imposed loadings at the site.

Examples of such imposed loadings could include the surcharge fill and heavy equipment traffic loading.

(c) The soil profiles would assist in assessing future support capability along the pipelines by identifying the more compressible soil layers and the pipe segments where these weaker foundation conditions exist. This information would also be important in the selection of future settlement monitoring locations.

Q.6 What settlements or deflections from intended design elevations (pipe inverts) have been recorded at Midland along the various piping systems?

A.6 Table I-1 (Attachment 2) provided by the Applicant in its report of December 15, 1981 to the NRC lists the seismic Category I pipelines founded in the plant fill which need to be addressed. Figure I-1 (Attachment 3) provided in this same report presents a plan view of buried Q-listed pipe locations. Attachment 4, submitted by the Applicant in its response to the Staff's 50.54(f) question no. 19, is provided to illustrate the pattern of pipe deflections from intended design invert elevations for some of the involved piping as established by past profiling efforts. More recent profiles for some of the involved piping were presented in the Appendices of the December 15, 1981 report.

The results of profiling seismic Category I pipes indicate that the present pipe invert elevations (bottom internal pipe elevation) have maximum deviations from 6 to 16 inches below the originally intended design invert elevations. The majority of these maximum deflections are in the range of 9 to 11 inches. The allowable placement tolerances for installing the pipe in the field during construction was specified at plus or minus 2 inches from the established design invert elevations. Allowing for the lower tolerance of minus 2 inches during installation would indicate that maximum pipe settlements of 4 to 14 inches could have occurred.

Profiling indicates that the pipe which may have experienced the greatest amount of settlement is Service Water line 8"-1HBC-81 (Attachment 4). This pipe is located between the Diesel Generator Building and the Turbine Building and was subjected to the full surcharge load placed in the Diesel Generator Building area. The Applicant excavated an approximate 140 foot length of this pipe after surcharge removal, and then rebedded the pipe after it was reconnected. This rebedding operation should have relieved stresses due to past settlement, but stresses due to future settlements are still possible.

Q.7 Has an estimate been made of potential future settlement of the seismic Category I underground piping?

A.7 Yes. In the previously identified report of December 15, 1981 Applicant estimated future settlement for the pipes buried in the plant fill for the anticipated 40-year period of plant operation. This estimate indicates that settlements of up to 3 inches are possible. This is based on settlement observations of a series of borros anchors which are measuring the settlement of the fill under its own weight.

Q.8 Does the Staff agree with the Applicant's estimated range of future settlement for the underground piping?

A.8 The Staff agrees that the estimated 3 inch maximum settlement is a conservative upper bound limit which can be expected during the years of plant operation, provided no additional load is placed over the piping. This Staff conclusion is based on discussions with the Applicant and its Consultant at meetings in Bethesda on January 21 and 22, 1982. For proper documentation, the Staff will require submittal of the technical information discussed at those meetings along with a technical summary supporting the basis for the 3 inch prediction. The Applicant will also be required to address this estimated settlement when establishing locations for future settlement monitoring.

Q.9 Has agreement been reached between the Applicant and the Staff on appropriate soil design properties to be used in the seismic analysis of buried piping?

A.9 No. The lack of particularity, as reflected by information provided in the December 15, 1981 report (Attachment 5), prevents resolution of this design issue at this time. Additional information provided by the Applicant's Consultant following the meeting of January 22, 1982 in Bethesda indicates the need for the Staff to examine the basis for selected properties and to assess the impact of reasonable variations in soil properties on the results of the analysis.

Q.10 In previous testimony by the Staff on remedial underpinning of the Auxiliary Building, a concern was expressed by the Staff regarding potential adverse effects of the proposed Freeze Wall on seismic Category I structures, conduits and piping by causing ground heave or resettlement upon unfreezing. Has this concern been resolved?

A.10 Yes. The Applicant initially attempted to show that ground heaving would not be a problem by providing comparable case histories where ground freezing was successfully performed. The information which was eventually located was considered inapplicable because of dissimilarities in either site or installation conditions from the documented cases with the conditions existing at Midland. The Applicant in its January 6, 1982 submittal to the NRC on the effects and monitoring procedures for installation of Freeze Wall dewatering abandoned the similar case history approach and chose an alternate solution. The alternate solution was presented in an enclosure to the January 6, 1982 letter. It involves a proposal to eliminate the inducement of any stresses to the conduits and piping because of heaving by excavating the soil directly beneath affected utilities within the projected area of influence of the Freeze Wall before ground freezing actually begins.

Figure 1 (Attachment 6), provided in the January 6, 1982 report, identifies three areas of concern where the proposed Freeze Wall alignment will intersect seismic Category I utilities. Figures 6 and 7 (Attachments 7 and 8) provide more details on one of these

Freeze Wall crossings and illustrate the proposed limits of excavation beneath the affected utilities within the crib enclosure.

The Staff concurs with the Applicant that this proposed solution will eliminate the effect of ground heaving on involved utilities. The Staff also notes that the excavation of soil above the piping will lessen the weight of surcharge and its beneficial effect in resisting ground heave. Because of the excavation and removal of surcharge, some additional heaving could occur, but would not reach the exposed piping. It will be several months before recompression is completed, and longterm foundation support for the piping is assured. The Applicant has committed to demonstrate to the Staff's satisfaction that recompression of the foundation soils beneath the piping has been completed before backfilling the excavation.

Q.11 What monitoring of underground pipe settlement has been proposed by the Applicant for the years of plant operation?

A.11 In the Applicant's December 15, 1981 report to the NRC on underground piping, the following monitoring program was proposed:

(a) Monitor the Service Water System piping at the terminal ends before the first anchor point of each pipe as it enters the building. This monitoring would establish the differential settlement between the pipe anchor and a point on the piping as the piping enters the structure.

(b) Monitoring frequency would be at a 90-day interval for the first 5 years of plant operation and then on a yearly basis for the remainder of the plant's operating life.

(c) Requirements to be stipulated in a technical specification would require a report to the NRC by the Applicant if the observed settlement reached 75 percent of the maximum allowable limit. The maximum allowable settlement limit would be established by calculating the amount of differential settlement which would result were pipe stresses to reach ASME III code criteria for nonrepeated anchor movements (3 Sc).

(d) If 75 percent of the calculated maximum allowable settlement limit was reached, the Applicant would decrease the monitoring frequency from the 90-day interval to 30 days. Applicant would then further assess the settlement rate and severity.

Q.12 Does the Staff concur with the Applicant's proposed settlement monitoring plan?

A.12 No. In addition to the above monitoring plan proposed by the Applicant, the Staff will require the following:

(a) Additional settlement markers that are attached to the underground piping at locations away from structures and in the plant fill itself. The locations considered for additional markers should include areas where maximum future differential settlements are estimated following an evaluation of the soil profiles which are being developed, as discussed in response to Q.5. Additional settlement markers should also be installed at strategic locations along the piping to verify the accuracy and functioning of the proposed vibrating wire strain gages which are to be installed to monitor changes in pipe ovality.

(b) A provision in the Technical Specifications requiring shutdown of the plant if the maximum allowable settlement limit is reached.

Q.13 What summary of conclusions can the Staff make following its engineering evaluation of the December 15, 1981 Report provided by Consumers on the analysis of buried piping for the Midland Plant, Units 1 and 2?

A.13 The Staff lists the following conclusions:

1. Based on the results of profiling completed on seismic Category I underground piping, maximum settlements of piping ranging from 4 to 14 inches may have occurred.
2. Three inches is a conservative upper bound limit of maximum future settlement beneath underground piping in the plant fill away from completed structures, provided no additional loading is placed over the piping.
3. The disconnecting, rebedding and reconnecting operations which the Applicant has completed on three Service Water Lines which have settled (8"-1HBC-81, 8"-1HBC-82, 10"-OHBC-28) is a

positive action for relieving settlement induced stresses. However, smaller amounts of future settlement may occur and again induce stresses in the pipe. This problem is being addressed by attempting to resolve differences in acceptable monitoring programs during plant operation.

4. The Applicant's proposed solution for avoiding potential adverse effects on underground utilities due to ground heaving above the proposed Freeze Wall is acceptable.

5. Soil profiles utilizing existing subsurface information need to be developed and evaluated in conjunction with measured pipe deflection profiles in order to permit assessment of future settlement effects.

6. Resolution of safety review issues remains outstanding regarding selection of appropriate soil design properties to be used in the seismic analysis of underground piping and in the establishment of an acceptable settlement monitoring program.

Q.14 In addition to the unresolved safety review issues which are identified in the response to Q.13, are there any other outstanding issues requiring resolution between the Applicant and the Staff with respect to underground piping?

A.14 Yes. In Attachment 4 to the testimony of Hari Narain Singh, presented to this Board on August 7, 1981 (following transcript page 3488), a concern was expressed concerning the minimum rattlespace available at locations of penetration where seismic Category I piping enters into the various structures. This concern is expressed on page 12 of Attachment 4, Paragraphs (d)(1) and (2).

The Applicant has not yet responded to this safety review concern and it remains an outstanding issue.

Q.15 Does the Staff have concern for the foundation stability of the four Category I steel Diesel Fuel Oil Storage Tanks which are buried in the plant fill south of the Diesel Generator Building?

A.15 No. The Applicant has demonstrated that the foundations of the Diesel Fuel Oil Storage Tanks are stable, and that settlements have been small and insignificant. The largest settlement measured to date following filling of the tanks and surcharging their foundations is 0.25."

A concern previously identified in the testimony of H. Singh on August 7, 1981 (following transcript page 3488, see Attachment 4 to that testimony, at 11) concerning the densification of a thin, loose sand layer under dynamic loading has been resolved. The Applicant has provided the results of a settlement estimate for this loose layer which indicates that the predicted settlement under dynamic loading is small, on the order of 0.04". The Staff and the Corps concur with the Applicant that this magnitude of settlement will not cause any difficulty during the years of planned operation.

Attachment 1

PROFESSIONAL QUALIFICATIONS AND EXPERIENCE

NAME: Joseph D. Kane

ADDRESS: 7421 Miller Fall Road
Derwood, MD 20855

EDUCATION:

B.S. Civil Engineering Villanova University	1961
M.S. Civil Engineering Villanova University	1973
Post-degree studies, Soils and Foundation Engineering	
University of California	1972
University of Maryland	1978

PROFESSIONAL REGISTRATION:

Registered Professional Engineer (1966) - Pennsylvania 12032E

PROFESSIONAL SOCIETY:

American Society of Civil Engineers

EMPLOYMENT POSITIONS:

February 1980 - Present	Principal Geotechnical Engineer U.S. Nuclear Regulatory Commission
May 1977 - February 1980	Geotechnical Engineer U.S. Nuclear Regulatory Commission
October 1975 - May 1977	Soils Engineer U.S. Nuclear Regulatory Commission
August 1973 - October 1975	Supervisory Civil Engineer Chief, Soils Design Section U.S. Army Corps of Engineers Philadelphia District
January 1963 - August 1973	Civil Engineer Soils Design Section U.S. Army Corps of Engineers Philadelphia District
January 1962 - January 1963	Design Engineer McCormick - Taylor Associates Philadelphia, Pa.

PROFESSIONAL EXPERIENCE SUMMARY:

1975 to Present

In NRC Division of Engineering, Geotechnical Engineering Section, Mr. Kane has specialized in soil mechanics and foundation engineering. Experiences in this position have included the following:

a. Evaluation of the foundation adequacy of proposed sites for nuclear facilities with respect to design and operational safety. This work has included evaluation of geotechnical, soils and rock mechanics, foundation and earthquake engineering related aspects. The results of this review effort are summarized in a safety evaluation report for each of the proposed facilities which have included nuclear power plants, nuclear fuel reprocessing plants and uranium mill tailings waste systems.

b. Serving as a technical adviser for soil and foundation engineering related aspects in the development of regulatory guides, acceptance and performance criteria that are intended to assure construction and operational safety of nuclear facilities.

c. Serving as a technical representative for the Office of Nuclear Reactor Regulation on the NRC Advisory Group concerned with federal dam safety.

d. Serving as an instructor for the Office of State Programs in the training of state personnel who are responsible for construction and operational inspections of uranium mill tailings embankment retention systems.

1963 to 1975

During this period Mr. Kane was employed with the U.S. Army Corps of Engineers, Philadelphia District and attained the position, Chief, Soils Design Section, Foundations and Materials Branch, in 1973. Professional experiences with the Corps of Engineers have included the following:

a. The embankment and foundation design of four large multi-purpose earth and rockfill dams with appurtenant structures (spillways, inlet and outlet structures, control towers, flood protection facilities, etc.). Responsibilities ranged from the initial planning of subsurface investigations to select the most feasible sites through all design stages which were culminated in the final preparation of construction plans and specifications. This work included planning and evaluation of laboratory testing programs, studies on slope stability, seepage control and dewatering systems, settlement, bearing capacity, liquefaction,embankment safety instrumentation and slope protection.

b. Served as a technical consultant to field offices charged with construction inspections for assuring completion of structures in compliance with design analysis and contract specifications. Participated in the development of needed modifications during construction whenever significant changed site conditions were uncovered.

c. Directed the efforts of engineers in the Soils Design Section in other fields of civil work projects that included the embankment and foundation design of levees, waterfront pile supported structures and disposal basins for the retention of hydraulic dredge waste.

1962 to 1963 — Served as design and project engineer for private consulting firm. This work included the design of large federally funded highways, a race track and various structures constructed to provide a Pennsylvania State park marina.

SEISMIC CATEGORY I LINES TO BE ADDRESSED

A. Service Water System (SWS)

8"-1HBC-310	26"-OHBC-53
8"-2HBC-81	26"-OHBC-54
8"-1HBC-81	26"-OHBC-55
8"-2HBC-310	26"-OHBC-56
8"-1HBC-311	26"-OHBC-15
8"-2HBC-82	26"-OHBC-16
8"-1HBC-82	26"-OHBC-19
8"-2HBC-311	26"-OHBC-20
10"-OHBC-27	36"-OHBC-15
10"-OHBC-28	36"-OHBC-16
	36"-OHBC-19
	36"-OHBC-20

B. Diesel Fuel Oil Lines (Fuel Oil)

1-1/2"-1HBC-3	2"-1HBC-497
1-1/2"-1HBC-4	2"-1HBC-498
1-1/2"-2HBC-3	2"-2HBC-497
1-1/2"-2HBC-4	2"-2HBC-498

C. Borated Water Storage Tank (BWST)

18"-1HBC-1
18"-1HBC-2
18"-2HBC-1
18"-2HBC-2

TABLE I-1 12/10/81

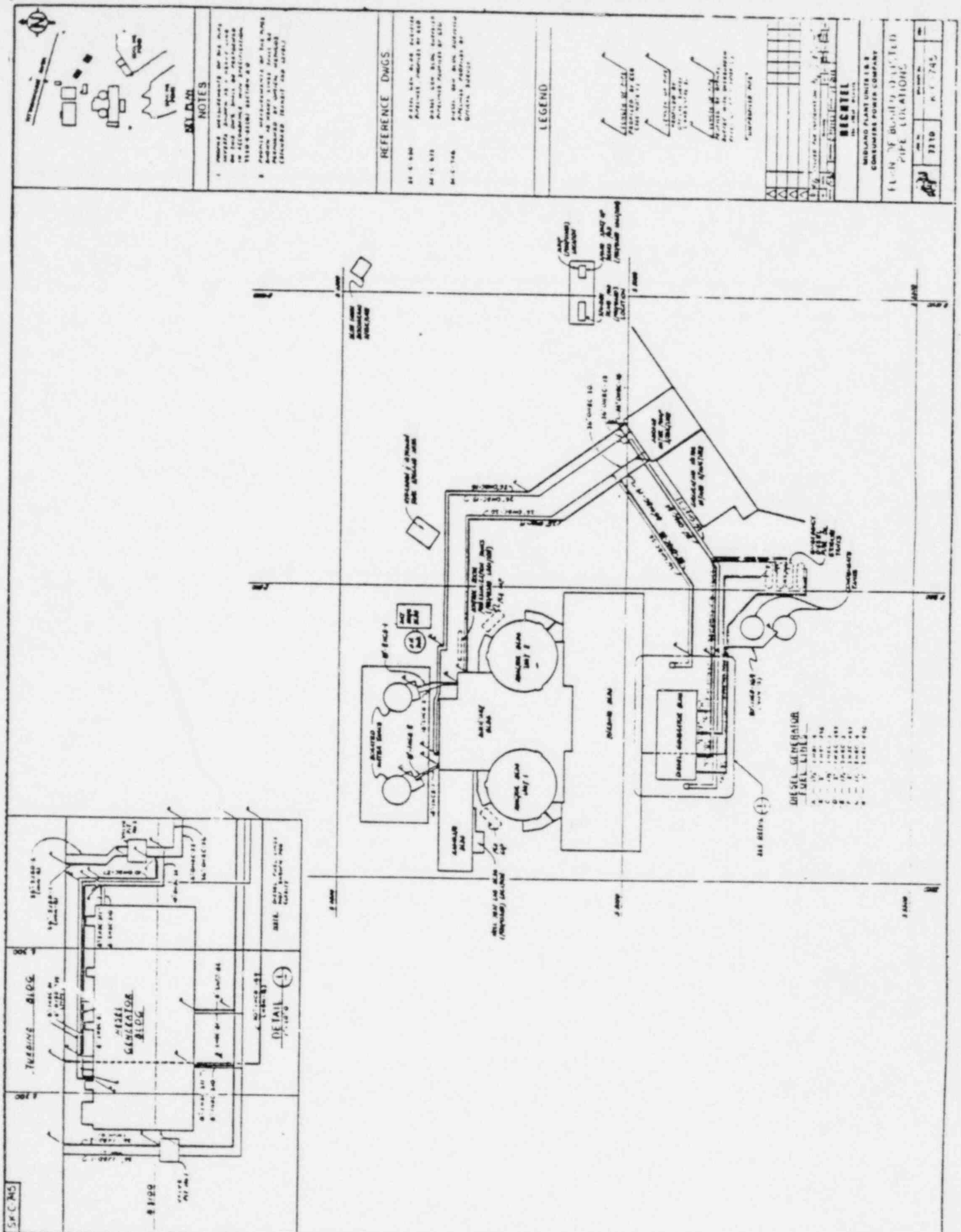
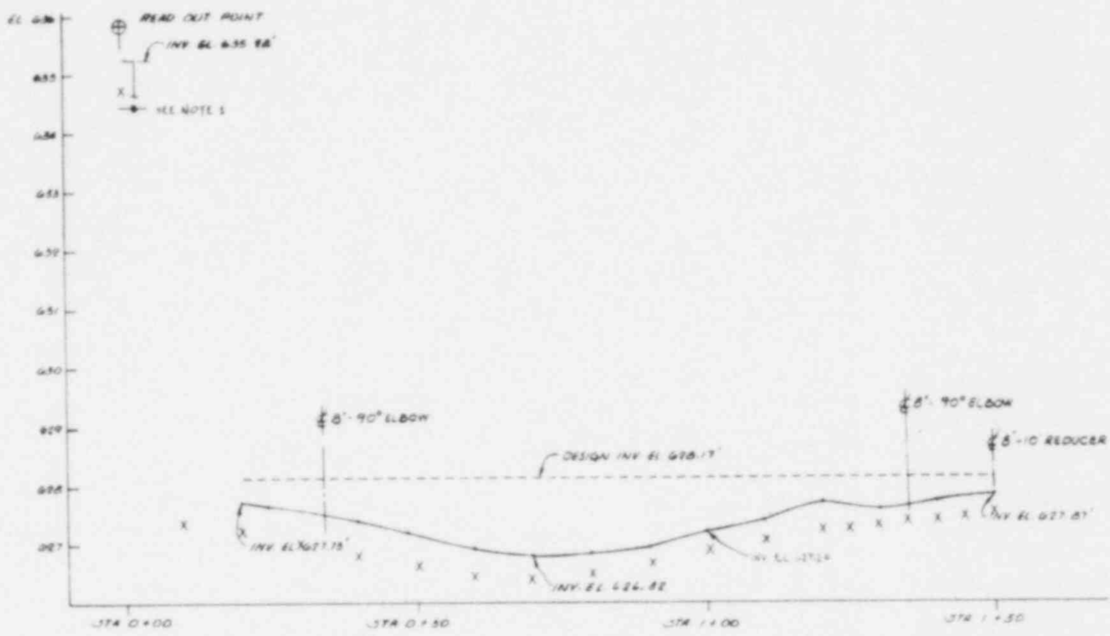
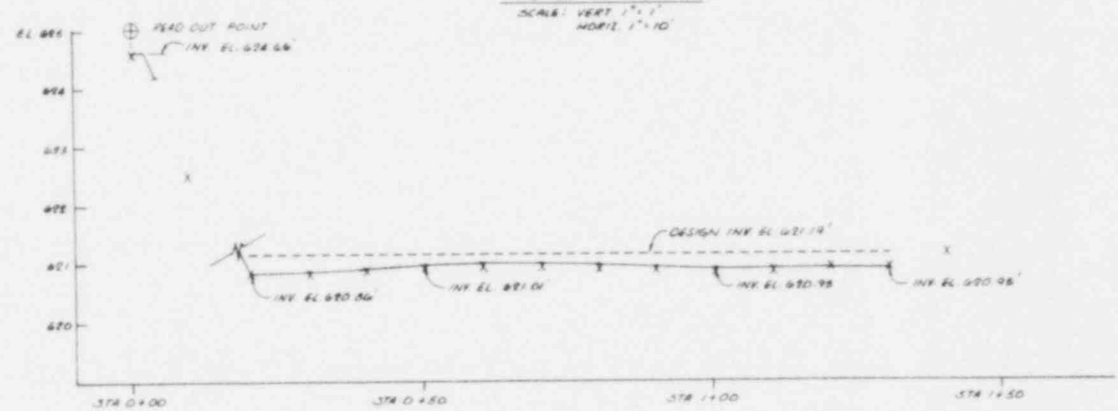


FIGURE I-1

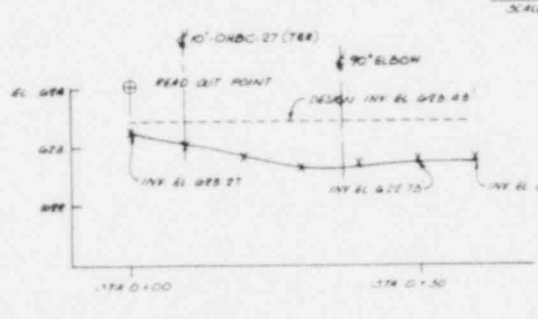
NRC Hood



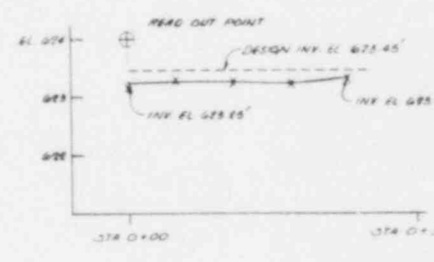
PROFILE 8"-1HBC-81
SCALE: VERT 1"=1' HORIZ 1"=10'



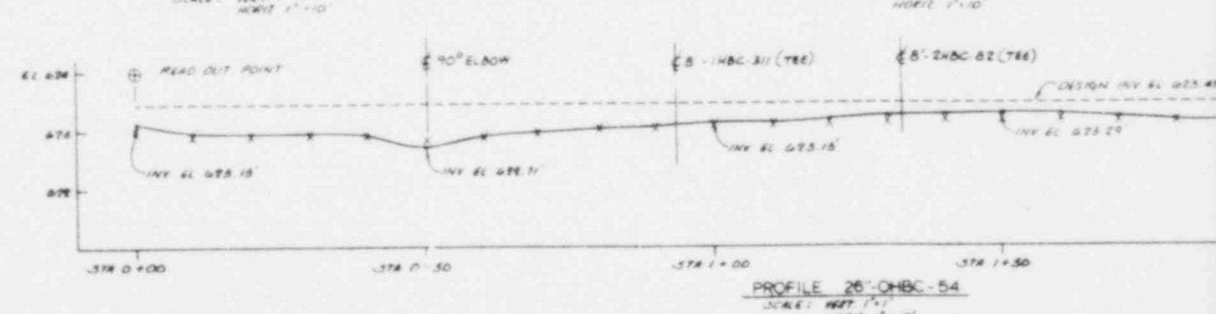
PROFILE 20"-1HCD-169
SCALE: VERT 1"=1' HORIZ 1"=10'



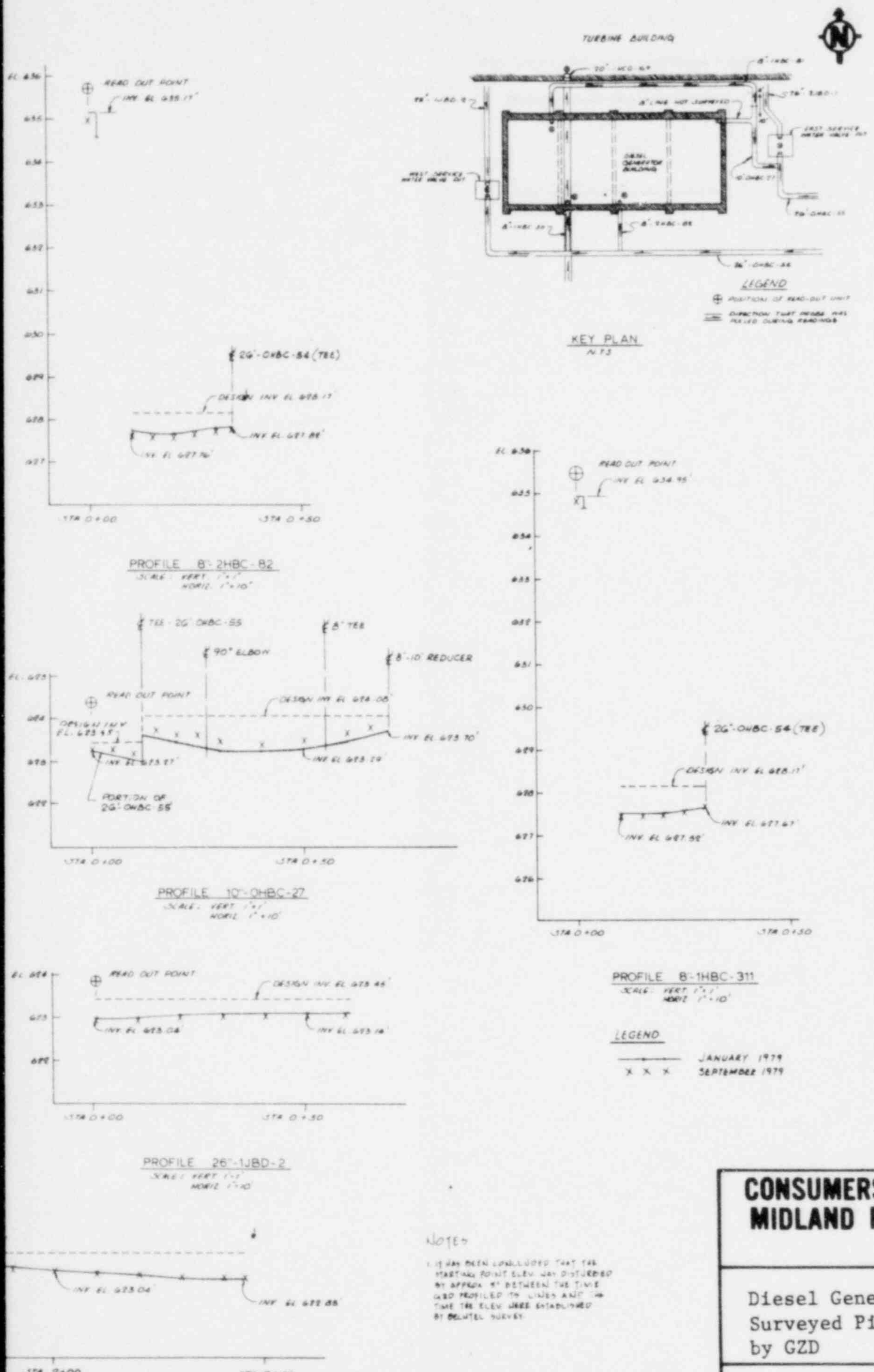
PROFILE 26"-OHBC-55
SCALE: VERT 1"=1' HORIZ 1"=10'



PROFILE 26"-2JBD-1
SCALE: VERT 1"=1' HORIZ 1"=10'



PROFILE 26"-OHBC-54
SCALE: VERT 1"=1' HORIZ 1"=10'



CONSUMERS POWER COMPANY
MIDLAND PLANT UNITS 1 & 2

Diesel Generator Building
Surveyed Pipeline Profiles
by GZD

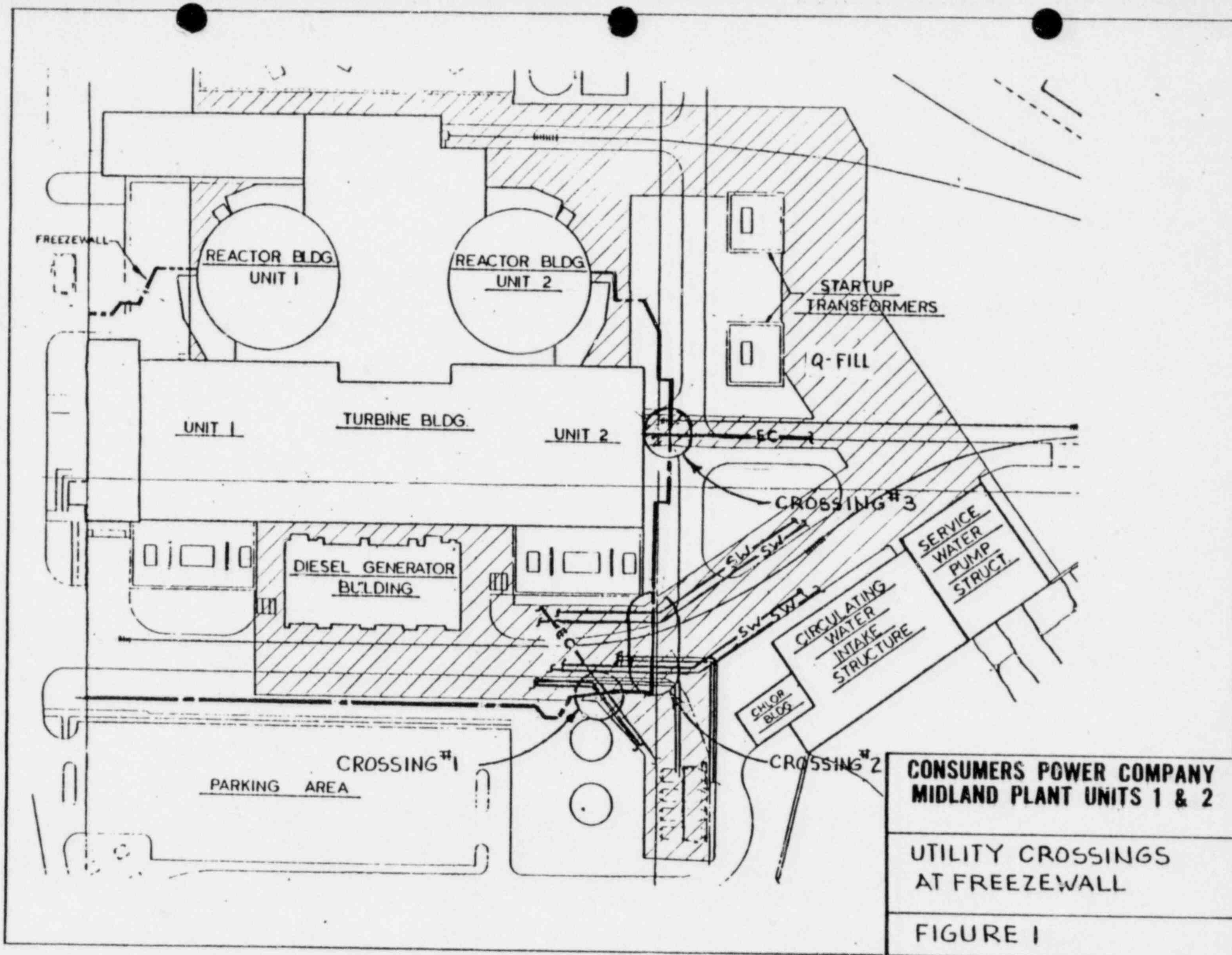
Figure 19-1

III.A.4.b) Variable soil properties

The analysis considers the following soil properties:

Poisson's ratio
Unit weight
Coefficient of friction (soil/structure)
Shear modulus
Shear wave velocity
Compression wave velocity
Surface wave velocity
Maximum particle velocity
Maximum particle acceleration
Maximum soil strain

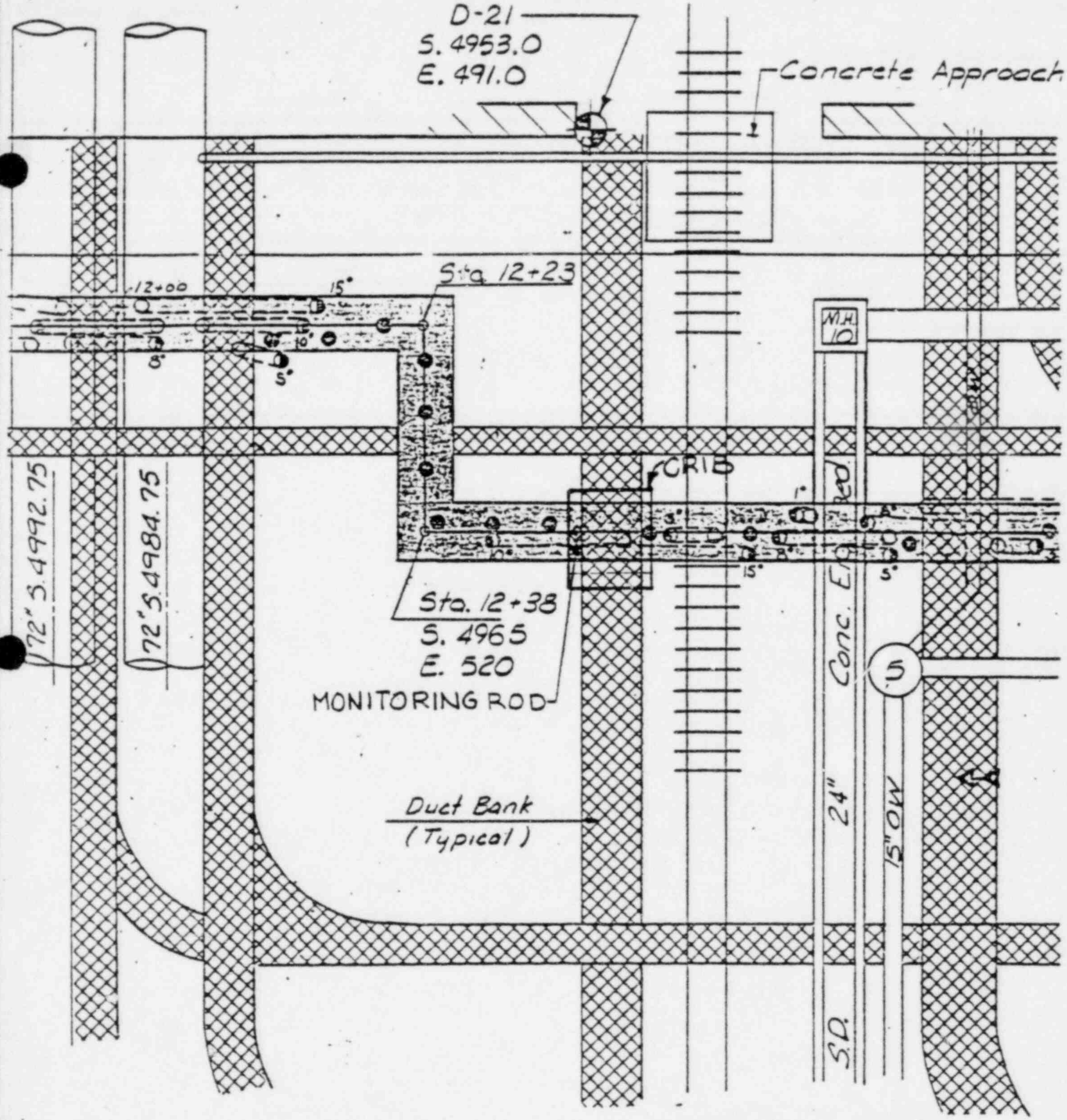
The soil subgrade modulus is calculated for each case, based on the soil and pipe properties. The values used for these soil properties were those determined from the investigation work at the jobsite. The soil modulus of elasticity was varied ±50%. The maximum particle acceleration was increased 50% above the SSE value as a margin for the site-specific response spectra.



CONSUMERS POWER COMPANY
MIDLAND PLANT UNITS 1 & 2

UTILITY CROSSINGS
AT FREEZEWALL

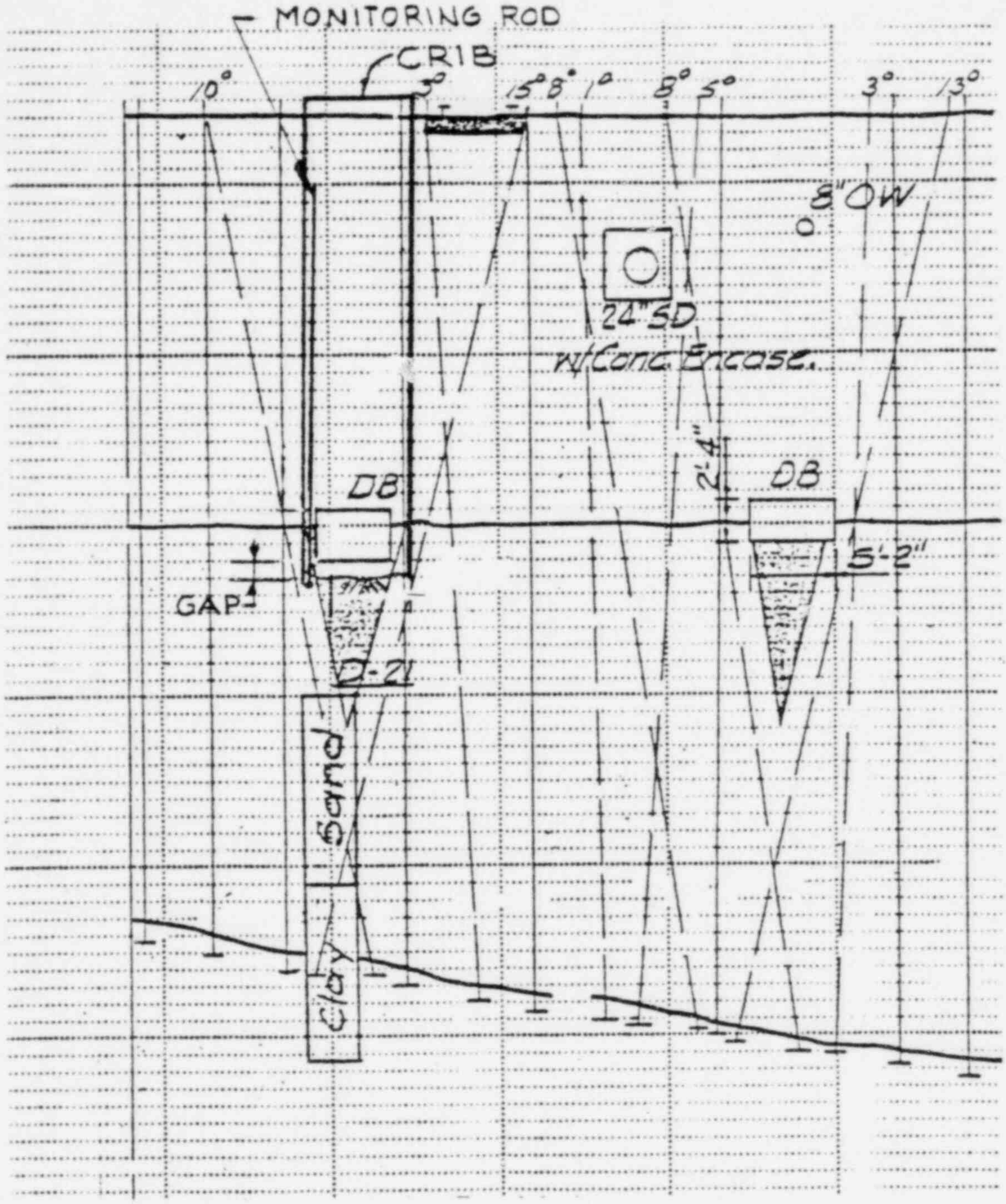
FIGURE 1



CONSUMERS POWER COMPANY
MIDLAND PLANT UNITS 1 & 2

CROSSING 3
PLAN

FIGURE 6



CONSUMERS POWER COMPANY
MIDLAND PLANT UNITS 1 & 2

CROSSING 3
PROFILE

FIGURE 7

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

February 5, 1982

Charles Bechhoefer, Esq.
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

In the Matter of
CONSUMERS POWER COMPANY
(Midland Plant, Units 1 and 2)
Docket Nos. 50-329 OM & OL and 50-330 OM & OL

Dear Administrative Judges:

Enclosed is the Staff's prepared direct testimony for the hearing session scheduled to begin on February 16, 1982. Four sets of testimony are included:

1. Testimony Of Joseph Kane Regarding The Effects Of The Plant Fill Problem On Foundation Support For The Seismic Category I Underground Piping;

2. Testimony Of Darl Hood, Hari Narain Singh, And Joseph Kane Concerning The Remedial Measures For The Borated Water Storage Tanks;

3. Testimony Of Frank Rinaldi And John Matra For The NRC Staff Regarding The Borated Water Storage Tanks, The Emergency Diesel Fuel Oil Storage Tanks And Electrical Direct Banks; and

4. Testimony Of. W. P. Chen For The NRC Staff Regarding Underground Seismic Category I Piping.

Sincerely,

M Blume

Michael B. Blume
Counsel for NRC Staff

cc w/enclosure:
see next page

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Atomic Safety and Licensing Appeal Panel
Secretary

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CONSUMERS POWER COMPANY	)	Docket Nos. 50-329 OM & OL
	)	50-330 OM & OL
(Midl d Plant, Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "TESTIMONY OF JOSEPH KANE REGARDING THE EFFECTS OF THE PLANT FILL PROBLEM ON FOUNDATION SUPPORT FOR THE SEISMIC CATEGORY 1 UNDERGROUND PIPING", "TESTIMONY OF FRANK RINALDI AND JOHN MATRA FOR THE NRC STAFF REGARDING THE BORATED WATER STORAGE TANKS, THE EMERGENCY DIESEL FUEL OIL STORAGE TANKS AND ELECTRICAL DUCT BANKS", "TESTIMONY OF DARL HOOD, HARI NORAIN SINGH, AND JOSEPH KANE CONCERNING THE REMEDIAL MEASURES FOR THE BORATED WATER STORAGE TANKS", and "TESTIMONY OF W. P. CHEN FOR THE NRC STAFF REGARDING UNDERGROUND SEISMIC CATEGORY I PIPING" (with attachments) in the above-captioned proceeding have been served on the following by deposit in the United States mail, first class or as indicated by an asterisk by deposit in the Nuclear Regulatory Commission internal mail system, or as indicated by a double asterisk by express delivery service, or as indicated by a triple asterisk by hand delivery, this 5th day of February, 1982:

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Counsel for NRC Staff

BY MR. BLUME:

Q Mr. Hood, are you one of the authors of the document entitled "Testimony of W. P. Chen and Darl Hood for NRC Staff Regarding Underground Seismic Category I Piping"?

A (WITNESS HOOD) Yes, I am.

Q And do you have any additions, corrections or deletions to the part of the testimony for which you are responsible?

A (WITNESS HOOD) No, I have none.

Q Dr. Chen, are you one of the co-authors of the testimony of W. P. Chen and Darl Hood for the NRC Staff Regarding Underground Siesmic Category I Piping?

A (WITNESS CHEN) Yes, I am.

Q And do you have any additions, corrections or deletions to that document?

A (WITNESS CHEN) Yes, I do.

Q What are they?

A (WITNESS CHEN) Okay, starting on Page 3, the fifth line from the top of the page, these should read instead of "Approximately 6" it should be "6 to 10 feet."

On Page 5 on Item 1 on the first line, the first word, strike the word "Current" and replace that with "Based on initial profile data accurate to plus or minus one-quarter of an inch."

That same line, replace the word "Average" with "Range from." At the end of that sentence indicate the Footnote 1. The Footnote 1 should read: "The line which was 1.13 feet below the design elevation has been rebedded."

And continuing with this same item, in the second sentence, strike the word "Current" and replace it with "Old profile data indicate that" -- I am sorry, the first word in that sentence should also be deleted.

In the second to the last line of that same item, Item 1, the word "Profile" should be replaced with "Reprofiled to within plus or minus one-sixteenth of an inch."

JUDGE DECKER: I didn't understand the first word. Did you say pre-profiled?

WITNESS CHEN: No, reprofiled.

In the second item, the word "percentage" in the first line should be replaced with "maximum." And starting at the end of the first line where it says "Two percent for the 26-inch piping and nearly," those words should be deleted.

JUDGE HARBOUR: Beginning with what?

WITNESS CHEN: Two.

JUDGE HARBOUR: Beginning with two.

WITNESS CHEN: Two and ending with nearly. And the words "26-inch" should be inserted between "the" and "36" in the second line.

JUDGE COWAN: Maybe you'd better read those two lines.

WITNESS CHEN: "A current maximum ovality for line inspected is nearly 3 percent for the 26 and 36 inch piping."

There is a second footnote that should go at the end of that sentence. The Footnote 2 should read as follows: "Ovality measurements are available only for the 26-inch and 36-inch seismic Category I lines."

4-2

lines

In Item 5, the third line, where it says, "Accept the 8 inch OHBC-81," the "the" should be replaced with "lines."

On Page 6, Item 10, "SWS" should be replaced with BWS." And the following should be added to the end of that sentence: "From the end of that tank to the dike."

BY MR. BLUME:

Q So that Item 10 should read: "The 18-inch diameter BWS piping is to be rebedded from the tanks to the dike"?

A (WITNESS CHEN) That is correct. On Page 7, the second line, the word "measurements" should be deleted. Item 3, the second to the last line of the first paragraph, should be two M's in the word non-symmetric.

On Page 8, the fifth line from the bottom of the page, where it says "Several types of analyses are generally used," that should read: "Several types of analyses were used." The second to the last line there should be a period inserted after the word "settlement" and the new paragraph started there.

On Page 9 -- no, I will withdraw that one.

On Page 10, Roman III, the "and 10" should be deleted.

CHAIRMAN BECHHOEFER: Where is that?

WITNESS CHEN: The title. A and B of that same item should be deleted and C should be A.

On Page 11, the second paragraph, it should read: "Based on the data, some of which are" -- so the words "Some of which are" should have been inserted between "data" and "shown."

On the second line of that same paragraph the "One and a half" should read "two."

The second to the last line of that same paragraph, the "two" should be "one and a half."

On Page 12, Item 3, the last line of that item, the words "yet to be" should be deleted and "been" inserted.

CHAIRMAN BECHHOEFER: What is inserted?

WITNESS CHEN: It should read "Have been considered."

And at the end of that sentence, the words "And are under review" should be added.

CHAIRMAN BECHHOEFER: How does that read then?

WITNESS CHEN: "The effects of future settlement over the life of the plant on degradation, existing clearance and movement on the seismic loads have been considered and are under review. They have been considered by the Applicant."

CHAIRMAN BECHHOEFER: Oh, "have been considered by the Applicant"?

WITNESS CHEN: I think for clarity we should add--what I would like to add is "by the Applicant." For further clarity, "are under review by the Staff."

The second to the last line on that page between "furthermore and potential," the words "conclusions regarding" should be inserted.

And on Page 13, the words following "Building" to "negligible" in that first sentence should be deleted and they should be replaced with "are subject to results obtained from the dewatering and recharged tests currently in progress."

14-

progress.

MR. WILLIAMS: Excuse me, could the witness indicate again where that correction is being made?

A (WITNESS CHEN) Okay. Starting on page 12, on the bottom of page 12, that sentence should read:

"Furthermore, conclusions regarding potential hazards resulting in flooding due to a failure in the circulating water discharge piping near the diesel generator building are subject to results obtained from the dewatering and recharged tests currently in progress."

BY MR. BLUME:

Q Do you have any further additions, Dr. Chen?

A (WITNESS CHEN) Yes, I am not done. Yes, I do. In Item 1 on that page, second to the last line of that item should be deleted and replaced with **are**. And the word on the last line of that item should be deleted, a new sentence added. It says, "Maximum ovality of these lines is less than 5 percent."

JUDGE COWAN: What was it that you eliminated?

WITNESS CHEN: The words after --

JUDGE COWAN: The word after pigged.

WITNESS CHEN: Pigged.

In Attachment 1 -- the resume there should be Attachment 1. It's not so identified. Under "Experience," between 1960 and 1962 --

JUDGE HARBOUR: Is this to be added?

WITNESS CHEN: Yes, there is a problem -- let's see, under "Experience" because I think the typing is not quite correct there. But over and above that, I am requesting that the following be added: Between 1960 and 1962 Quebec North Shore and Labrador Railway. This should be underlined. My duties there were a soils inspector and division soils engineer for railway construction.

One other item should also be added where it says "Membership."

CHAIRMAN BECHHOEFER: Where?

WITNESS CHEN: Membership.

JUDGE HARBOUR: At the bottom of the page.

WITNESS CHEN: Yes. This is ASME Solar Pressure Vessel Code Civil Standards Committee.

JUDGE HARBOUR: Which standards?

WITNESS CHEN: Solar. And the committee, the Power Subcommittee, the working group on elevated temperature design membership.

BY MR. BLUME:

Q Does that conclude the corrections to your testimony, Dr. Chen?

A (WITNESS CHEN) Except for the obvious typing error saying "Experience" in Attachment 1. Do you want me to address that?

CHAIRMAN BECHHOEFER: We now have experience from 1960 through '62 and nothing up to '65. There is a question what that next one applies to, probably what is typed there. You are missing some years.

MR. BLUME: I don't think it is necessary, unless the witness wants to amend that.

WITNESS CHEN: No, what I was getting at is the 1965 to 1971 is on the same line with "Experience." Assignment to Fraser University in Canada should all be indented I guess to be, you know, on the same column with the basic technology.

BY MR. BLUME: That being done, do you have any further questions, Dr. Chen?

A (WITNESS CHEN) No, I don't.

Q Now, Dr. Chen and Mr. Hood, is the testimony of W. P. Chen and Darl Hood for the NRC Staff regarding underground seismic Category I piping true and correct to the best of your knowledge?

A (WITNESS HOOD) It is.

A (WITNESS CHEN) It is.

MR. BLUME: Mr. Chairman, I offer into evidence the testimony of W. P. Chen and Darl Hood for the NRC Staff regarding underground seismic Category I piping and ask that it be bound into the record as if read.

MR. WILLIAMS: No objection.

CHAIRMAN BECHHOEFER: Without objection, that testimony will be admitted in evidence and bound into the record as if read.

MR. BLUME: Thank you.

(The prepared testimony of W. P. Chen and Darl Hood follows:)

02/05/82

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CONSUMERS POWER COMPANY	)	Docket Nos. 50-329 OM & OL
	)	50-330 OM & OL
	)	
(Midland Plant Units 1 and 2)	)	

TESTIMONY OF W. P. CHEN & DARL HOOD
FOR THE NRC STAFF REGARDING
UNDERGROUND SEISMIC CATEGORY I PIPING

My name is Wellington Paul Chen. I am manager of the Stress Analysis Unit of the Systems Engineering Department of the Energy Technology Engineering Center (ETEC). ETEC is a U. S. Department of Energy (DOE) laboratory which is operated by the Energy Systems Group (ESG) of Rockwell International (RI).

A resume of my professional qualifications is attached hereto (Attachment 1).

I have served since September 1979 as Principal Investigator of the Mechanical Engineering Case Reviews III contract between the U.S. Nuclear Regulatory Commission (NRC) and ETEC. In addition to, and as a result of, serving as Principal Investigator of this contract, I have been directly involved since January 1980 in the technical reviews of the effects of soil settlement on the underground, seismic Category I piping at the Midland Plant, Units 1 and 2, as requested by the Mechanical Engineering Branch (MEB) of the NRC. In particular my review has been restricted to the adequacy from a mechanical engineering perspective of the Consumers Power Company (CPC) responses to Questions 16 through 20 of

"Responses to NRC Requests Regarding Plant Fill" (10 CFR 50.54(f) Request) and related materials, as requested by the MEB.

My name is Darl Hood. I am a Senior Project Manager in the Division of Licensing, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. I am the Project Manager for the Midland Plant application for operating licenses. I have served in that position since August 29, 1977, when the application for operating licenses was tendered to the NRC for acceptance review. My responsibilities include management of the Staff's environmental and radiological safety reviews. I am responsible for that part of this testimony describing the function of the service water system.

The purpose of this testimony is to provide technical support for the NRC Staff on (1) the soils settlement problem as delineated above, and (2) Stamiris Contention Numbers 4A(4) and 4C(f), and Warren Contention Number 3, as they relate to underground seismic Category I piping.

The seismic Category I piping to be addressed is founded in the plant fill area and identified in the response to Question 17 of the 10 CFR 50.54(f) Request, and includes piping for the service water system (SWS), borated water system (BWS), and emergency diesel fuel system (EDFS). The nominal pipe size for these lines vary between 8 inches to 36 inches (SWS), 18 inches (BWS), and 1-1/2 to 2 inches (EDFS), respectively.1/

1/ Some, but only a small portion of non-seismic Category I lines affected by soils settlement are identified in the responses to Questions 13 and 19 of the 10 CFR 50.54(f) Request. The nominal outside diameter for these lines vary between 3 inches and 96 inches.

The 26 and 36 inch diameter pipes consist of ASTM A-155, Class 2 Grade KC-70 carbon steel while the 8 and 10 inch diameter pipes are ASTM A-106 Grade B carbon steel, and both types are constructed in accordance with the requirements of the ASME B&PVC Section III, Class 3. Depth of cover for these lines varies between approximately 6 feet for the 8 to 36 inch lines, and 2 feet for the 1-1/2 to 2 inch lines.

The service water system, of which the Service Water System piping is a part, is a shared system for both Midland Unit 1 and Midland Unit 2. It consists of two redundant Essential Service Water trains and two turbine building service water trains. In addition to providing treated cooling water for various components during normal plant operations, the system also provides cooling water to engineered safety features equipment, and provides a backup water supply for several safety-related systems during a design basis accident. Each Essential Service Water train serves half the safety-related cooling components of both Midland units.

The Essential Service Water trains are designed to provide a cooling water supply for the Containment Recirculating Air Cooling Units, which act to remove energy from the containment after a steam line break accident or loss-of-coolant accident. A portion of the Service Water System is designed to provide cooling water supply for the Diesel Generator Coolers to permit continuous operation of Emergency Diesel Generators at required power during design basis accident conditions.

The Essential Service Water train is designed to provide the supply of cooling water for the safeguard chillers which maintain air temperature of the control room, switchgear rooms, battery rooms, and engineered safety features equipment rooms below the room design ambient air temperature during operation under accident conditions. The Essential Service Water train is designed to provide the supply of cooling water to heat exchangers of the component cooling water systems which, in turn, provides cooling water to engineered safety features systems during a loss-of-coolant accident. The component cooling water system thus provides cooling water for removal of heat from the decay heat removal heat exchanger, decay heat removal pump seal coolers, reactor building spray pump coolers, reactor coolant pump seal coolers and makeup lube oil coolers. The Service Water System, operating in conjunction with the Decay Heat Removal System and the Component Cooling Water System, provides a means to cool the reactor core and reactor coolant systems following shutdown. The Essential Service Water train provides alternate water supplies to the Auxiliary Feedwater Pumps, Spent Fuel Pool, and the pressurized water storage tank of the Containment Penetration pressurization System.

The Borated Water System is described in the testimony of Hood, Singh and Kane offered for this hearing session.

The function of the Emergency Diesel Fuel System is of course to supply fuel to the onsite Diesel Generators in case of loss of offsite power.

The current condition of the piping is described in data supplied in (1) responses to Questions 17, 19, 34 and 45 of the 10 CFR 50.54(f)

Request, and (2) various reports and meeting handouts. These data indicate that:

1. Current invert elevations for lines profiled average 0.2 feet above to 1.8 feet below the design elevations. The current elevations are predominantly below the design elevations, and the difference between these elevations is variable both for given lines and from line to line. All of the 26 inch and 36 inch diameter seismic Category 1 piping has been profiled to indicate the present condition of the pipe due to soil settlement.

2. Current percentage ovality for lines inspected is nearly 2 percent for the 26 inch piping, nearly 3 percent for the 36 inch piping.

3. Profile data indicate that differences in invert-inside diameter profiles of up to 1/4 inch exist within 2 inches of either side of weld joints in the profiled 26 inch and 36 inch piping.

4. Current rattlespace annulus dimensions vary considerably from the design dimensions.

5. All of the 8 and 10 inch seismic Category I SWS piping in the vicinity of the Diesel generator building has been or will be rebedded, except the 8"-2HBC-81, 8"-2HBC-82, 8"-1HBC-310, and 8"-1HBC-311. Each of these lines is approximatly 30 feet long.

6. Diameter verification pigging operations conducted on the four 8 inch SWS lines mentioned in (5) above indicated that the inside diameters are greater than 7.781 inches, and no obstructions are present.

7. Local kinking i.e., discontinuity in the slope of the pipes, at weld joints is apparent in the profiled 26 and 36 inch diameter SWS piping.

8. Apparent local sagging is evident at four of the five locations where roadways or railways cross the profiled lines.

9. Differential settlement stresses at the ends of some lines has been relieved by cutting and refitting of the ends.

10. The 18 inch diameter SWS piping is to be rebedded.

11. The 1-1/2 inch and 2 inch diameter EDFS piping was installed after the Diesel Generator Building surcharging, thus obviating any problems due to past settlements related to these pipes.

The eleven items cited above give rise to the following observations regarding the seismic Category I underground piping:

1. It is not known how much of the deviation in invert elevations is attributable to soil settlement per se. Though fabrication and installation tolerance on overall location was ± 2 inches, and no construction nonconformances related to this requirement were reported, there are no profiles to verify post-installation locations. In view of Items 7 and 8, i.e., kinking at weld joints and sagging beneath roadways and railways, it would appear that part of the deviations are due to fabrication and installation and part to settlement.

2. It is not known how much of the ovality of the 26 inch and 36 inch SWS piping is due to longitudinal bending due to differential soil settlement. The responses to Questions 19 and 45 of the 10 CFR 50.54(f) Request show that at least one line (96"-2YBJ-4) was out-of-round with the vertical diameter larger than the horizontal, prior to surcharging of the Diesel generator building area. Though this 96 inch pipe is not strictly safety related, similar behavior may be exhibited by safety related piping. Since ovalization of this type will occur in flexible

piping during placement of the fill material at the sides of the pipe, the current ovality measurements cannot be due solely to longitudinal bending of the pipe. Furthermore, the allowab:e manufacturing ovality tolerance is one percent for 26 and 36 inch ASTM A-155 straight pipe.

3. Although the apparent 1/4 inch weld mismatch of Item 3 exceeds the ±5/32 inch local and ±3/32 inch overall mismatch allowed in fabrication and installation of the piping, it is not known how much of this apparent mismatch is due to nonsymetric weld shrinkage and the tolerance in profile measurement.

In view of the above described condition of the seismic Category I piping, the Staff believes that the following criteria are necessary to assess the structural adequacy of the piping for its intended function over the life of the Midland plant:

1. Strength Criteria: These criteria are intended to assure the strength of overall cross-sections of the piping to resist the forces and moments due to all loads imposed upon the piping over the life of the plant. These loads include, pressure, thermal expansion, over burden and traffic, soils settlement and seismic loads.

2. Buckling Criteria: These criteria are intended to guard against local buckling (which could lead to cracking of the piping) and gross collapse (which could lead to loss of function of the piping).

3. Minimum Rattlespace Criteria: These criteria are intended to assure that both local and gross overstressing of the piping and gross overstressing or distortion of piping components or attached equipment does not occur due to loads to be imposed during the life of the plant.

4. Nozzle and Other Interface Loads Criteria: These criteria are intended to provide assurance that the structural adequacy or functional integrity of attached components (e.g., pumps, valves, vessels, supports, etc.) associated with the seismic Category I piping will not be compromised over the life of the plant.

5. Criteria for Effects of non-Category I Piping: Since both seismic Category I and non-Category I piping are founded in the plant fill, these criteria would ensure that failures of non-Category I piping have no detrimental effects on Category I piping.

The above criteria have been discussed with the Applicant:

1. Strength Criteria: The applicant had proposed the 3.0Sc criterion of sub paragraph ND-3652.3(b) of the ASME B&PVC Section III, Class 3 for bending stresses due to soil settlement. This criterion applies to "any single nonrepeated anchor movement (e.g., predicted building settlement)." The Staff would accept this criterion for application to soils settlement bending stresses.

Difficulties have been encountered, however, in verifying compliance with this criterion due to uncertainties regarding the maximum stresses in the piping over the life of the plant. These uncertainties relate to methodology of analyses for the current piping configurations and changes in those configurations due to additional settlements anticipated over the life of the plant. Several types of analyses are generally used to deal with the difficulties of verification. They are based upon the assumption that deviations in current invert elevations from design elevations are due solely to soils settlement, simple elastic analyses, which utilize displacements corresponding to the profile data as inputs, indicate that the maximum stresses in the 26 and 36 inch lines are on the order of 200ksi. These exceed the proposed 3.0Sc allowable stress of 52.5 ksi. Analyses performed at ETEC, as well as by CPC and its consultants, showed that stresses due to current settlement were acceptable for all but localized areas. These analyses, however, contain limitations in that soil reactions are not modelled realistically. The reactions are not distributed along the length of the pipe but rather are concentrated at displacement input locations. But, linear elastic analyses were performed by Structural Mechanics Associates (SMA) with refinements to account for 1) continuous soil reaction, and 2) variations in soil material property constants. These analyses yield results which do not differ much from those detailed by the simple elastic method of analysis described above.

Further analytical refinements were then introduced by SMA to include non-linear soil and piping properties. These yielded inconclusive results but identified problem areas not very different from those obtained in both the simple elastic and refined elastic methods of analysis.

Southwest Research Institute, another CPC consultant, then introduced analytical refinements to incorporate possible construction defects such as offsets and misalignment, as well as continuous soil reactions. This analysis identified problem areas not too different from those obtained by SMA's simple elastic method of analysis.

Staff concludes, therefore, that the simple elastic method of analysis can be utilized as a screening tool to identify regions where stress criteria are exceeded due to soil settlement for lines for which profile data can be obtained, i.e., 26 and 36 inch diameter SWS piping. This method of analysis can also be used to account for local effects due to misalignments, mismatch and weld shrinkage. Future settlement effects can also be evaluated by this method of analysis if the distribution of such settlements along the lines can be defined.

Results of analyses for stresses due to overburden, traffic, and seismic loads on piping are still under review.

In summary, the status of Staff's review to assure that strength criteria have not been exceeded is as follows:

i) <u>26 and 36 inch SWS piping</u>

a) Current soils settlement problem areas have been identified.

b) Review of future soils settlement effects is incomplete.

c) Review of stresses due to other loads is incomplete.

ii) <u>Rebedded 18 inch BWS and 8 and 10 inch SWS Piping</u>

a) Review of future soils settlement effects is incomplete

b) Review of stresses due to other loads is incomplete.

iii) <u>Non-rebedded 8 and 10 inch SWS Piping</u>

a) Current soils settlement problem areas have not been identified.

b) Review of future soils settlement effects is incomplete.

c) Review of stresses due to other loads is incomplete.

iv) <u>1-1/2 and 2 inch EDFS Piping</u>

a) Review of future settlement effects is incomplete.

b) Review of stresses due to other loads is incomplete.

2. <u>Buckling Criteria</u>

CPC has previously proposed a five percent ovality criterion to preclude buckling. This criterion is predicated on adequate compaction of the pipe backfill. Since the adequacy of the Midland pipe backfill is questionable, however, use of this criterion is precluded. CPC has nonetheless more recently proposed a less conservative criterion of eight percent. Since buckling of the piping could occur due to the combined effects of pipe bending caused by soil settlement and circumferential or ring type bending due to overburden and traffic loads, the buckling criterion for Midland should be determined considering the interaction of both types of bending. A review of the literature by Staff indicates that no data were available for bending with lateral restraints. Assuming that this restraint is negligible, because there is a lack of data on the degree of compaction of the backfill, the data for pure bending with no lateral restraint shows decreasing consistency with increasing diameter to thickness ratio (D/t). Based on currently available data, the minimum critical ovality at buckling versus D/t plot is as shown in Attachment 2.

Based on the data shown in Attachment 2, Staff's position is that maximum permissible ovality values of 1-1/2 and 4 percent are satisfactory to preclude buckling for the 36 and 26 inch diameter piping, respectively. The margin of safety associated with these values is approximately equal to two provided that total ovalization is limited to these values.

Based on presently available data, as noted above, the 36 inch diameter SWS piping would be unacceptable. However, a search for additional data is underway, and the authors of the publications containing the current data have been contacted for assistance and interpretation of the findings. The 26 inch diameter piping is acceptable with respect to buckling. In addition, the effects of future settlements and seismic loadings anticipated over the life of the plant are still under evaluation.

Buckling criteria for piping less than 26 inches in diameter are still under review, but Staff believes that a minimum of at least four percent is acceptable.

CPC has proposed a pipe ovalization monitoring program for the 26 and 36 inch diameter SWS piping over the life of the plant. This program addresses the functional capability of the piping only and is still under review. Final recommendations regarding acceptability will be made pending completion of this review.

3. Minimum Rattlespace Criteria

These criteria are still under review. The effects of future settlement over the life of the plant on the degradation of existing clearance and movements under seismic loads have yet to be considered.

4. Nozzle and Other Interface Loads Criteria

The status of these criteria are the same as that for the minimum rattlespace criteria.

5. Criteria for the Effects of Non-Category I Piping

The effects of breaks in non-seismic Category I on Category I piping where the former lies beneath the latter have been evaluated and found to be acceptable. Those evaluations were based on the worst-case condition of a washout extending to the surface. Furthermore, potential hazards resulting in flooding due to a failure in the circulating water discharge piping near the Diesel Generator Building have been evaluated and have been shown to be negligible.

Response To The Stamiris And Warren Contentions:

1) Stamiris Contention 4A(4). The effects on seismic Category I piping of completed or proposed remedial actions by CPC are still under evaluation. In particular, the EDFS and SWS piping in the vicinity of the Diesel Generator Building are still under review. However, since the EDFS piping was constructed after the surcharge program and most of the 8 and 10 inch diameter SWS piping has been or is going to be rebedded, the effects of completed remedial actions is negligible except for those 8 inch lines which have been pigged and were discussed above.

2) Stamiris Contention 4C(f). The concerns regarding differential soil settlement and seismic effects on seismic Category I piping are currently being investigated.

3. Warren Contention 3. The surcharge program did not affect the seismic Category I EDFS lines since those lines were constructed after the program.

CONCLUSIONS

On the basis of the above, no conclusions regarding the adequacy of the seismic Category I piping over the life of the plant can be reached at this time. Areas where additional data are required or ongoing reviews are in progress have been identified. Final conclusions will be made pending satisfactory disposition of all ongoing and/or additional reviews.

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ENERGY TECHNOLOGY ENGINEERING CENTER (ETEC)

EDUCATION B. Eng. Civil Engineering & Applied Mechanics, McGill University, 1959

M. Eng. Civil Engineering & Applied Mechanics, McGill University, 1962

Ph. D. Theoretical and Applied Mechanics, University of Illinois, 1965

EXPERIENCE 1965-1971 Simon Fraser University, Burnaby, B.C., Canada

Teaching and research in the Mechanics of Deformable Media with particular emphasis on problems of limit analysis and contained plastic flow of elastic-plastic media.

1972-1974 Basic Technology, Inc., Pittsburgh, Pa.

Thermal stress analysis of components.

1974-Present Energy Technology Engineering Center

ASME B&PVC compliance analysis of piping and components. NRC LWR licensing support and snubber research activities. Technical support for Solar Central Receiver and Ocean Thermal Energy Conversion projects.

PUBLICATIONS

1. A complementary Linear Theory of Plasticity for Plane Strain, Arch. Mech. Stos., Vol 18, P. 731-749, 1966

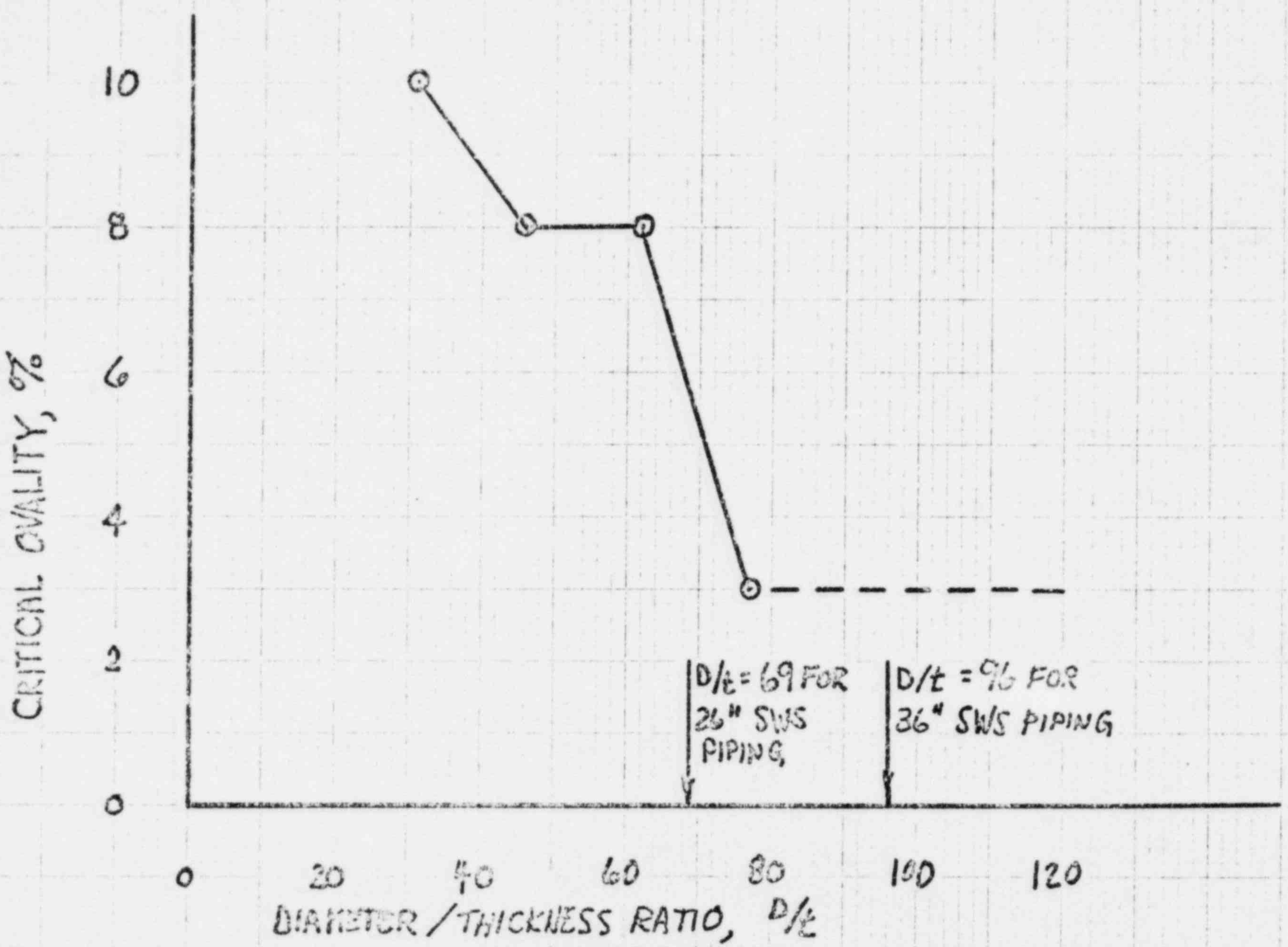
2. On Classes of Complete Solutions for Rigid Perfectly Plastic Truncated Wedges in Plane Strain, Arch. Mech. Stos., Vol. 21, P. 469-494, 1969

3. On Uniqueness of the Limit Load for Unbounded Regions, Arch. Mech. Stos., Vol. 21, P. 679-699, 1969

4. On the Collapse of Rigid Perfectly Plastic Tapered Cantilever Beams Under End Shear, Acta. Mech., 1972

5. On Torsion of Elastic - Perfectly Plastic Cylinders of Polygonal Cross Section (In Preparation)

ATTACHMENT 2



you.

MR. BLUME: We have some further direct testimony, Mr. Chairman.

BY MR. BLUME:

Q Mr. Kane, were you here during Mr. Meisenheimer's testimony regarding straining gauges today?

A (WITNESS KANE) Yes, I was.

Q And are you in agreement with his statements regarding the use of strain gauges and the objectives for a settlement monitoring program regarding underground piping at the Midland plant?

A (WITNESS KANE) There are actually two items there, one is with regard to the strain gauge and the other is with regards to his statements on the settlement monitoring program. My personal experience with the strain gauge is not extensive.

For the lack of that, I have attempted to contact people with more significant experience than I have had, and I have learned that there are problems with the strain gauges and their reliability. It has been indicated that the best strain gauge that is available today are the ones that are being proposed by the applicant. But there is some question on the life of their expectant -- in giving reliable information. There is some concern on the Staff whether these gauges will be available for the 40-year plant operation. We hope to be able to work out an understanding and a commitment with the applicant to require the placement of these gauges as the behavior during plant life operation indicates the need for it.

With regards to the other issue about the settlement monitoring program, I am in agreement with what was indicated by Mr. Meisenheimer, except for one additional clarification, and, that is in our discussions we talked about also putting settlement monitoring instruments at locations where we felt we had the potential for the largest differential settlement, and that would be based on evaluation of the soil profiles and our understanding of the structures in conduits that are along the alignments of these pipelines. They were the only additions that I wished to make to what I had heard.

Q Mr. Hood, were you here during the testimony of Mr. Lewis today regarding the Applicant's plans to replace the present 36-inch service water system pipes with new pipes?

A (WITNESS HOOD) I was.

Q And has the Staff reached its position at this time as to the adequacy of the plan to replace these 36-inch pipes?

A (WITNESS HOOD) No, it has not. The Staff heard for the first time Friday of last week, near the close of business, I believe sometime between 2:00 and 3:00 o'clock, this plan, heard it verbally from Mr. Jim Rooney. It was a very brief description of the plan. There simply has not been time for the staff to evaluate the proposal.

As you know, Monday was a holiday spent in transit by the staff. We have had all but one to two hours to evaluate the presentation. We have had nothing in writing from the applicant regarding the proposal between the initial proposal and the proposal we heard today. There is potential for some variation.

Q Dr. Chen, directing your attention to Page 10 of the testmony of Mr. Landers, Mr. Lewis and Mr. Meisenheimer rearding underground piping and tanks, there is a statement in the second paragraph on that page that "The maximum differential settlement along the longitudinal axis of buried utilities is anticipated to occur at anchor points which may be at or near building entry."

Do you agree with that statement?

A (WITNESS CHEN) No, I don't. The maximum differential settlements do not necessarily occur only at the anchor points. They could occur somewhere along its length, the length of what is buried piping or whatever it is, duct bank, because of variability of soil properties that are there.

Q Now, directing you to Page 13 of the Applicant's testimony on underground piping, at the top of that page it is said: "It has been conservatively assumed that all deviations from design location are due to settlement."

Do you agree that that is a conservative assumption?

A (WITNESS CHEN) It is not necessarily conservative to assume that all the deviations are due only to settlement. The most conservative assumptions would be one which assumes that -- is one which would give you the maximum differential settlement along the line.

Q How does that differ from what is stated in Applicant's testimony?

A (WITNESS CHEN) Because it's possible that if you get a change in slope, okay, or a kink initially, within this plus or minus 2-inch installation tolerance, that you will have higher stresses.

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stresses

Q So are you saying that it would be more conservative to assume that the pipe started out at 2 inches above design elevation?

A (WITNESS CHEN) No, I'm not saying that.

Q Directing your attention to Page 21 of the Applicant's testimony on underground piping, the first sentence in Section 3.5 states: "The data exhibited in Table UP-2 and plotted in Figure UP-8A show considerable scatter."

A (WITNESS CHEN) I think there is an inconsistency here. Table UP-2 gives D/T versus ovality data and Figure UP-8A gives -- I think that's R/T versus strain data.

Q In other words, then the data exhibited in Table UP-2 are not plotted in Figure UP-8A?

A (WITNESS CHEN) That's correct.

Q Above that sentence on Page 21 of the Applicant's testimony in the fifth line of that paragraph, it is said that "Ovalization of less than 5 percent are of no concern."

Do you agree with that statement, Dr. Chen?

A (WITNESS CHEN) Okay, the sentence I think --

MR. WILLIAMS: I object to that question. Before the witness answers, I think the counsel should read the whole sentence. I don't think that the testimony --

I think the testimony is paraphrasing the information in the references and not asserting that as a bald statement.

I think the whole context of the statement should be put to the witness as opposed to just that extracted little segment of an incomplete sentence.

MR. BLUME: I apologize to counsel. I did not mean to misconstrue applicant's testimony. I will read the whole sentence.

It says: "This information supports the data in Table UP-2 and indicates that ovalization of less than five percent are of no concern."

Do you agree with that statement?

WITNESS CHEN: By itself I do because some of the sources in Reference 3 require that soils be compacted very well.

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CHAIRMAN BECHHOEFER: Are you implying that when taken in context, you do not agree with it? You said by itself you agree.

WITNESS CHEN: Well, I am not sure that this criterion, this 5 percent criterion could be applied to the piping at Midland considering the condition of the soils here. This 5 percent is predicated on having compacted soils and fairly good backfill.

BY MR. BLUME:

Q Directing your attention to Page 22 of the Applicant's testimony on underground piping, Dr. Chen, in the third sentence of the last paragraph on that page, it says: "That author recorded longitudinal bending strength prior to buckling(specimens 1 to 4) in the range of 0.31 percent to 0.68 percent, which for a 48-inch diameter pipe represent ovalities of 4.8 percent to 22.8 percent respectively."

Do you have any comments on that statement?

WITNESS CHEN: Yes. I believe that the conversion from strains to ovalities was based on Figure UP-9 in the testimony. This was taken from Reference 4 of the testimony, which is based on an analysis by Woods. The analysis in Reference 4 is an elastic analysis.

Since the kind of strains we are talking about here are in the inelastic range, I do not believe that the conversion is appropriate. The Applicant has proposed that the conversion of strain data to ovality data be based also on the results of this figure and I do not believe that that is correct because again the analysis on which this figure is based is based on an elastic material and, because of the strains that we are talking about, this curve is inapplicable.

Q Is it your testimony, Dr. Chen, that there is no method available to convert strain to ovality?

MR. WILLIAMS: Objection. I think that goes a little bit too far in leading the witness. The witness has not testified to date that there is no such method. If he wants to ask him if there is any, he can ask him that. But he should not testify in his place.

MR. BLUME: I am not sure I see the difference of the question, but I will ask him is there a way to convert strains to ovality if that meets with counsel's objection?

MR. WILLIAMS: Yes, it does.

A (WITNESS CHEN) I think there is another way to convert from strains to ovality. This method I think would be used on the available experimental data at this point.

BY MR. BLUME:

Q And do you have --

JUDGE DECKER: Excuse me. Was that question and answer limited to inelastic strain or strain into the inelastic area or was it limited only to elastic deformations?

MR. BLUME: The question was not limited, Judge Decker, to either elastic or inelastic.

JUDGE DECKER: All right.

WITNESS CHEN: Maybe I should clarify my answer.

My answer is in response to the case where we do have inelastic behavior. In the case of elastic behavior only, these curves would be appropriate.

JUDGE HARBOUR: Excuse me, just a clarification, because it seemed to me that these sentences or questions have proceeded one upon the other in the range of .31 percent to .68 percent strains.

Did your response refer just to this test of specimens of 48-inch diameter pipe or were you speaking more generally?

WITNESS CHEN: I was speaking more generally.

JUDGE HARPER: And you are saying that all of these tests within the range or, excuse me, I will ask the question, are you saying that all of these tests within the range of .31 percent to .68 percent are outside the elastic range?

WITNESS CHEN: Not necessarily all of these, I think, but at least the .68 is.

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15.9

JUDGE HARBOUR: Thank you.

you.

BY MR. BLUME:

Q Dr. Chen, do you believe that strain can be accurately converted to ovality for purposes of monitoring the piping at the Midland Plant?

A (WITNESS CHEN) In reviewing the available data in some of the tests that were run, only ovality was measured. In other tests only strains were measured. In some tests, both were measured.

I think that the criteria can be expressed either in terms of strains or ovality, and I believe that you can come up with some kind of conversation based upon the test data available.

JUDGE HARBOUR: And now you are speaking to include the inelastic range here?

WITNESS CHEN: That is correct. In particular I am talking about the tests which are reported in Figure UP-8A in the testimony.

BY MR. BLUME:

Q Dr. Chen, directing your attention to page 23 of the Applicant's testimony on the underground piping in the next-to-the-last paragraph on that page, it is said that, "Collapse is a yield strength phenomenon."

Do you agree that collapse is a yield strength phenonenon?

A (WITNESS CHEN) I believe that collapse is not only a yield strength phenonemon, but is also a geometric phenonemon and that it depends on the D/T ratio of the pipe for the cylinder and consideration. I think that any conclusions which are drawn solely on this one consideration, this is that collapse is a yield strength consideration only, in particular the conclusion on page four where it says that the corresponding ovality of this strain is 4.6 percent -- 24, on page 24, I'm sorry -- that the conclusions -- well, this conclusion I think is missleading.

Q Dr. Chen, on page 24, the last two paragraphs on that page describe a procedure whereby plots of yield strength versus ovality are used to obtain a critical ovality for the 26-inch and 36-inch pipes at the Midland site.

Do you agree with the procedure described in these two paragraphs?

A (WITNESS CHEN) No, I do not agree with this procedure. In particular, the procedure I think -- well, it's shown in Figure UP-8C and UP-8B. These figures give plots of ovality versus yield strength data only.

The D/T or geometric considerations that I alluded to previously have been ignored in these plots. I think the plots are incomplete and results based on these plots alone are questionable.

Q On page 26 of the Applicant's testimony, Dr. Chen, equations relating strain to ovalization are represented. Do you believe that these equations should be used to relate strain to ovalization?

A (WITNESS CHEN) Of the two equations presented there, one for ovality and the second one for the quantity W_0, the first one is acceptable since this is based purely on geometric considerations. But the second equation for W_0 would be inappropriate in the case of the piping at Midland, again because this equation is based on an elastic analysis only.

Q Turning to page 27 of the Applicant's testimony, the bottom paragraph on that pages:

> "The calculated seismic stresses are combined with stresses from other loading conditions according to the recommended appropriate ASME code equations for the final design."

Do you agree that the ASME code equations are the only way or even the best way to calculate combined loads for the piping at Midland?

A (WITNESS CHEN) It's my understanding that these calculations are done in the usual manner and that the results are presented in Table UP-3.

A review of these, of the numbers at Table UP-3 indicates that the actual stresses reported there are based on usual methods. In considering the magnitude of the soil settlement problem at Midland, I question whether or not these methods should have been modified to include soil settlement stresses.

Furthermore, even if all the code criteria had been satisfied, since the D/T ratios of both the 26 and the 36-inch piping are in excess of 50, I believe buckling should also have been addressed.

The code gives minimum criteria only and I think, considering the D/T ratios, that additional criteria should have been imposed.

15-3

imposed

Q Perhaps it would be helpful, Dr. Chen, if you could explain the basis for your concern over large D over T piping.

A (WITNESS CHEN) Well, the larger the D over T ratio, under either displaced -- well, under a bending moment load, the percent ovality of buckling is fairly low. With increasing D over T there is a decreasing ovality at buckling or the onset of buckling.

Q And this is represented in Attachment 2 to your testimony, is it not?

A (WITNESS CHEN) That is correct.

CHAIRMAN BECHHOEFER: Counsel, we wanted to inquire what -- this type of testimony which is essentially criticizing certain aspects of the testimony we heard this morning, is this the type of thing that is in the process of being worked out between the applicant and staff or is --

MR. BLUME: Yes, sir.

CHAIRMAN BECHHOEFER: I wondered what the purpose of some of the details were.

JUDGE DECKER: In fact, what is the purpose of having any, either Staff or Applicant testimony brought before the Board today?

JUDGE COWAN: When there hasn't been a resolution of the problems to the point that it might be expected between the Staff and the Applicant before the Board is presented with it.

MR. BLUME: Well, I believe that was the purpose of the testimony.

JUDGE COWAN: I see.

MR. BLUME: And I do not think it is appropriate for counsel for the parties to stand up before the evidence is in the record and say that there is no resolution. There are areas of resolution and my next question to Dr. Chen would have shown a substantial area of resolution.

There are disagreements over methodology and some are outstanding.

JUDGE HARBOUR: Do you expect the Board to resolve these disputes over methodology?

MR. BLUME: No, I don't, Judge Harbour.

JUDGE COWAN: May this be looked at as a progress report?

MR. BLUME: It could be. We were hoping to be further along and this is where we are right now.

MR. WILLIAMS: Mr. Chairman, if I might address the Board for a moment?

The Applicant has made strenuous efforts to provide analysis and information to meet the Staff's concern on this particular issue. We have had extended negotiations on exactly what the acceptance criteria in terms of ovality will be and frankly I am a little bit surprised by Mr. Chen's testimony on this equation that appears on Page 26, because I believe this is the first time -- and I've attended most of these meetings -- this is the first time I heard the Staff that this equation was not appropriate.

Now, notwithstanding all of that, I think that the acceptance criterion for the 26-inch pipe, by whatever method it may be reached by the Staff is essentially the same as we have presented in this testimony.

I agree with the Board. I really do not see the point of all this discursion on exact methods because they reach exactly the same results by another method and we have agreed to replace the 36-inch pipe. So to that extent the issue is really moot.

MS. STAMIRIS: Judge Bechhoefer, may I ask a question?

The Board in the end has to obtain reasonable assurance on the issue of the buried piping, do they not? I mean, this Board and this proceeding.

CHAIRMAN BECHHOEFER: Eventually we do, yes.

MS. STAMIRIS: Okay, I just want to make sure then that in order to do that, this all cannot be put off to the OL, and not before this Board in this proceeding.

MR. BLUME: Staff agrees with that statement, Mr. Chairman.

CHAIRMAN BECHHOEFER: You may continue.

MR. BLUME: Thank you.

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BY MR. BLUME:

Q Dr. Chen, with all of your comments in mind, is it still your opinion as expressed on Page 11 of your testimony that an ovality criterion of 4 percent is satisfactory to preclude buckling for 26-inch diameter piping?

A (WITNESS CHEN) Yes, I do.

MR. BLUME: I have no further questions, Mr. Chairman.

CHAIRMAN BECHHOEFER: Normally Miss Stamiris would go next, but would the Applicant prefer to go next in view of the testimony we have just heard or would you prefer to follow Miss Stamiris?

MR. WILLIAMS: I think at this point I think I would rather allow Ms. Stamiris to proceed and at that point, before I go into cross examination I would like to have a five minute opportunity to caucus with some of the technical people from the company.

JUDGE DECKER: Mr. Hood, are there proposed remedial actions concerning the piping for which the Staff has determined that Staff approval will be required before that remedial action is taken as has been the case in other remedial actions we have been discussing?

WITNESS HOOD: It's my understanding that the Applicant intends to acquire Staff approval before he rebeds the pipe with respect to the 36-inch lines. I do not have strong confirmation of that. It's more my opinion than it is based on any definite commitment by the Applicant.

JUDGE DECKER: Well, has today concurrence been sought by the Applicant of the Staff and given by the Staff for any remedial actions taken today?

WITNESS HOOD: Are you referring specifically with regard to underground piping?

JUDGE DECKER: Yes, sir.

WITNESS HOOD: Judge Decker, we have had very lengthy dialogue and continuing dialogue with the Applicant on underground pipes. Because of the ongoing nature of the review, I don't think there has been -- that we've arrived at that point where the opportunity for a continuation of that is behind us. It's still in front of us and I expect to have those discussions with the Applicant.

I do not at this point have strong statements from this applicant that he plans to get NRC approval before he would rebed a pipe. I think that would be very prudent for him to do that. I expect him to do that. I do not at this point have that assurance.

JUDGE COWAN: I think he asked whether in the past there had been concurrence, perhaps not formal, but informal in regard to remedial things such as rebedding of the pipelines and possibly minor things of that nature.

WITNESS HOOD: Thank you for that clarification. That was not the question that I answered.

The answer to that question is yes, there has been that by practice.

JUDGE COWAN: Not necessarily formal, I assume?

WITNESS HOOD: That is correct, not necessarily formal.

CHAIRMAN BECHHOEFER: Ms. Stamiris?

MS. STAMIRIS: Well, I must admit to being confused at this point.

CROSS EXAMINATION

BY MS. STAMIRIS:

Q I would like to ask I guess a general question first of Mr. Hood.

WITNESS HOOD: Excuse me, Miss Stamiris.

MS. STAMIRIS: Yes.

WITNESS HOOD: Mr. Kane advises me that I misinterpreted the question from Judge Harbour and I would like to correct that if I may interrupt.

MS. STAMIRIS: Fine.

WITNESS HOOD: I believe the question as I understand it was have we approved rebedding of pipe in the past?

JUDGE COWAN: Yes.

WITNESS HOOD: No, we have not.

JUDGE COWAN: Did you consider that a remedial action?

WITNESS HOOD: I considered it a remedial action, yes.

CHAIRMAN BECHHOEFER: I take it some rebedding has taken place?

WITNESS HOOD: That's correct. There has been testimony on the part of Mr. Lewis. We were aware, certain Staff were aware of the fact that that was to be done. We were advised of that. There was no specific acknowledgement of the NRC to proceed with that.

MR. BLUME: If I may be of assistance, Mr. Chairman, I am informed that there are ongoing discussions on rebedding and other remedial measures, and before those rebedding actions have been taken, they have been proposed to the Staff, the Staff has agreed in concept and then the applicant has gone ahead.

WITNESS HOOD: Yes, that is true. I accept that.

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that.

JUDGE COWAN: That is why I specified informal. Informal has quite a lot of elasticity.

MR. BLUME: Yes.

JUDGE DECKER: Just a minute, please.

Mr. Hood, it has been argued that part of the reason that the modification order should not be placed into effect is that the Applicant agreed not to proceed with soils work voluntarily. He voluntarily agreed not to proceed without explicit Staff concurrence and approval. I am concerned as to whether or not that -- I may still hold to that understanding, whether that understanding still exists and whether that commitment still exists. I would like your views on that.

MR. PATON: Judge Decker, I don't want to interrupt your question to Mr. Hood. I would like an opportunity to answer that question, but if you want him to answer it first, because I think it is a legal question.

JUDGE DECKER: Well, in that case, go ahead.

MR. PATON: I think the reason that the order is not in effect is that by its own terms, if the Applicant asks for a hearing on the order, it is not in effect.

JUDGE DECKER: Oh, I agree. The question is whether or not this Board should conclude that it should be into effect.

MR. PATON: The Applicant thereafter volunteered not to go ahead with work until the Staff approved.

JUDGE DECKER: I understand. Now, is that agreement still in effect, that understanding?

MR. PATON: To my knowledge, it is, but I suppose we ought to hear from the Applicant on that. But to my knowledge that agreement still is in effect.

MR. ZAMARIN: As far as I know, it is.

JUDGE DECKRE: Okay.

MR. PATON: Could I ask Mr. Hood --

MR. ZAMARIN: I don't know of anything that in my judgment would be inconsistent with it.

MR. PATON: Could I ask Mr. Hood one question?

Mr. Hood, do you have any knowledge that would indicate to you that that agreement is still not in effect?

WITNESS HOOD: I have no knowledge that that agreement is not still in effect.

CHAIRMAN BECHHOEFER: And specifically with regard to piping, has there been any activity which you think is inconsistent with that agreement, underground piping?

WITNESS HOOD: May I have a moment, please?

CHAIRMAN BECHHOEFER: Yes.

MR. BLUME: Will you repeat the question for me.

(Question read.)

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A (WITNESS HOOD) I have to admit that in my opinion regarding underground piping fits the category of the agreement. Quite frankly, it is falling in the crack. In the sense that we have previously recognized and had formal discussions with the applicant in regard to proceeding of that activity and in the past have issued a letter noting that agreement as to how to proceed. I believe it should have been the part of the responsibility for the Region that it did not happen.

First this occurred to me as I am sitting here now. I do belive that further rebedment of pipes should be the subject of the verbal agreement that is in place and should not be undertaken without NRC approval.

MR. ZAMARIN: I ask this be clarified. I am not sure whether we are elevating form over substance at this point and whether Mr. Hood's response is simply talking about the fact that we didn't have this formal -- a letter coming from the Staff to Consumers Power Company; because what I think that I have heard him say is -- or the Staff counsel -- that, in fact, that there had been this concurrence of principle by the staff, but at the same time, there hadn't been this formal passing of a document. That's my understanding of it so far.

But I am not sure that's correct or not, although I think it is. And I just want to make sure that we don't have elevated form over substance and made form more important.

CHAIRMAN BECHHOEFER: I think you can certainly make that clear if there is any --

WITNESS HOOD: To me a proven concept means that the applicant came down to meetings and he advised of this plan to rebed and the Staff raised no objection to that plan. That is a little different than the approval that had been granted on other specific activities associated with remedial actions.

CHAIRMAN BECHHOEFER: Such as dewatering?

WITNESS HOOD: I have specifically polled the technical staff involved with the given remedial action. I have solicited their opinions, their technical opinions; and when I have indicated -- I have received information from those branches that they are satisfied, I have then issued such an agreement from the Staff on the part of my Assistant Director, Mr. Robert Tedesco.

That has not been done in the case of pipes. The pipes have been rebedded to date.

MR. PATON: Mr. Chairman, could I make one more comment on the matter we have just been discussing? The applicant in this agreement that they have generally are not to go ahead without the Staff's approval, agree to advise the Board, and what I can't remember is whether they were going to advise the Board when they went ahead with work with the Staff approval or only if they went ahead with work if they didn't have Staff approval. And I just can't remember.

CHAIRMAN BECHHOEFER: I can't recall. We get copies of the various letters of the Staff approving work. So if it has been approved by the Staff and we got sent a copy of the letter, I don't think the Applicant's have to independently advise us. I can't recall.

MR. ZAMARIN: I quite frankly can't recall either, although it seemed to me that it would have made sense that we would advise the Board if we were going to go ahead in a situation that the Staff disapproved of because that would be clearly contrary to the commitment that we have made. So that's my best recollection, and that is the way it seems to me that would make sense.

CHAIRMAN BECHHOEFER: It seems logical but I can't specifically remember. I do know we get copies of the various letters such as dewatering and several other things which authorized the applicant to go ahead with certain work, and I wouldn't expect an additional notification saying "We have been authorized to go ahead and do work and we are going to do it."

I assume once you are authorized, you will go ahead with the work.

WITNESS HOOD: Judge Bechhoefer, I would only add one perhaps obvious statement: In the case of an underground pipe, the fact that it's a remedial action is not as immediately obvious as say the underpinning of a structure. Certainly one would recognize that as a remedial action. But I do not quarrel that replacement of pipe or rebedment of pipe is a remedial action, and it is in my view -- or should be subject to the verbal agreement.

I just did not connect it I'm afraid.

MR. WILLIAMS: Can I inquire as to if Mr. Hood is using the word "verbal agreement"?

WITNESS HOOD: Verbal agreement.

MR. WILLIAMS: Verbal agreement.

WITNESS HOOD: Verbal agreement from the Applicant that he would not proceed with remedial action without prior concurrence from the Staff.

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staff.

MR. WILLIAMS: Didn't you say that is what had happened in the past?

WITNESS HOOD: With regards to remedial action, yes.

MR. WILLIAMS: So you are not asking for anything different than what happened in the past?

WITNESS HOOD: All I am saying is I consider replacement or rebedment of underground pipes to be a remedial action. I, therefore, consider that subject to verbal agreement.

CHAIRMAN BECHHOEFER: Okay, you may.

BY MS. STAMIRIS:

Q Mr. Hood, did you believe that the important point in this discussion that we are having is whether or not the Board is aware and informed of what is going on in terms of the remedial actions with the piping?

A (WITNESS HOOD) Yes, I consider that to be an important factor.

Q When you say that you have come to this realization now and consider that is something that perhaps the Board should have been informed of -- and forgive me if I am not paraphrasing that correctly or correct me if I'm -- is that basically what you have said?

A (WITNESS HOOD) It is an action that I arrived at the point where I would issue Staff concurrence. I would have most definitely informed the Board. The mechanism by which I did that would be a letter from Mr. Tedesco. The Board would have received copies of that letter.

Q Well, I understand that to be the process. That was not followed in this case regarding the pipes. And I want to ask whether -- I'm not -- I honestly can't remember or didn't understand from the way you said it whether you had arrived at this realization earlier than today and had sent -- did you say you had sent a letter of some sort to Consumers regarding the rebedment of pipe?

CHAIRMAN BECHHOEFER: He said he didn't.

WITNESS HOOD: No, ma'am, I did not.

BY MS. STAMIRIS:

Q Oh, did not.

A (WITNESS HOOD) I did not before today connect that the underground pipe is a remedial action that should be subject to the verbal agreement.

Q Mr. Chen, keeping in mind, if you can, the comments and criticisms that you made of the testimony just now, of Consumers testimony, can you in a general sense comment on the significance of the combined effect of these criticisms as to whether or not it implies to you a proper degree of conservatism for work involving nuclear plants?

MR. BLUME: Could I have that question read back.

(Question read.)

MR. BLUME: I'm going to object to that question, Mr. Chairman. That involves so many different questions within it and it should be broken down into its component parts before Dr. Chen answers it.

CHAIRMAN BECHHOEFER: Could you rephrase it? I'm not sure it necessarily has to be broken down certainly into each item. I know what you are interested in is the combined effect of the particular --

MS. STAMIRIS: I will try and ask it in a better way.

BY MS. STAMIRIS:

Q Dr. Chen, considering the combined effect of these criticisms of the testimony of Consumers regarding the pipes, does it cause you any concern for the method in which this testimony was obtained, the method by which it was done?

A (WITNESS CHEN) I guess I am going to have to ask you to explain the question to me.

Q We have heard often talk of something being a matter of different professional opinions, and then I think also an element that I want you to consider is whether this -- if you had to categorize it as more in terms of different professional opinion or in terms of elements of a lack of care or --

A (WITNESS CHEN) Can I say something and then we will go from there?

Q Yes.

A (WITNESS CHEN) Despite what I have said, okay, I think the Applicant and the Staff are agreed that the 4 percent criteria on the 26-inch pipe is acceptable. The 36-inch pipe I understand is going to be rebedded. What kind of criteria are going to be imposed on that rebedding I think is still under consideration.

As far as the remainder of the pipe goes, you can look on page 10 of my testimony and you will see some things there that -- you see the 8, 10-inch pipe in there, the 8 and 10-inch piping and the one-and-a-half and two-inch piping in there addressed. There are some additional concerns and these concerns are being addressed right now in reviews which are in progress.

Does that help you now?

Q Yes, it helps some.

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some

MR. WILLIAMS: I would like to correct one point in Mr. Chen's response. He indicated 36-inch pipe is going to be rebedded. The testimony will show it's going to be replaced in its entirety.

WITNESS CHEN: Yes, I stand corrected.

MR. WILLIAMS: Thank you. I believe Mr. Hood essentially made the same mistatement when he referred to it, but I think there should be no misunderstanding the pipe is going to be replaced from scratch.

WITNESS HOOD: If my comment was specifically for the 36-inch pipe, you are correct. I did refer to pipe other than 36-inch also. But you are quite right, the 36-inch is to be replaced.

BY MS. STAMIRIS:

Q Mr. Chen, can you explain now or do you intend to explain in the future the basis upon which you accepted the end result of the -- is it .04 percent, the acceptability end result? I don't know how you get to accepting it when you don't seem to accept the method by which they got there, and I haven't heard anything about how you got there.

A (WITNESS CHEN) I think the method by which I got to the acceptance criterion for 26-inch piping is described in my testimony.

Q Oh, okay.

MR.BLUME:Just for clarification, you are referring to your prefiled direct testimony, is that correct, Dr. Chen?

WITNESS CHEN: That is correct.

BY MS. STAMIRIS:

Q Mr. Hood, can you answer at this point whether you envision that the method that we heard proposed this morning of strain gauges being applied to the pipes at selected locations to determine the ovality of the pipes i. the method that is going to be used, or is that something you don't know at this point?

A (WITNESS HOOD) Are you referring to some specific pipe or --

Q I am talking to the overall procedure that Consumers witnesses testified about this morning regarding application of strain gauges to measure and use a certain equation to arrive at ovality.

A (WITNESS HOOD) With your permission, I would like to refer to Mr. Kane.

A (WITNESS KANE) Eventually I am going to refer back to Dr. Chen. I think your question is in two parts, one of them is the reliability of strain gauge measurements. And I think we could assure by an acceptable monitoring program that they will function properly. Whether those measurements are proper to evaluate the condition of the pipe I think should be answered by Dr.Chen.

A (WITNESS CHEN) Can I ask you to repeat the question, please.

Q It was really the second part of what Mr. Kane mentioned that I'm more concerned about, whether the method described by the applicant to measure ovality in terms of the strain gauges is an acceptable methodology.

A (WITNESS CHEN) Okay. I think I have said that an acceptance criterion can be phrased either in terms of strains or ovality. The applicant I think is proposing to measure the strains. Bearing in mind what the current ovality is in the pipes as reported in the testimony, I think they intend to subtract that from the total ovality, acceptable ovality, and determine then what additional ovality should be imposed on it, what additional ovality the pipe can seek.

Using the Woods formula or the Woods equation, I think they intend to convert that to allowable strain. That is the way I understand the program.

Q And did you find that acceptable?

A (WITNESS CHEN) I agree with everything up to the point where we do the conversion from strains to ovality using the Woods formula.

Q Mr. Hood, would I be correct in assuming then that point at which Dr. Chen reserves his acceptability on this or his judgment of acceptability on this is something -- is that a point then that needs to be resolved yet between the Staff and the Applicant?

A (WITNESS HOOD) Yes, it is.

Q So can you tell me do you know whether or not that process and those instruments -- can you answer whether or not what we heard this morning is what's going to be done?

A (WITNESS HOOD) I don't think at this stage we can address what's going to be done. The issue is still in front of us.

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Q Mr. Kane, did you have an opportunity to review the description of the soil beneath the administration building from your report 7820?

A (WITNESS KANE) I did.

Q Do you have it with you? Could you read that or tell us what that description was from that report?

A (WITNESS KANE) I think the applicant has a copy of it, if I could borrow it.

MR. ZAMARIN: Did you get it back?

WITNESS KANE: I gave it to Attorney Farnell. I think he put it on the table.

BY MS. STAMIRIS:

Q Mr. Kane, would you read the sentences describing the soils beneath the Administration building which were compacted to the same criterion as the other Category I soils.

MR. WILLIAMS: Your Honor, I object to this because information about the soils in the vicinity of the administration building have no bearing whatsoever on the condition of the soils in the vicinity of the buried piping.

MS. STAMIRIS: Mr. Kane, are you waiting for me?

MR. WILLIAMS: I think there is an objection pending and the Board has to rule.

CHAIRMAN BECHHOEFER: Given the fact the soils are compacted to the same specifications, we will overrule the objection.

MR. WILLIAMS: Excuse me, Mr. Chairman, I don't believe that the administration building is under discussion. I think there is a relevance problem here.

JUDGE DECKER: I think the Chairman did not base his judgment on whether the administration building was or was not a Q structure. What he has stated, as far as I know it, is that the soils in the area where the piping are and the area where the diesel generator building is and the area where the administration building is were all constructed to the same specification.

CHAIRMAN BECHHOEFER: Compacted.

JUDGE DECKER: Compacted to the same specification. The type of materials and compaction criteria were the same. And if there is a barn built on part of it which is non-Q, it's immaterial, it's irrelevant.

MR. ZAMARIN: I think the point of Mr. Williams' objection -- less superfluous -- I don't know, and I quite frankly don't know whether the placements of soil under the administration building was a Q activity, and it occurs to me that it might make a rather significant difference. We are nonetheless comparing apples and oranges or attempting to. That is more the point rather than what the structure was. I honestly don't know whether it was or not.

WITNESS KANE: I think what is in this document will help clarify that.

CHAIRMAN BECHHOFFER: I don't have the document before me.

MR. ZAMARIN: That is the basis for it. I don't either. He has my copy.

CHAIRMAN BECHHOEFER: I think that is where it came from because I recall it. I just don't have it with me.

WITNESS KANE: I have been exposed to the legal process for too long a period of time, I am going to identify the document I am reading from. It is dated March 22nd, 1979. It's a letter from James G. Keppler to Mr. Steven H. Howe. I am reading from Page 21 of the enclosure to that letter which is entitled "Review of Settlement of Administration Building Footings."

I am going to take excerpts from it. I think to answer the first question that has been raised, I will read: "Although the administration building is a non-safety related structure, it is supported by plant area fill material compacted and tested to the same requirements as the material supporting safety related structures and, therefore, pertinent current settlements are being experienced by the diesel generator building."

The second part of the response to Ms. Stamiris question and that has to do --

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MR. ZAMARIN: Excuse me. Before you get to that point, I think the first one goes toward the basis of the objection, and so before we get to the second one, I would like now that the objection be considered and I believe that the basis is that while I believe that was Mr. Gallagher's report that he is referring to, it still is not indicated by that that this was Q placement of soils. I do not think that it was.

I also have a recollection in discovery with Mr. Gallagher that at some point he had misapprehensions as to -- but, in any event, I still -- I don't think that that says that it was the subject of the Q placement. I think that might make a difference if you attempt to compare the two and say that one is necessarily the same as the other which is obviously where this is going. If it is not going there, it is irrelevant.

CHAIRMAN BECHHOEFER: Well, I assume that is where it is going.

MR. ZAMARIN: Yes, and I would object to that basis. I do not think that there is a sufficient basis that they are identical and that you can assume identify between the two.

CHAIRMAN BECHHOEFER: I think it does say to the same criteria and I don't know whether that -- but I think you have to reach the criteria in some way so we will overrule it and see what the witness has to say about it.

A (WITNESS KANE) The paragraph is the third paragraph on Page 22 that I am reading:

"The concrete footings on the order of seven foot six inches by seven foot six inches by one foot nine inches deep were removed along with the grade beam. The random fill material was also removed. According to U. S. Testing personnel, it was observed during excavation of the fill material that there were voids of one quarter inch to two inch or three inch within the fill and these were associated with large lumps of unbroken clay measuring up to three feet in diameter."

I think that is the portion that Mrs. Stamiris is referring to.

BY MS. STAMIRIS:

Q Mr. Kane, if there were soils of this nature beneath the buried piping, do you believe that it could produce a point of stress in that piping that would be difficult to locate?

MR. WILLIAMS: Objection. There is no evidence in the record that there are any such soils beneath underground piping. In fact, we have had testimony to the contrary from Mr. Meisenheimer this morning.

MR. STAMIRIS: That is why I said if. That is why I posed it as a hypothetical. If I am going to be criticized for asking if such a condition exists, you can rightfully say that. I cannot believe that it does exist, but I can say that you cannot prove that it does not exist. That is the whole point.

MR. WILLIAMS: Well, opinion evidence has ultimately been founded on some evidence in the record, and I think an opinion on this basis would be improper.

MR. BLUME: Mr. Chairman, I am informed that that document is an exhibit in the record. I don't know that Mr. Meisenheimer --

MR. WILLIAMS: But I --

MR. BLUME: Excuse me. May I finish my statement?

MR. WILLIAMS: I thought you were done.

MR. BLUME: I do not know that Mr. Meisenheimer's opinion necessarily outweighs the opinion or observation in that document.

MR. WILLIAMS: I am not arguing about whether the document itself is in the record, but the document states on its face that it relates to conditions underneath the auxiliary building. There is no evidence in the record which would indicate the conditions of this type that occurred at the -- excuse me, I meant to say the administration building.

MR. ZAMARIN: There is I believe already evidence in the record, there had been some excavations for construction underneath that building in that area and there is simply no indication whether that fill was placed at the same time. One of the basic problems with that document. That objection has already been ruled on, but on this one there simply is no evidence in this record that that condition exists under any piping.

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piping.

MR. WILLIAMS: And I believe there are numerous borings in the vicinity of the piping and I seem to recall Mr. Meisenheimer testified that there was no indication of such conditions in those borings.

MR. BLUME: Mr. Chairman, perhaps it would be possible to get around the objection by asking Mr. Kan e whether he believes it is possible that such conditions are duplicated in the area of the underground piping?

MS. STAMIRIS: Yes.

MR. BLUME: If he answers yes --

MR. ZAMARIN: Well, that is possible.

MR. BLUME: -- then the hypothetical would be proper, would it not?

MR. ZAMARIN: Well now --

MR. WILLIAMS: I do not think it would.

MR. ZAMARIN: Not on a question in that form. Anything is possible. That calls for sheer speculation. If in his opinion it occurs, I think that maybe you are getting closer to foundation. It might still be objectionable.

BY MS. STAMIRIS:

Q Yes, I think I would like to ask the question that Mr. Blume suggested as a predicate to my other question and ask you, Mr. Kane, considering the statements made about the similar compaction criteria involved, do you believe that it is possible that soils of that description exist beneath buried piping?

MR. WILLIAMS: Objection. The question calls for speculation.

CHAIRMAN BECHHOEFER: You should say "likely."

BY MS. STAMIRIS:

Q I meant to say is it your opinion that such soils could exist under the buried piping?

MR. WILLIAMS: Again, could.

MR. ZAMARIN: Could exist.

JUDGE HARBOUR: Please say "exist".

MS. STAMIRIS: All right.

BY MS. STAMIRIS:

Q Is it your opinion that soils of that type exist under the buried piping?

WITNESS KANE: Am I free to answer?

JUDGE HARBOUR: Yes.

BY THE WITNESS:

A (WITNESS KANE) Part of the Applicant's testimony makes the conclusion that the settlements that we have observed by the pipe profiles, and we are talking about settlements of four inches to 14 inches of settlement, that difference between plan design elevation and where we are finding the pipe now, we are saying that we attribute that to the settlement.

To me, the conditions that are being identified here could be the cause of why we are finding 4 to 14 inches below design elevation.

BY MS. STAMIRIS:

Q Well, do you believe that, given the circumstances that exist in regard to the buried piping at the Midland plant, that it will be extremely difficult to locate all of the points of stress due to variable soil properties or all the significant points of stress on the buried piping?

A (WITNESS CHEN) I think the profile which has been performed has identified the areas of highest stress. I think what we will add to that in the way of requiring settlement monitoring based on past behavior, settlemen t behavior, based on boring that we have which exist and indicate potential for -- I don't want to say soft, but they are not dense soils.

I think between the two monitoring systems, we would have a system that would tell us the areas of highest stress.

Q Mr. Hood, I would like you to look at a letter from Robert Tedesco dated October 20, 1980, and the subject is request for details of stress analysis for underground piping.

MS. STAMIRIS: I would like this identified as Stamiris Exhibit 34. This is a document that was discussed this morning with Consumers' witness Mr. Lewis.

MR. WILLIAMS: May I look at it again, please?

MS. STAMIRIS: Yes.

MR. BLUME: Will you identify the document, please?

MS. STAMIRIS: I did.

MR. BLUME: Oh, I am sorry.

CHAIRMAN BECHHOEFER: What was the date of that?

MS. STAMIRIS: October 20, 1980.

WITNESS HOOD: Ms. Stamiris, are you going to give me a copy?

MS. STAMIRIS: Oh, I am sorry.

WITNESS HOOD: Thank you.

MR. WILLIAMS: Wait a minute. Excuse me. Before we proceed, this has to be marked as Stamiris Exhibit 34 for identification?

MS. STAMIRIS: Yes.

MR. WILLIAMS: It is not in evidence yet.

MS. STAMIRIS: The procedure that has been followed before is that I can ask questions first and then ask that it be introduced into evidence.

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CHAIRMAN BECHHOEFER: Yes, you asked that it be marked for identification.

MS. STAMIRIS: Yes.

CHAIRMAN BECHHOEFER: As what?

MS. STAMIRIS: Stamiris Exhibit 34 for identification.

(The document referred to was marked Stamiris Exhibit No. 34 for identification.)

BY MS. STAMIRIS:

Q Mr. Hood, do you agree with the statement by Mr. Tedesco in the middle paragraph that the ETEC analyses indicate that the maximum bending stress due to soil settlement for several of the pipe profiles already exceeded the ASME code allowable stresses in the material yield strength?

A (WITNESS HOOD) Yes, I agree with that.

MR. BLUME: You agree that is what the document says?

WITNESS HOOD: I agree that is what it says.

Is that the question?

BY MS. STAMIRIS:

Q No, that is not what I meant. I meant do you agree that they have been, the ASME code has been exceeded as of October 20, 1980?

MR. WILLIAMS: Before the witness answers, I do not believe Mr. Hood is really qualified to answer that question technically. I think if there is someone technically qualified, that question should be addressed perhaps to Dr. Chen.

MS.STAMIRIS: I would be happy to address that question to Dr. Chen.

A (WITNESS HOOD) I am the author of the document.

CHAIRMAN BECHHOEFER: I was about to ask you that.

MR. WILLIAMS: Well, that is not in evidence heretofore.

WITNESS HOOD: I would also like Mr. Chen to express his opinion.

A (WITNESS CHEN) Based on the assumptions here this is the profiles from 17-2 and 19-1 were used, based also on the information at that time that we had in hand.

Well, we didn't really know what the plan of these lines looked like, so we assumed that it was straight lines. I think that is true.

Can I go on?

BY MS. STAMIRIS:

Q Please do.

A (WITNESS CHEN) Several more analyses have been done since then. The conclusion as to whether or not the ASME code allowables have been exceeded, the answer to that would depend on which version of the code you are talking about, firstly, whether or not there is a 1971 version of the code or the 1977 version of the code.

The 1971 version of the code to which I think this plant is committed, the answer is no, because no criteria, no criterion existed for soil settlement at this point.

But based upon subsequent versions of the code, the answer is yes.

Q Dr. Chen, I cannot remember which Consumers' witness stated that in making a correction in their testimony to the affect that the 1977 code was used.

A (WITNESS CHEN) That's with the 3S Sub C. The values of 3 S Sub C. It's in the context of that.

Q Well --

A (WITNESS CHEN) Let me say this: The conclusion as to whether or not you have exceeded ASME code allowable is dependent upon the end positions that you assume in the models. You take an analysis referred to in here, it assumes at least two end conditions: One free and one fixed.

The models which assume that you had fixed end conditions gave you very high stresses. This analysis also was based on the preliminary profile end data. More recent analyses have been performed based upon the profile data obtained by Southwest Research Institute, which is more accurate than that at the time this letter was written, at the time this analysis was performed.

The new analysis shows that except at a few places, the 3 S Sub C criterion is satisfied.

I think a lot of the places where the 3 S Sub C criterion is exceeded, if you look at that -- if you look at the profile data critically, you can dismiss a lot of these points. This is also mentioned in my testimony. This was the situation as we knew it then.

then.

6:00 p.m. session starts.

Q Well, I do not understand all the details that you have given in your answer.

A (WITNESS CHEN) Yes.

Q But I guess I would have to ask Mr. Hood whether he believes it is NRC policy, in view of their mandate to protect the public health and safety, to assume the most conservative codes and conditions for the most recent -- well, I should say the most conservative code for allowable stresses regarding this underground piping?

A (WITNESS HOOD) I don't think you can answer that in a vacuum. It is a judgment call. I think you have to look at that on a case-by-case basis as to why that code has changed.

I think the real question is, there has got to be an assurance of safety certainly, but that assurance does not mean that you are going to take the most conservative approach or the most conservative code on each item. It's really a judgment call. Staff constantly makes those types of decisions.

Q Okay. Dr. Chen, did you tell me that some of the conditions of the pipe that were evaluated in this statement are different today than they were at the time that they were evaluated here?

A (WITNESS CHEN) I am saying the assumptions and the analyses that were performed back in 1980 are not valid really.

Q You say are not valid?

A (WITNESS CHEN) They're not valid, that's correct.

Q Well, what I asked was, what I meant to say is are they not valid because of some change in the physical aspect of these pipes or are they not valid because of different calculations or interpretations at this point in time?

A (WITNESS CHEN) They are not valid because we had more accurate data since this analysis was performed, and we had more information regarding the actual laying of the piping which we didn't have then.

Q Okay. Mr. Hood, going beyond the last answer that you gave me about the judgments that the NRC has to make on values of conservatism, does the NRC have any set policy as to whether or not, when ASME code is revised as it was in 1977, whether you then go by the revised code, the code that is current as opposed to going by the code that was used in 1971?

MR. WILLIAMS: I object to the form of the question. The term "go by" does not really give the witness or counsel any understanding or any idea of what it is the NRC is doing with respect to this particular code.

MS. STAMIRIS: I meant to ask whether the NRC has any policy as to whether they adopt the most recent ASME code and the most current ASME code.

BY THE WITNESS:

A (WITNESS HOOD) It depends on the code. There are, in a given plant, the codes are established at the construction permit stage and then, as new codes come out, they are evaluated. In some cases it's necessary to make a decision to upgrade a code. Sometimes the issuance of the code itself recognizes those types of matters.

But generally it's the practice, barring significant reason to the contrary, to adhere to the code that was established at the time of the construction permit or previously established.

BY MS. STAMIRIS:

Q Mr. Hood, you stated that you agreed with the statement -- well, you said that this was in fact, these were in fact your words written on October 20, 1980. Do you have an opinion as to whether this holds true today as to whether the ASME code allowable stresses have been exceeded today?

A (WITNESS HOOD) I agree with Dr. Chen that the techniques that we were talking about then are different today. But I understand your question is are the pipes that are there today, are they overstressed according to the code allowables? There have been pipes that have been overstressed and consequently those pipes have been **rebedded.** I previously testified to a pipe to the south of the diesel generator building, that pipe being the condensate storage tank line, as being overstressed and which was to be **rebedded.** There have been other cases of **rebedded** pipe discussed in this hearing.

Again, though, when you are talking about pipes being overstressed, you are confronted with some of the calculational techniques and the problems of the analysis and the assumptions that go into that analysis and that conclusion and I am really not an expert in that area. I think really I should not speak to that.

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that.

MR. BLUME: Mr. Chairman, excuse me, Miss Stamiris. Perhaps it would assist to point out that 10 CFR 5055(A) Subparagraph (d)(2) addresses the particular requirements regarding codes for piping.

MS. STAMIRIS: Thank you. Do you have anything else to add?

MR. BLUME: No. Thank you, Miss Stamiris.

BY MS. STAMIRIS:

Q Dr. Chen, when a pipe has been overstressed and then that pipe is rebedded, is there some weakness that has been induced in the pipe that is permanent?

A (WITNESS CHEN) Yes, but the code also permits some, if you wish, imperfections as far as placing the pipe itself. Now, if after the pipe was dug up it satisfied the imperfection requirements, then it could be used.

Q In other words, the pipe would have to be dug up and tested in some way and deemed to be adequate before it would be rebedded?

A (WITNESS CHEN) That is not the only way.

Q Mr.Hood, do you know whether the pipes that have already been rebedded at the Midland plant, do you know how they have been tested as to any weakness that has been induced into this pipe?

A (WITNESS HOOD) I didn't get the last part of your sentence. Tested as to what?

Q Weakness that has been induced into the pipe at the time it was overstressed.

A (WITNESS HOOD) Just a minute.

MR. BLUME: Perhaps Dr. Chen would like to answer that question.

WITNESS CHEN: No, I have no information regarding examination of the pipe before it was rebedded.

BY MS. STAMIRIS:

Q Do you, Mr. Hood?

A (WITNESS HOOD) No, I do not.

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Q Well, do you have any way of assuring yourself that indeed some defective piping was not rebedded?

A (WITNESS HOOD) Ms. Stamiris, all you are really doing when you are rebedding a pipe is relieving the existing stress in it. For example, you expose a pipe, cut it. Since it's elastic --

JUDGE DECKER: Excuse me, I can't hear you at all and I am very much interested in this.

WITNESS HOOD: My understanding is what is done is the pipe is exposed and its cut and that relieves the existing stress on the pipes. The pipe is then -- a new fit up that may involve some transition piece for the proper fit up, but it's been reconnected and then recovered.

MR. WILLIAMS: I wonder if I could clarify one point because if I let it wait for later on, I would let a misleading inference be drawn from the record. I believe Mr. Hood testified that there was a condensate pipe which had been assessed as being over-stressed. Is that a fair characterization of what you said?

WITNESS HOOD: I said the condensate tank line.

MR. WILLIAMS: Now, that is a seismic Category I line?

WITNESS HOOD: No, it is not.

MR. WILLIAMS: Were there any seismic Category I lines which were assessed as overstressed?

WITNESS HOOD: Yes.

MR. WILLIAMS: Could you identify those?

WITNESS HOOD: No, I cannot specifically identify those.

MR. WILLIAMS: Thank you.

BY MS. STAMIRIS:

Q Mr. Hood, did the NRC -- you explained the process by which you believe the pipes were rebedded. Did the NRC have any inspections or observations of this pipe reimbedment that has taken place?

A (WITNESS HOOD) I do not believe that we did. I cannot say for sure. If there was, it would have been on the part of our office of inspection enforcement. I am not aware of any participation on their part with respect to the reimbedment of pipes.

MS. STAMIRIS: This goes back to some questions from a while ago, but I never did have Stamiris Exhibit 34 introduced into the record as evidence.

MR. WILLIAMS: I would object to it being introduced as evidence.

CHAIRMAN BECHHOEFER: On what basis?

MR. WILLIAMS: On the grounds that neither the author or the recipient, neither the apparent author, Mr. Tedesco, or the recipient has authenticated this document which was transmitted between the two. We have had extensive testimony on Mr. Hood's opinions or statements, and I don't see there is any need for introducing the letter as evidence in any event.

MR. BLUME: Mr. Chairman, to respond to that, Mr. Hood stated that he is the author of this letter. However, Dr. Chen stated that he does not believe that the assumptions in the analyses used were correct. Nonetheless, I believe that the exhibit should be allowed in and the Board can judge the weight of the evidence for itself.

CHAIRMAN BECHHOEFER: Just purely for authentication purposes, Mr. Hood, is this the letter not only that you drafted but this is the form in which you drafted it?

WITNESS HOOD: Yes, sir, it is. I wrote the letter on behalf of my assistant director Robert Tedesco.

CHAIRMAN BECHHOEFER: This is not something Mr. Tedesco took a first draft and then rewrote it? This piece of paper is the letter you wrote?

WITNESS HOOD: Is your question did Mr. Tedesco make changes to the letter that I wrote?

CHAIRMAN BECHHOEFER: Well, that's --

WITNESS HOOD: To the best of my recollection, there was no changes from the time that I personally prepared it to when it went out the door.

CHAIRMAN BECHHOEFER: I think we will overrule the objection and allow the letter to be admitted as Stamiris Exhibit 34.

(The document referred to, previously marked Stamiris Exhibit No. 34 for identification was received in evidence.)

CHAIRMAN BECHHOEFER: Ms. Stamiris, about how long do you have still to go? Because we want to at least take a short break if you have --

MS. STAMIRIS: Probably ten minutes at the most.

JUDGE COWAN: You have another exhibit to present?

CHAIRMAN BECHHOEFER: Why don't we take a five-minute break.

(Short break.)

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BY MS. STAMIRIS:

Q Mr. Kane, on Page 3 of your testimony in question 8(A)(5) where we crossed off a paragraph and added two sentences.

A (WITNESS KANE) Yes.

Q In response to the question, "What are the foundation conditions that exist along the various seismic Category I piping systems which are found in the plant fill," are there other piping systems in addition to those two that you mentioned that have not been addressed by this question?

A (WITNESS KANE) I indicated that soil profiles were provided for two lines.

Yes, there are many other lines which soild profiles have not been developed for.

Q And would it be correct to understand that those -- the soil profiles that are pending then are being or will be evaluated by the Staff?

A (WITNESS KANE) The two profiles that we were provided, one runs from the service water structure to the valve pit adjacent to the diesel generator building and the other runs from the service water structure to the auxiliary building. There are lines that are parallel to those, so the profiles that were provided for those lines will cover other lines. It has not yet been determined what additional profiles we will need to work out the details of the monitoring program.

Q I am sorry if I did not listen carefully to your first answer, but what I am concerned with is not the two service water lines that you discussed that are being developed and evaluated by the NRC, but when you said there were many other Category I piping systems in addition to these, are there other Category I piping systems for which profiles still need to be provided?

A (WITNESS KANE) I would say yes, and the ones that would be would be the ones that would be needed to lay out the final plans for the monitoring of the settlement. I think the applicant has started in that direction and they are partially complete. He would have to complete those and we would look at those to resolve the monitoring problem.

Q I am not sure which testimony this part was in. Dr. Chen, did your testimony address non-safety piping that ran under some Category I piping?

A (WITNESS CHEN) That's correct.

Q Did you analyze or consider any aspects to the integrity of non-safety piping in any other aspects than the one that you discussed in that part of your testimony?

A (WITNESS CHEN) Is the question did I consider any others other than the ones that I considered in my testimony?

Q Yes.

A (WITNESS CHEN) No.

Q Mr. Hood,can you conceive of a situation in which failure of non-safety pipes could indirectly end up having an impact on the safety system at the Midland plant?

MR. WILLIAMS: Objection. The question calls for speculation.

CHAIRMAN BECHHOEFER: I think you could perhaps state it but --

MS. STAMIRIS: I don't know if this will be any better, but I will try.

BY MS. STAMIRIS:

Q Mr. Hood, do you think that failure of the non-safety piping could lead through some chain reaction to an impact on the safety system at the Midland plant?

WITNESS HOOD: May I answer?

CHAIRMAN BECHHOEFER: Yes.

A (WITNESS HOOD) Yes, ma'am, I do.

BY MS. STAMIRIS:

Q What safeguards do you have to guard against that?

A (WITNESS HOOD) The instance I have in mind is a matter we intended to discuss with the Board during tomorrow's session. We have a concern that a break of the non-seismic line that is directly beneath the diesel generator building may give rise to liquifaction problems. I have the same concern for other non-seismic lines.

In our review of the dewatering system, we are considering such matters.

Q And would I be correct to understand that there will be some testimony in this proceeding regarding those concerns?

A (WITNESS HOOD) Yes, ma'am, there will be a hearing session, as I understand it, to address dewatering. That session will encompass this concern.

concern.

MS. STAMIRIS: I will pass out another exhibit which I had marked as Stamiris Exhibit 35 for identification. I will identify this document as a summary, an NRC summary of the July 18, 1979, meeting on Soil Deficiencies at the Midland Plant Site.

BY MS. STAMIRIS:

Q Mr. Hood, are you the author of this document?

A (WITNESS HOOD) I am.

Q On the bottom paragraph of the first page is some mention of corrosion regarding stainless steel piping removed from the condensate storage tank and also corrosion of the injection piping from the borated water storage tanks.

A (WITNESS HOOD) No, ma'am.

Q Is that not right?

A (WITNESS HOOD) That's not what it says.

Q Oh, that is right.

A (WITNESS HOOD) It says that the material of the BWST piping is also stainless steel. It notes a corrosion problem with a condensate storage tank piping, which is stainless steel.

Q Okay. I appreciate your correction on that.

Was this stainless steel piping that was corroded in the condensate storage tank buried piping?

A (WITNESS HOOD) [illegible]s, ma'am, it was.

Q It was in contact with soil?

A (WITNESS HOOD) Yes, ma'am.

Q Could you explain to me what the situation was regarding the corrosion of this piping?

A (WITNESS HOOD) Yes. That pipe, when it was exposed, it was discovered to be pitted. There was an investigation -- which was somewhat of a surprise, considering this was stainless steel. Stainless steel is not supposed to corrode.

There was an investigation into the cause of the pitting. As I recall, the results were never conclusive. However, it is generally accepted that the cause of the pitting was due to use of the pipe as a grounding for welding purposes, electric arc welding, which could explain that type of pitting.

Q Did you have any more to add?

A (WITNESS HOOD) I was going to add that I requested of the Applicant, in the process of cutting the borated water storage lines, to make visual observations of that piping to determine, to verify that no such pitting exists in the stainless steel piping from the borated water storage tank. I have had no feedback as a result of that request.

Q Was that request in 1979?

A (WITNESS HOOD) No, ma'am, that was fairly recently. It was during the discussions with the Applicant with respect to the proposed, then-proposed plans to surcharge the borated water storage tank valve pits.

I pointed out the fact that the lines had **to be cut** presented an ideal time for verification that the same problem that had been discovered with the condensate storage tank lines did not exist with the borated water storage tank line. The line is stainless steel. I would not expect to see such a phenomenon, but the comment was made because of the reasons for the pitting of the condensate storage tank line was really never that conclusive.

Q Can you tell me roughly when this request was made of the Applicant?

A (WITNESS HOOD) Just a moment.

I believe it would have been sometime around August 1981. This was the time that we were having the rather intensive discussions with respect to the surcharging activity at the plant and I would expect it to be around that time period.

Q The sentence that borated water storage tank piping is of the same composition and is also unprotected under the electro-chemical attack, when you spoke of the condensate line, I think you said it was being used for grounding purposes. Is that different than electro-chemical attack?

A (WITNESS HOOD) The grounding could give rise to electro-chemical attack.

Q I am sorry, I did not hear you.

A (WITNESS HOOD) Use of a pipe for grounding purposes could give rise to an electro-chemical type of corrosive attack.

Q I will ask Dr. Chen. Could properties of the water that was in the soil also give rise to electro-chemical attack?

A (WITNESS CHEN) I believe that that is outside my sphere of knowledge.

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ledge

Q Okay.

A (WITNESS HOOD) That is getting a bit outside of mine too, Miss Stamiris. I hope I am correct.

Q It is certainly outside of mine.

A (WITNESS HOOD) I refer to my previous answer.

There were other investigations that were done. In attempting to understand why the stainless steel line had corroded, there was tests done of the composition of the soils for chemicals. One suspicion was, one of the earlier suspicions was that there was some strange chemical, possibly by virtue of proximity to Dow. That prompted some chemical tests. One of the elements, agents that was investigated was a dust preventive additive that is routinely added to the soils to keep down dust when doing construction.

Those results did not give rise to any indication that would cause this type of concern.

Q Who conducted these tests?

A (WITNESS HOOD) I don't know. I've forgotten.

Q I mean, was it the NRC or the Applicant?

A (WITNESS HOOD) No, I seem to recall that it was sent to some laboratory for analysis. My memory just is too vague on that. I don't remember who.

Q Do you know how much of the -- roughly how much of the piping at the Midland site is stainless steel?

A (WITNESS HOOD) Could I have that again, please?

Q How much of the piping at the Midland plant is stainless steel roughly?

A (WITNESS HOOD) I believe most of the piping is carbon steel. The borated water storage tank line is definitely stainless steel and the condensate line. Those are really the only lines that I am aware of that are stainless steel, underground stainless steel lines.

Q When you requested this information on the status of the borated water storage tank pipe from the applicant -- well, what I want to know is --

MS. STAMIRIS: I withdraw that question I was starting to ask.

BY MS. STAMIRIS:

Q What assurances do we have that corrosion is not a problem that is widespread in the piping at the Midland plant?

A (WITNESS HOOD) Your question is generally, I take it?

Q Yes.

A (WITNESS HOOD) You are not referring to these specific incidents?

Q No, I mean to go beyond them.

MR. WILLIAMS: Excuse me. Could I have the question reread.

(Question read.)

MR. WILLIAMS: I think that Mr. Hood has testified that there was only a limited amount of stainless steel piping to which this corrosion problem might be applicable. If I could assist, I think that there is information in Table UP-1 in Applicant's testimony which on proper decoding will indicate exactly what that is, but the suggestion in the question, I object to the form of the question because the suggestion in the question is that there is a possibility that the corrosion problem would be widespread. I think the testimony will support that it could be in stainless steel piping.

CHAIRMAN BECHHOEFER: I think that is what the question is. I don't think it's suggesting that. I think it's just asking.

JUDGE HARBOUR: As additional information, your Applicant's testimony on page 7, in conjunction with that pipe, gives those pipes which are stainless steel.

MR. WILLIAMS: If I might add, the code in table, the middle letter in group of -- well, it would be the second letter from the end in the group of letters that designate pipes indicates the material, one HCB, the C in the center indicates they are stainless steel pipes.

The same is true for the bottom-most entry in that table. The second from the last letter C indicates that those are also stainless steel.

BY MS. STAMIRIS:

Q Mr. Hood, are the majority of the pipes which I believe you said are carbon steel, would they be susceptical to corrosion?

A (WITNESS HOOD) More so with stainless steel but carbon steel has reasonably good corrosion properties, as I understand it.

Ms. Stamiris, I should mention I am not a corrosion expert.

Q Well, can you suggest -- if this is not the proper time or if you are not the proper witness to address these questions to -- and I don't have a whole lot more -- but just the concerns about possible corrosion in the piping, who would be from the NRC?

A (WITNESS HOOD) Well, it's a question -- it's a materials question. The Staff does have material engineers.

Q Well, Dr. Chen, you said that this was not within the field of your expertise, didn't you?

A (WITNESS CHEN) That is correct.

Q Is there anyone that you know of that will be in this proceeding that will be more able to address --

JUDGE DECKER: Mr. Chairman, it seems to me that Ms. Stamiris has raised what could be an important point. It seems to me that it's up to the Staff to address that.

MR. BLUME: Well, --

JUDGE DECKER: And to find out who is a proper witness and get him scheduled.

MR. BLUME: It being Thursday night, I'm not particularly optimistic we can get anybody out here this week, but perhaps for the next hearing session we might be able to get somebody here for that.

CHAIRMAN BECHHOEFER: This does relate to the corrective action. That part could be brought up again later.

JUDGE DECKER: The whole thing is going to have to be brought up again later, the whole subject of underground piping.

MR. BLUME: That is the Staff's position, that we are not through with underground piping.

CHAIRMAN BECHHOEFER: That's correct.

MS. STAMIRIS: I would be happy to wait and see who would be able to address these questions better.

CHAIRMAN BECHHOEFER: I think someone who knows something about corrosion in piping.

MR. BLUME: We have definitely worked on getting somebody out here who is familiar with these types of problems.

CHAIRMAN BECHHOEFER: Perhaps at the same time, assuming we take up piping again.

MS. STAMIRIS: I would like to have Stamiris Exhibit 35 introduced as evidence for the purpose of clarifying the testimony that we have had today on the subject.

CHAIRMAN BECHHOEFER: Any objection?

MR. WILLIAMS: Mr. Chairman, it appears to me from the notations on this letter that it's already in evidence as Consumers Exhibit No. 5.

MS. STAMIRIS: That was from a deposition. I don't believe that counts.

MR. WILLIAMS: I will not make an objection at this point. I am just too tired.

CHAIRMAN BECHHOEFER: I also don't have a list of all the exhibits with me. So I can't tell whether it's--

MS. STAMIRIS: It's not an exhibit in this proceeding I don't believe except from the Commission.

CHAIRMAN BECHHOEFER: Does the Staff have any objection?

MR. BLUME: I am sorry, I missed that.

CHAIRMAN BECHHOEFER: Does the Staff have any objection to Stamiris Exhibit 35?

MR. WILLIAMS: With one exception, your Honor, the document has been authenticated as to printed matter in the document, but I don't want any of the handwritten materials on the Xerox copy to be treated as evidence.

MS. STAMIRIS: I would just like to add I am not sure whose notes they are and they are not mine.

MR. WILLIAMS: Therefore, they are not authenticated and I would not them as evidence with the exhibit.

CHAIRMAN BECHHOEFER: We will not regard the notes as evidence, just the exhibit itself. The document will be admitted, subject to that one qualification about the notes.

MS. STAMIRIS: I don't have anymore questions at this time.

(The document referred to, previously marked Stamiris Exhibit No. 35 for identification, was received in evidence.)

CHAIRMAN BECHHOEFER: The Board proposes that we adjourn for tonight, but before we do, I wanted to inquire about exactly what we are going to be taking up tomorrow.

First, will the Applicant have any estimation of the amount of cross examination from a time standpoint, just for our planning purposes.

MR. BLUME: Mr. Chairman, I think that's probably going to be under negotiation tonight.

MR. PATON: Mr. Williams has been in here, but -- can we go off the record?

CHAIRMAN BECHHOEFER: Go off the record.

(Discussion had off the record.)

MR. BLUME: Before we break up, we have one last very brief matter. Mr. Hood wanted to let you know that he has mailed a letter concurring with the Applicant's proposal to activate the freeze wall. I have copies here for the Board and the parties which I will now distribute.

CHAIRMAN BECHHOEFER: We will adjourn until 8:30 tomorrow morning.

(Whereupon an adjournment

was taken in the above-entitled cause until 8:30 a.m. on the following day, Friday, February 19, 1982.)

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

NUCLEAR REGULATORY COMMISSION

in the matter of: CONSUMERS POWER COMPANY-Midland Plant, Units 1 & 2

Date of Proceeding: February 18, 1982

Docket Number: 50-329 OL & OM; 50-330 OL & OM

Place of Proceeding: Midland, Michigan

were held as herein appears, and that this is the original transcript thereof for the file of the Commission.

Pauline James & Associates

Official Reporter (Typed)

Pauline James

Official Reporter (Signature)