ACRST-1650

ORIGINAL

UNITED STATES
NUCLEAR REGULATORY COMMISSION

In the Matter of:

335th General Meeting

Pages: 280 - 491

Place: Washington DC

Date: March 11, 1988

HERITAGE REPORTING CORPORATION

Official Reporters

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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

In the Matter of:)
)
335TH GENERAL MEETING)

Friday,
March 11, 1988

Room 1046
1717 H Street, N.W.
Washington, D.C. 20555

The above-entitled matter came on for hearing, pursuant to notice, at 8:30 a.m.

BEFORE: DR. WILLIAM KERR
Chairman
Professor of Nuclear Engineering
Director, Office of Energy Research
University of Michigan
Ann Arbor, Michigan

ACRS MEMBERS PRESENT:

DR. FORREST J. REMICK
Vice Chairman
Associate Vice-President for Research
Professor of Nuclear Engineering
The Pennsylvania State University
University Park, Pennsylvania

MR. JESSE C. EBERSOLE
Retired Head Nuclear Engineer
Division of Engineering Design
Tennessee Valley Authority
Knoxville, Tennessee

DR. CHESTER P. SIESS
Professor Emeritus of Civil Engineering
University of Illinois
Urbana, Illinois

DR. HAROLD W. LEWIS
Professor of Physics
Department of Physics
University of California
Santa Barbara, California

MR. CARLYLE MICHELSON
Retired Principal Nuclear Engineer
Tennessee Valley Authority
Knoxville, Tennessee
and Retired Director, Office for Analysis
and Evaluation of Operational Data
U.S. Nuclear Regulatory Commission
Washington, D.C.

DR. DADE W. MOELLER
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Associate Dean for Continuing Education
School of Public Health
Harvard University
Boston, Massachusetts

DR. PAUL G. SHEWMON
Professor, Metallurgical Engineering Department
Ohio State University
Columbus, Ohio

DR. CHESTER P. SIESS
Professor Emeritus of Civil Engineering
Argonne National Laboratory
Argonne, Illinois

MR. DAVID A. WARD
Research Manager on Special Assignment
E.I. du Pont de Nemours & Company
Savannah River Laboratory
Aiken, South Carolina

MR. CHARLES J. WYLIE
Retired Chief Engineer
Electrical Division
Duke Power Company
Charlotte, North Carolina

ACRS COGNIZANT STAFF MEMBER:

Raymond Fraley, Executive Director

NRC STAFF PRESENTERS:

Steve Richardson
Angelo Marinos
P. N. Randall
Mike Mayfield

I N D E X

P R O C E E D I N G S

CHAIRMAN KERR: The meeting will come to order. This is the second day of the 335th meeting of the Advisory Committee on Reactor Safeguards.

Today we plan discussion on the Sequoyah nuclear plant, NRC Regulatory Guide 1.99, further discussion of the radiation embrittlement of reactor pressure vessel structural supports, quantitative safety goals, and some other safety-related issues.

Items for consideration on Saturday are listed on the schedule posted on the bulletin board outside this meeting room.

The meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act and the Government and Sunshine Act. Mr. Raymond Fraley is the designated federal official for the first part of the meeting. We have received no written statements or requests to make oral statements to today's session.

A transcript of this portion of the meeting is being kept. I ask that each speaker use a microphone and identify himself or herself.

We will now begin, and I ask Mr. Wylie for opening remarks.

MR. WYLIE: Thank you, Mr. Chairman. Gentlemen, the subject for this session is regarding the TVA organization and

Sequoyah restart issues. The agenda and background information for this portion of the meeting are in handout No. 5, which we have, or Tab 8 in your book. Number 5 has been adjusted slightly.

The purpose of the session is for the Committee to be informed on how certain TVA organization and technical issues pertaining to the restart of TVA's nuclear operations and in particular Sequoyah nuclear plant either have been or are being resolved.

The Committee has reviewed the activities associated with these issues since early 1986 in four previous ACRS meetings, two subcommittee meetings in which the subcommittee delved into these issues in some detail, and on two previous site visits to the Sequoyah nuclear plant.

The agenda for today's session has been arranged to address those issues on which the Committee has identified that it needed additional information regarding their resolution.

We have representatives from the NRC's Office of Special Projects and from TVA who are available to answer questions regarding these issues. And at this point, I will ask the Committee whether they have any questions or comments they would like to make before we proceed?

Hearing none then, we will turn to the agenda, and I will call on Steve Richardson to, of the Office of Special

Projects, to begin our meeting.

MR. RICHARDSON: Good morning. I am Steve Richardson. I am the division director for TVA in the Office of Special Projects.

The Office of Special Projects last briefed the Full Committee at the February meeting. At that time, Sequoyah had just entered Mode 4. Currently they are in Mode 3. They have been there for approximately two weeks. They are going through a number of evolutions as part of the TVA restart test program. Two of those evolutions have been completed. Approximately ten remaining; there is a number of key ones ongoing today. A number of items, that the type of items remaining are main steam safety relief valve testing, AFW pump test, MFW pump testing. They have to do some control rod drop time testing, and they are planning on rolling the main turbine. Right now they anticipate that they will not, be ready for criticality no earlier than the 17th. The staff believes that is optimistic. It will probably be at least several days past that based on the progress we have got to date.

The major issues remaining, and we will brief you on all of these this morning, one of them is the Appendix R concerns. We are down here. At the last meeting we had just received a letter from an individual who had a number of allegations on the Appendix R program at Sequoyah, and we will

give you an update on where we stand on that.

The other major issues are the operational readiness of the plant itself, not only in completing the remaining evolutions, but in convincing the staff and the members of the staff that we have, on-site monitoring at TVA is ready. They have had a number of unusual events and personnel errors, procedural non-compliances during the heat-up period, and we want to make sure that the corrective actions for those are in place prior to authorizing criticality.

The staff met with the Commission last Friday and reviewed the status of the Sequoyah restart items with the Commission. We recommended to the Commission that based on completion of a number of these open technical issues, that the Commission give the staff authorization to release TVA to enter Mode 2 when these technical issues are resolved. The Commission has not yet voted on that. They are currently scheduled for an affirmation schedule on those votes on the 17th.

Are there any other questions on general status of Sequoyah right now? Yes, sir?

DR. MOELLER: There were the, there was the material where the, this American Nuclear Ensurer Team did the review. Did we hear responses or comments on that evaluation or review of the Sequoyah plant?

MR. RICHARDSON: In brief, the American Nuclear

Assurance went in and in the December timeframe of last year. They published a report where they had problems with the plant operations review Committee at Sequoyah. They have gone back and done a subsequent inspection and indicated that they are now satisfactory with TVA's corrective actions.

They have published a report dated March 1st which I will make sure that is available to the Full Committee that essentially goes through all of their previous findings, addresses the TVA corrective action, and indicates that they are generally satisfied. They have indicated areas where TVA needs to continue to, by management oversight, to make sure their corrective actions are fully implemented.

MR. MICHELSON: In the case of something like the Appendix R concerns, could you tell me briefly to what extent the Nuclear Safety Review Board has even looked at or reviewed situations of that sort?

MR. RICHARDSON: I would defer--Mr. Fox, do you have an answer for that?

MR. FOX: The NSRB has actively looked at Appendix R issues, primarily at Browns Ferry.

MR. MICHELSON: I am thinking specifically of the allegations.

MR. FOX: Oh, the allegations? They have not dug into the allegations.

MR. MICHELSON: At what point in time do they or do

they ever?

MR. FOX: They have I believe, and I will have to verify this, but I believe at this month's nuclear they are at Sequoyah, there will be some coverage of Appendix R issues.

MR. MICHELSON: I think that that being your independent safety reviewer, that they would certainly want to look, if somebody makes accusations that seem to have substance at least, they would certainly want to look at them.

MR. FOX: Absolutely.

MR. MICHELSON: I hadn't seen any evidence yet that they had been involved, but you are saying that is coming up?

MR. FOX: Yes, sir.

MR. EBERSOLE: In that same context, I think we would like to hear now the Nuclear Safety Review Board actively generate its own grist rather than being dependent on somebody hauling things into it, and whether it has a technical staff capability to go in and probe as an inspector would.

MR. FOX: I think--would you please repeat the question, Mr. Ebersole?

MR. EBERSOLE: I would like to see you say something about the capacity of the Safety Review Board both technologically andmanagerially to you not really be dependent on people bringing in the grist of their mill, rather supply it themselves and walk the trenches, and see what the hell is

going on.

MR. FOX: They do walk the trenches. They do set their own agenda. As we have mentioned previously, the NSRB is staffed from key managers inside TVA, and then we have a number of advisors, particularly in the case of Sequoyah we have people like Bob Urig and people of that stature.

MR. KYLIE: Were you planning to address that in answer to Attachment A, item 5, which I think was that question?

MR. FOX: Yes. We had planned to touch on that.

MR. EBERSOLE: Fine.

MR. RICHARDSON: If there are no further comments on the federal overview, I would like to talk about the Appendix R situation right now.

(Slide)

MR. RICHARDSON: A former contractor of TVA has talked to the NRC about a number of concerns in the area of fire protection. This individual worked on fire protection programs for several of the TVA plants.

CHAIRMAN KERR: I'm sorry. You said a former contractor?

MR. RICHARDSON: A contract individual that did Appendix R who know longer is employed by TVA.

CHAIRMAN KERR: Thank you.

MR. RICHARDSON: We interviewed the individual,

spent approximately 15 to 20 hours in transcribed conversations. We took the transcribed details. We analyzed them. We broke them down into 26 separate questions that we needed additional information from TVA to determine whether or not the allegations are substantiated.

Those questions were sent to TVA on February 26th. TVA responded to the questions early in March. March 2nd was one submittal. There were several others. We had a public meeting Wednesday of this week wherein we went through the responses to the questions and asked TVA for any additional information that we need to resolve the allegation.

At the public meeting, the alleger was given an opportunity, 20 minutes to put his comments on the record. The results of the public meeting is that there are three areas where the staff does not have adequate resolution at this point. The first area is spurioius actuation of several components particularly in the high pressure, low pressure interface area, and that's the pressurizer PORV. TVA has given us the information they have got, and we are putting together a team to go down to Sequoyah starting Monday morning to look at this particular area.

MR. MICHELSON: Are you aware now that Sandia has completed its report on potential fire risks? We had our subcommittee meeting this week on that issue, and I'm hoping that, of course, you are aware of it when you go down to

Sequoyah to look. You ought to be at least, you ought to have read their report. Now that doesn't mean their report is right or wrong. It certainly gives you some of the things to think about.

MR. RICHARDSON: If we can get a copy of the report?

MR. MICHELSON: That's the direction from which you can rest assured the activity is coming. I think it is well expressed, although not completely agreed to, in the report.

MR. RICHARDSON: The second area of concern is in the availability of a reactor coolant system letdown path. We have talked to TVA a number of times. Again, this is an area we need to go down and study it. I believe TVA is currently working on an analysis right now to make sure that that letdown path is available, but we will need to look at their work this week.

The third area is the numerous procedures that TVA uses for directing operator actions in case of a fire. During the course of the discussion in the public meeting, a number of things came up in terms of manipulating valves inside containment, that there were some uncertainties as to whether or not that, with the spurious actuation of some other valves, whether that part of containment would be accessible, and we need to go look and walk through some of these procedures and make sure that the actions that TVA has done are adequate from Appendix R standpoint.

MR. EBERSOLE: Yesterday let me comment we heard some recent operations events, over the last month or so, and strangely, in the last almost few weeks, there have been three occasions for virtual total loss of audible, visible enunciation systems as a result of fires on the enunciator panels, which leads very quickly to the question of how do you now continue operation when the windows, black lit, there is no sounds, which would be a pertinent question to put into your investigation?

MR. RICHARDSON: Fire inside control cabinet is one of the specific areas.

MR. EBERSOLE: P[illegible]e I think generally think the enunciation and audible systems are safety grade. In fact they are subject to single failures. They have never been brought up to coincident redundant status, and therefore, you can still depend upon the vertical paneled board to know where to go and how you track that in the absence of the help you get from the windows. There is an interesting topic.

MR. RICHARDSON: It was one of the specific areas that the team will be looking at, and that's one of the areas of concern brought up during the--

MR. MICHELSON: Are you going to be looking then at the inadvertent actuation of the fire protection systems themselves under various circumstances?

MR. RICHARDSON: Yes.

MR. MICHELSON: Okay.

MR. RICHARDSON: The team we are sending down is made up of five members, four NRC members and one member from the Brookhaven National Laboratory, the people that have accompanied the NRC on most of their Appendix R audits of the different sites.

MR. EBERSOLE: I have been told in the matter of the system interaction aspects of the diesels that TVA has prudently performed an experiment in which they ran the diesels, and I say that now at full power. I have been told this all. I haven't a paper on it--verified they have a comfortable interval before they have overheating.

MR. WYLIE: That is item 4 on the agenda.

MR. MICHELSON: Are we going to get more on the fire later, which this is just the diesel?

MR. RICHARDSON: I want to cover the specific fire protection thing.

MR. MICHELSON: I am surprised you are using a consultant from Brookhaven since--

CHAIRMAN KERR: I can't hear you.

MR. MICHELSON: I am surprised they are using a consultant from Brookhaven since the focus of the fire protection investigative business has been at Sandia for the last year or so. They are the ones that are doing the, for the agency for research and investigation of fire risk and

that doesn't mean just probabalistic risk. That means mechanistic considerations as well, and they are probably the most knowledgeable at the moment of people that I have talked to at least on what some of these potential risks might be.

CHAIRMAN KERR: Maybe they are too busy to make the trip.

MR. MICHELSON: I am wondering why they--

MR. RICHARDSON: The Brookhaven consultants have been a part of the NRC's Appendix R inspection program subcesince its inception.

MR. MICHELSON: This isn't an inspection problem. This is a problem of, some of the issues being brought up by the, by this alleger are not necessarily being considered now. They are not new. Sandia has been looking at them for the last several months, but I am not sure Brookhaven has been looking at this for the last several months.

MR. RICHARDSON: They are coming because we believe the principal problems are in the associated circuit analysis area and systems interaction.

MR. MICHELSON: When we see the results, I am wondering if the scope of the walk-down is, is adequate. That's what I am wondering, in view of the allegations being made.

Is that going to be an adequate--the walk-down, are they just going to look at one part of the problem?

MR. RICHARDSON: The scope of the inspection is relatively narrow compared to a normal Appendix R inspection. We are going to look at the specific problems that are still unresolved from the public meeting.

CHAIRMAN KERR: Please continue, Mr. Richardson.

MR. RICHARDSON: Okay. The other issue that the team is going to look at is a number of miscellaneous allegations that don't fall into the three principal areas that I just discussed.

For example, one of them was an allegation that the sense lines are located too close together, so the single fire would take out your redundant pressurizer level indication, or pressure indication. We are going to go down and walk down the plant, make sure those items are properly taken care of.

TVA is prepared to address any other particular areas on the Appendix R analysis. That we expect to be done no later than Friday. There is going to be an exit meeting on Friday at the site. We have the responsibility of keeping the Commission informed of where we stand on the Appendix R allegations so that they can factor that into their voting on Sequoyah restart, and we will make sure that the Full Committee is also informed of the outcome of the inspection.

CHAIRMAN KERR: Suppose you get another letter of allegations this afternoon? Will that probably hold up the restart for another period?

MR. RICHARDSON: Depends whether the allegations are--we have a mechanism for screening allegations for safety significance, and if they are safety significant issues that need to be addressed before Mode 2, they will have to be addressed.

DR. MOELLER: I had a couple more questions on this American Nuclear Ensurer review.

MR. RICHARDSON: Yes, sir.

DR. MOELLER: And if there is anyone that is here who can help me with that, that would be great.

One of the problems they cited was in the handling of radioactive waste. Now out of curiosity, had the NRC staff ever observed those same problems or had--and I realize you are not the one that necessarily should answer this, but I wonder if INPO in any of their evaluations had ever observed these same problems? Does anyone know?

MR. RICHARDSON: I am not familiar with any specific NRC inspection findings that picked up the same problems A&I brought up.

Mr. Fox, did INPO raise any of these issues?

MR. FOX: I am not aware of INPO's finding any significant problems in the area.

DR. MOELLER: Another thing, and these are just things that trouble me, it says a team of American Nuclear Ensurer engineers--this is their December the 24th

report--recently conducted a special inspection of the Sequoyah facility, and then this tells us the team consisted of, and it names a man who is a Sequoyah facility engineer. It was four people. Well, that's number one.

Well, how is he an independent outsider? Was he the guide for the group or was he actually the leader of the team?

MR. FOX: His title is Sequoyah facility engineer. He is an A&I employee.

DR. MOELLER: Okay

MR. FOX: Mr. Kirk LaRoss.

DR. MOELLER: The implication I received is he is an employee of TVA. All right.

Then the next one is the A&I director of operations, well, he obviously is an A&I employee.

The third one is the Browns Ferry facility engineer. Is he A&I?

MR. FOX: He is also an A&I.

DR. MOELLER: For Browns Ferry, okay. They sure could have worded this a lot better. Thank you.

MR. MICHELSON: Are they full-time at the site?

MR. FOX: No, sir. They have the responsibility for the site, but they come periodically. TVA has been put in what they call a facility requiring attention status, which means that they visit the site approximately once a month.

MR. MICHELSON: Unannounced?

DR. MOELLER: They said they--

MR. MICHELSON: Wait a minute. Are they unannounced visits?

MR. FOX: So far, they have had, they have not been unannounced. They have been on two, three week a month notice.

DR. MOELLER: One last thing--they say they attended meetings of the plant operations review committee.

Does the NRC staff sit in on those meetings?

MR. RICHARDSON: Yes, sir. Our resident inspector routinely attends those meetings.

DR. MOELLER: Thank you. That's all.

MR. MICHELSON: What did the resident inspector have to say? He must have sat in at a number of meetings.

CHAIRMAN KERR: The microphone--

MR. MICHELSON: What did our resident inspector--did he agree with the observations of the fire people?

MR. RICHARDSON: He agreed with the observations. He noted that at the time that the A&I people were in there, TVA was in a transition mode. It was the first meeting with the, first or second meeting with the new plant manager, but he agreed that what that, the A&I people saw was factually correct at this particular meeting, but he did note that that was a somewhat atypical situation.

MR. MICHELSON: Had he reported such an inspection

report previously?

MR. RICHARDSON: He had commented on similar issues that TVA had made various improvements in the level of knowledge and the, having the PORC members attend themselves rather than send their alternates, and the quality of the presentation.

MR. MICHELSON: I might have missed a point. My point is did he tell you earlier there was a problem?

MR. RICHARDSON: We have known that the PORC area is something that needed continued work by TVA, and that he had flagged various issues and TVA knew about these issues and were working on them, yes.

In other words, he was not saying everything was fine and then A&I came in and contradicted, that he had pointed out weaknesses in PORC they needed to improve.

MR. MICHELSON: Apparently not enough to cause it to be a point of concern, enough to put pressure on that?

MR. RICHARDSON: That is true.

MR. MICHELSON: I didn't sense in the documentation that the NRC had ever put pressure on TVA in this area.

MR. RICHARDSON: That is correct.

MR. MICHELSON: Thank you.

MR. WYLIE: Any other questions?

MR. FOX: Mr. Richardson, I have a copy of this if you would like to have it to provide to ACRS, the March 1st

response, which summarizes not only their latest inspection, but also the, their response to the TVA responses to their observations in that first meeting.

MR. WYLIE: Is that all--

MR. RICHARDSON: That is all on fire protection for now.

MR. MICHELSON: We have only very recently received the replies that TVA made, in fact, just yesterday. I knew about the questions, but we managed to find a copy of the questions finally, but the agency has not been very sterling in its providing these documents to us quickly. It was only with great effort we even got them finally, so I haven't had a chance to read them.

CHAIRMAN KERR: Which document is--

MR. MICHELSON: The first one we had to work for was to get a copy of the concerns, which was the letter of February.

CHAIRMAN KERR: Are you referring to the A&I concerns?

MR. MICHELSON: No. I am referring to the fire protection concerns raised by the alleger, and so I haven't had a chance to look at TVA's replies and see how suitable they are. I just got it yesterday, finally.

MR. WYLIE: Let's move to licensing, to the next issue then.

MR. RICHARDSON: The next issue is diesel generator sequence issues. Mr. Angelo Marinos, who is chief of the Reactor Systems Branch and Special Projects, will make the staff presentation.

MR. FOX: Excuse me just a moment. In answer to the question that Mr. Michelson asked, we have just called and verified, we just talked to Chuck Wilson, who is the secretary for the Sequoyah NSRB. He says that NSRB is already reviewing Appendix R documents in preparation for the 3/30/88 Sequoyah NSRB meeting. Appendix R is on the agenda, and it is already being reviewed by the team.

MR. MICHELSON: Thank you.

MR. MARINOS: My name is Angelo Marinos. I am the Chief of the Reactor Operation Branch, which among other responsibilities, has the responsibility for addressing concerns related to electrical issues allegations and also any work, other work regarding electrical calculations that TVA has conducted for Sequoyah.

Diesel generators falls into that category. The areas that caused TVA to investigate further the diesel generator capabilities were concerns on the adequacy of the diesel generator capacity that was recorded through employee concerns, and also the original pre-operational test that was conducted by TVA during the licensing of the plant some eight years ago was also under question, so TVA through their

restart test program that they have instituted recently have prepared special test instructions for retesting the diesel generators, and they conducted these tests last July I believe or through October as a matter of fact, and the test results were evaluated more recently in January, and at that time, our branch, the office got involved in evaluating TVA's results.

Last January, in the middle of January, TVA informed us that their test results may have revealed that Regulatory Guide 1.9 may be violated in some cases as the test results indicated. They informed us--

CHAIRMAN KERR: Excuse me. What is the sense of a regulatory guide being violated since it is not a regulation?

MR. MARINOS: The Regulatory Guide 1.9 is the basis that, that has been used for the technical specifications, and the Regulatory Guide was, it was Safety Guide 9 which TVA committed to meet during licensing. The Regulatory Guide 1.9 was issued later as a revision to Safety Guide 9.

CHAIRMAN KERR: So it is the tech specs that have been violated?

MR. LIAW: My name is P. Liaw. I am the assistant director of the technical program.

I guess, Dr. Kerr, you are correct. A regulatory guide is not the document. However, if a licensee were committed to it, and that was the basis for the item entering the technical specification, the regulatory guide becomes a

document.

CHAIRMAN KERR: It is the spec techs that have been violated, not the guide?

MR. LIAW: Right, basis of tech spec items.

MR. MARINOS: The regulatory guide was used as the basis for the technical specifications. The specification of areas where TVA felt that they were not meeting the regulatory guide was in the area of overshooting voltage in recovery during a transient loading and the undershoot, undervoltage or overvoltage containment.

It turns out that only in one case they did violate the overvoltage. They have done an analysis to demonstrate to our satisfaction that this condition will not affect the performance of the components under which this overvoltage occurs, and the other area of concern was the recovery within the 60 percent of the interval of the next loading sequence. T..e regulatory guide requires or recommends that within 60 percent of the interval, the voltage should recover to nominal, and TVA felt at first that there, they would not be able to meet that. It turns out after further evaluation of their test results, demonstrating that they met that requirement, so that requirement was met as far as Regulatory Guide 1.9 is concerned.

The more important issue that has arisen from these tests was the fact that during TVA's testing, the transient,

testing of the transient loading, testing of the diesel generators were simulation of the accident loading has to be assumed with the assumption of loss of overside power and safety injection signal initiated. TVA is required to load the diesel according to the prescribed sequence of loading as the accident analysis in Chapter 15 requires.

The loads were applied according to the sequence required. However, a full load of each of the components that is applied at the particular interval was not able to be exercised because of the fact that TVA has, does not have the capability in the plant to apply the full load of the mechanical load on its pump, so therefore, at each interval that new load is applied, the previous constant load that has been applied in the past and serves as a constant KVA load as it is called in these terms is less than the normal constant load would have been for the next application of the transient load.

In order to compensate for the appropriate response of the diesel generator that would be expected during that loading, of the full loading, TVA conducted calculations. They calculate the response of the diesel generator assuming exactly the conditions that were applied to the diesel generator with the reduced loading, and arrived at a certain response in voltage for that loading, and then they calculated the response of the diesel generators with the full loading

assumed on the diesel generators.

The difference of the response was taken and applied to the actual test result so that to predict what would be the actual voltage reduction in the, on the machines, if the full load was able to be applied.

We reviewed that information from TVA, and we became concerned that the calculated values were more optimistic. They were not bounding in fact the actual test. Neither the test, the calculation done for the exact loading that the diesel generator saw, and also for the maximum loading that would be expected, neither one of two calculations results bounded the test, so we--

CHAIRMAN KERR: What do you mean by bounding it?

MR. MARINOS: We expected theoretically when the calculation is done on exactly the same loading at a minimum, the test results should be exactly as the test, and it is an imperfect world. We wouldn't expect it to be really exactly there, but we will expect it to be lower, to be more conservative, more drop in machine than what--

CHAIRMAN KERR: Why would you expect it to be more conservative? I would want it to be as accurate as I could get.

MR. MARINOS: Indeed either exactly or we were expecting more.

CHAIRMAN KERR: I didn't say exact. I said as

accurate as one could calculate. I would be surprised if the calculation came out to be the same as a measurement.

MR. MARINOS: Given the conservatisms that are taken for calculating the response, we would expect that, theoretically we would expect it to be lower or equivalent at best.

CHAIRMAN KERR: Okay.

MR. MARINOS: Now additionally, however, the calculational results for the maximum loading that would be expected for the diesel generators also came out less, more, less conservative than the actual test, meaning that the voltage drop was lower, less drop in the maximum loading calculations than what the actual test was.

CHAIRMAN KERR: Was this by factor of 2 or 3 percent or 50 percent or--

MR. MARINOS: In some cases, we have more than 3 percent, yes.

CHAIRMAN KERR: That's serious?

MR. MARINOS: Two or 3 percent is not a matter of seriousness. It is the idea now that we have to take the difference between the calculated values and apply it to the actual test to predict what the actual response of the machine would have been if the full load was applied to it. I could, we could not give credibility to the calculations to make the right prediction.

CHAIRMAN KERR: What you are trying to find out is whether you consider 3 or 4 percent difference to be a serious difference or something that one might expect in a situation like that?

MR. MARINOS: It would be more accurate--I would not know whether the 3 or 4 percent is accurate since the calculations do not bound the test, so impedances used for the test were inaccurate, the answers will be, it is not a linear situation so we cannot make a prediction.

Now 2 or 3 percent in the actual--

CHAIRMAN KERR: I suppose if it had been 1 percent difference, wouuld you have considered that serious?

MR. MARINOS: Any difference in the calculations, the calculations will not speak to the proper response of the machine because they did not bound the test.

CHAIRMAN KERR: So unless the calculations, the measurements had been exact, unless it had been an exact agreement, you would be skeptical of the calculations?

MR. MARINOS: It is not the exact agreement to the test. It is, we expected it to be more conservative.

MR. LIAW: Can I add something to it? I guess the question is not the accuracy but rather whether or not they are more conservative results in the sense that in the real situation we do expect, the calculation has certain built-in conservatives in there. Therefore, the results of the

calculation will be more conservative than what Mr. Marinos refers to as being bounding.

CHAIRMAN KERR: Why do you build in conservatism in a calculation which is meant to show you what would happen? It seems to me you want to know what happens in a situation like this.

MR. LIAW: Input into calculation are not based on result. Each component of the calculation--

CHAIRMAN KERR: I cannot imagine why if you are trying to understand what is happening in a test, you wouldn't make the best calculation you could make rather than trying to make a conservative calculation. There must be some reason. I probably won't hear it in the discussion this morning.

MR. WYLIE: I think you are mixing results and calculations here. I mean--

CHAIRMAN KERR: The results of calculation.

MR. WYLIE: You make the calculation as accurate as you can make it. You compare it with the capability of the machine, and--

CHAIRMAN KERR: That's not what I am hearing here. I am hearing that they did some conservative calculations. For what reason I don't know.

MR. MARINOS: If the characteristics of the machine were portrayed accurately, the calculations should bound the test. There is no question about that, in this area, but

there is a great question about how the parameters of the machine were portrayed. Were they calculated accurately when the nameplate was developed for that machine some ten years ago, whenever that manufacturer developed that machine? So those are uncertainties tnat we don't have an answer for, and it should have bound the calculation, and it did not bound the calculation. Obviously it was not conservative.

CHAIRMAN KERR: I still don't know what you mean by bounding the calculation. I mean bounding the measurements or whatever.

MR. MARINOS: I am saying that the, the results of the calculations should have been worst case, worse than the test. That's what I mean by bounding.

CHAIRMAN KERR: Okay.

MR. EBERSOLE: What the problem is, you really can't build real load sequentially because you can't, at each stage you can't put a true load on it because of physical problems.

MR. MARINOS: That is correct.

MR. EBERSOLE: But tell me, in the end, you finally did put a full load on the machine?

MR. MARINOS: A full load is put, not a transient full load, but a steady state full load by synchronizing the machine on to the grid and then slowly pick up load to the full load. That is not--this is a little different.

MR. EBERSOLE: You can't bring that load up in

synchratic stages to represent the actual time to build up, can you?

MR. MARINOS: That is correct. TVA's physical design does not provide for that.

MR. EBERSOLE: Can't step up the artificial load on the grid at all? Don't have stepping mechanisms to do that?

MR. MARINOS: I don't think so.

MR. EBERSOLE: Okay.

MR. WYLIE: Let me say this. Isn't it true that practically no plants have this capability?

MR. EBERSOLE: Right.

MR. MARINOS: That is correct. Well, newer plants do. They have full flow bypass on the large machines, motors.

MR. WYLIE: It is not unique to TVA?

MR. MARINOS: It is not unique to TVA for that vintage of plant, that is correct.

MR. WYLIE: They all rely on calculation?

MR. MARINOS: I believe so. Since that challenge to TVA regarding the calculations, TVA attempted another approach to predict the additional voltage drop on diesel generator as a result when the maximum load would have been applied, and this was done by an analysis of ratios.

They have relied completely on the actual measured values that, pre-transient conditions of voltage and current on the machines, and the post-transient and transient

conditions of voltage and currents that they measured and kept on record. Then they ratioed their mathematical analysis and arrived by the predicted additional drop for, the voltage drop for the machines during the maximum loading, and that additional value was considered there, and calculations were performed for establishing the performance of components for that level all the way down to 120 volts components from 6.9 kv down to 120 volts.

We reviewed that analysis. We found that analysis acceptable not based only on TVA's calculations, but we consulted with technical papers that have been published over a number of years that make predictions of how dynamic loads will behave if they were applied to machines with certain capacity, and we were basically in agreement, that within 1 percent of error we agreed with TVA that this would be reasonable basis to, to predict the response of machines for the full load.

CHAIRMAN KERR: How accurate do you think the full response of the machines could be measured?

MR. MARINOS: How accurate? Would you repeat that?

CHAIRMAN KERR: Yes.

MR. MARINOS: With this analysis?

CHAIRMAN KERR: No. How accurate do you think the response could be measured? Not calculated--measured.

MR. MARINOS: Exactly, if the load is put on the

exact load.

CHAIRMAN KERR: Surely you don't mean that. There is error in measurement. What sort of measurement error do you anticipate in a test of this kind?

MR. MARINOS: Five percent measurement error? I don't know what error TVA has--

CHAIRMAN KERR: But you are saying that the calculations and measurements agree within 1 percent, and you have, you expect the 5 percent error in the measurement. Is that--

MR. MARINOS: Well, not 5 percent all voltage; 5 percent of the accuracy of the instrument that you are measuring. I don't expect to have 5 percent of the--

CHAIRMAN KERR: Let's suppose the instrument is measuring voltage drop. How accurately do you think the measurement will be?

MR. MARINOS: We can ask TVA to maybe tell us.

CHAIRMAN KERR: If you have set a 1 percent tolerance between the measurements in calculations, you must have some idea of what the measurement error is. Otherwise it doesn't make sense then to set that criterion.

MR. MARINOS: What TVA has used was the latest very, you know, up-to-date machines, pretty accurate now.

CHAIRMAN KERR: It is pretty accurate for 10 percent or 1 percent?

MR. MARINOS: Now the accuracy escapes me now. TVA may have a comment on that.

MR. FOX: Our chief electrical engineer Bill Raughley can speak to this accuracy.

CHAIRMAN KERR: I am not trying to find out--I am trying to find out how the 1 percent criterion was set, and I gather it was set without knowing how accurate the instruments are when they are doing it I suppose?

MR. FOX: Bill Raughley, would you care to comment on that?

MR. RAUGHLEY: Bill Raughley, chief electrical engineer at TVA--what were used are less than a half a percent accurate.

MR. WYLIE: What is the overall accuracy? I mean you have got instrument parameters.

MR. RAUGHLEY: In this, the measurement intake, 1 percent.

MR. WYLIE: Within 1 percent.

MR. WARD: That's terrific.

CHAIRMAN KERR: That is very good in non-laboratory conditions, field conditions I would say.

MR. RAUGHLEY: You are measuring in one case 80 voltage over 3 inches.

CHAIRMAN KERR: I have done some electrical measurements. I even have done some with TVA. Okay.

DR. SHEWMON: There has been progress in the last 30 years.

CHAIRMAN KERR: . know how those estimates work.

MR. MARINOS: Nonetheless, these analyses and the results which we have received, of course, do still leave us with certain uncertainties, so there indeed--

CHAIRMAN KERR: I will accept that statement.

MR. MARINOS: Yes. So as my next bullet says, there is an evaluation of the improvement factors that TVA has committed to perform. We received a letter from TVA of commitment to evaluate some improvements for the response of these machines because of the to some degree unpredictability in their responses as they now are designed.

These particular improvements are braced on observations made by TVA's consultant, Mr. Concordia, evaluated by us and our consultant, Dr. Alexander Cass who we retained for this period of time. These improvements relate to mainly the excitation system for the generators, principally on the voltage regulator which seems to be a slow responding system, and TVA is going to evaluate the overall response of the excitation system and will have completed modifications, whatever necessary to improve the response of these machines by the next, by the first refueling outage of Unit 1.

MR. WYLIE: What is the purpose of these

enhancements?

MR. MARINOS: These enhancements are to improve first of all the response of the voltage regulator for the recovery, the voltage recovery during these transient loading is slow relative to other machines that have more modern excitation systems, particularly voltage regulators.

MR. WYLIE: What is the safety significance of that?

MR. MARINOS: The safety significance will be the following--TVA, though they have convinced us that the safety has not suffered from the response of these machines, nonetheless, the components that are being operated by these machines, the margin that exists between their minimum voltage requirements and the applied voltage through these transient conditions has eaten into the nameplate margins that the components generally are recommended to by the vender.

The vender has a nameplate minimum voltage conditions that should not be exceeded, and TVA, in a number of cases, exceeds them, the minimum voltage that the nameplate recommends, but however, they have done, conducted tests, laboratory tests, on these components and demonstrated that there is added margin besides the minimum margin that the nameplate of the components have indicated, so in some situations, they have gone into that added margin which is inordinate, and they would expect to improve that, and we would expect them to do so and regain that nameplate margin

that normally is inherent.

MR. WYLIE: These are very short transients?

MR. MARINOS: Yes.

MR. WYLIE: And the--

MR. MARINOS: The principal concern is for contactors down in the 480 volts range where they require certain minimum voltage to pick up and certain minimum voltage in order to hold their, their condition in state.

MR. WYLIE: That is a concern. Then you have got a concern now, don't you?

MR. MARINOS: We do not have a concern right now because TVA has conducted tests at the laboratory in the established outer margins, below the margins that the vender has indicated as a nameplate, so the pick-up requirements are much lower than what the nameplate indicates on the contactors.

MR. WYLIE: Why the enhancement?

MR. MARINOS: Because we aren't, these machines, these excitation systems may degrade further and if there is such a degradation, we will expect them to regain that margin.

MR. WYLIE: I have never known machines to degrade as long as you keep them calibrated to degrade. These machines are not used that often, right?

MR. MARINOS: That's right.

MR. WYLIE: Just don't test.

MR. MARINOS: That is correct. We intend to monitor, of course, doing the technical specification required monitoring surveillance of these machines to see.

MR. WYLIE: What does TVA think they are gaining by these modifications?

MR. FOX: Bill Raughley, would you like to comment on that?

MR. RAUGHLEY: Bill Raughley, chief electrical engineer--by making these changes, we would increase the safety margins of the plant.

MR. WYLIE: What?

MR. RAUGHLEY: Increase safety margins.

MR. WYLIE: What safety margins?

MR. RAUGHLEY: Between the, in the load sequence time intervals; we would improve--the time of the voltage regulator would have to settle out. We ar evaluating additional changes in addition to the ones--

MR. WYLIE: This improves the plant safety?

MR. RAUGHLEY: Gives you more margin.

MR. WYLIE: Margin in what?

MR. RAUGHLEY: In the ultimate pumps he is talking about.

MR. WYLIE: Do the, are we changing the risk?

MR. RAUGHLEY: You would be increasing the time between the safety limit and the time the device actually

performs its safety function.

CHAIRMAN KERR: I would say it gives them more margin than the regulatory response. I am not talking about full grade.

MR. WYLIE: Okay. Thank you.

MR. EBERSOLE: I got the impression it was a margin in holding voltage. Maybe I was wrong.

MR. WYLIE: What?

MR. EBERSOLE: The holding voltage they were going to protect, but am I wrong?

MR. WYLIE: Nope. I think it is--I think it is marginal margin.

MR. EBERSOLE: It is not always that the mechanical engineers sit next to the electrical engineers and tell him what goes on on the mechanical side.

The way to start a pump, if you can stand the shelf head, is to start it with a closed discharge, and considering further the accuracy of your measurements, have you considered the full range of possibilities for runout flow at low pressure to close the discharge in the variety of pumps that have to get with it when you are in trouble?

MR. MARINOS: In fact, most of the pumping systems for TVA in the safety injection sequence are open valves. They are--

MR. EBERSOLE: Also open flow paths?

MR. MARINOS: Open flow paths; the run-on condition would be less of an electrical load than would be at a, at another head.

MR. EBERSOLE: That is a peculiar bunch of pumps.

MR. MARINOS: Runout load essentially would be less so the calculations, at least the capacity factor--

MR. EBERSOLE: That is not always the case. Is it just unique that your pumps have runout flow demands that are less than closed discharge?

MR. MARINOS: I, in the calculations that I have done, I find that to be true across the board. I don't know if--

MR. EBERSOLE: Have you looked at pump characteristics?

MR. MARINOS: I have looked at the charging pumps. I looked at the runout flow.

MR. EBERSOLE: I can understand charging pumps. I wouldn't understand an RHR.

MR. MARINOS: In fact I looked at the charging pumps and the runout flow is less of a horsepower requirement than it would be at the, at another head.

MR. EBERSOLE: Okay.

MR. WYLIE: I guess I have a concern that we, that you feel like that there is a need to enhance the characteristics of these machines by replacement of voltage

regulators and this kind of thing.

Do I read into that that you, you think that these machines are not adequate now?

MR. MARINOS: They have four machines. Each one of them had different response. They tested them all, and of course, TVA in doing their analysis conservatively, they have taken the worst case from each interval of particular diesel and put them together in a composite so they have given us a paperwork representing four diesel generators that worst case for each one on a particular interval.

That to me is an indication that the generators are not performing--theoretically they should perform equivalently. They shouldn't have these variations, large variations in the, on the very, the same step, four different steps, four different types of tests, you have different results, and of course, they have taken the worst case.

CHAIRMAN KERR: Why do you care if they perform differently? That has some influence on the behavior of equipment that they drive?

MR. MARINOS: As indicated, behavior of the equipment, this is unusual that TVA is taking credit for added margin beyond the nameplate minimum allowed by the venders on the components that they drive.

CHAIRMAN KERR: I thought you said that TVA had run tests which convinced you that at the present time, the

performance was acceptable and what you were worried about was the future degradation?

MR. MARINOS: Yes. Now it is not merely the machine degradation.

CHAIRMAN KERR: Excuse me. If the vender performed the test, the performance is now acceptable, why do you worry that the machines may perform in slightly different ways?

MR. MARINOS: It is a combination--it is not just merely the diesel generators performing slightly different. It is the components deteriorate and their efficiency goes down so their demand is going to be different.

CHAIRMAN KERR: Doesn't one do tests on this periodically to find out where the performance is degraded?

MR. MARINOS: If the test could be done accurately, the uncertainty removed, of course. Who would argue with that?

CHAIRMAN KERR: You just said I thought--correct me if I am wrong--that they had done a series of tests and you were convinced that the performance was acceptable now, so it must be possible to do tests that will convince you that the performance is acceptable.

MR. MARINOS: That is correct.

CHAIRMAN KERR: Therefore it seems to me in the future one should be able to do tests that also would convince you that performance is or is not acceptable.

MR. MARINOS: That is correct. If the tests can be done in such a way that the uncertainties can be removed, there will be absolutely no question about that.

MR. WYLIE: Is that the case now?

MR. MARINOS: Pardon me?

MR. WYLIE: Is that the case now? The testing has removed the uncertainties?

MR. MARINOS: That is not what TVA has indicated their future plan is right now.

MR. LIAW: I think that is not the case. They are not, they cannot test for an expected accident condition.

CHAIRMAN KERR: Mr. Marinos didn't really--

MR. WYLIE: They have gone through the calculations. Do you disbelieve their calculations?

MR. LIAW: We believe their calculations with some scepticism I guess. Even after the evaluation, we find it acceptable enough margin for the time-being, but what TVA consultant proposed to do to further enhance the reliability of the machine--

MR. WYLIE: All you are talking about is changing voltage responses in regulators. That hasn't got a thing to do with loading of--

MR. LIAW: Well, I presume that Mr. Concordia is expert on the machine. That is what he recommended. We just present the case to you, unless TVA can speak for Mr.

Concordia at this moment.

MR. RICHARDSON: Let me bring up one other comment. The replacement of the voltage regulators with up-to-date regulators, solid state regulators, has been a topic that TVA has been planning to do for sometime, just very low priority task. They have had new regulators in the warehouse for a number of years and we are just encouraging them to go ahead and carry through with those plans and make it proved.

DR. CONCORDIA: Do you want me to speak for myself?

MR. FOX: Dr. Concordia, he is here today, if the NRC would like him to speak.

MR. LIAW: Mr. Chairman, would you allow Mr. Concordia to speak, explain his recommendation, because I would like to hear it, too, myself?

CHAIRMAN KERR: There seems to be overwhelming call for your response, Mr. Concordia.

DR. CONCORDIA: I am Charles Concordia, consulting engineer. I really didn't make a recommendation that any changes need be made, but I made the statement that if we desired enhancement, we could in the first place improve the response of the voltage regulator.

Now the reason, the result of that in my opinion would be that between each of the five steps at which the voltage is applied, the system would quiet down a little bit. In other words, it would sort of, you would feel more

comfortable with the results than you do at the moment perhaps, that the NRC staff at the moment since you haven't finished the last transient before you started a new one. The result in my opinion again, and my experience with other cases where we have applied a load from a transient state is that in actual fact the performance would be different in the fact that the over voltages would be less, but the minimum voltages observed each step would be practically the same as they are now.

CHAIRMAN KERR: Thank you, sir. Oh, excuse me. I didn't mean to cut you off if you aren't finished.

DR. CONCORDIA: Okay.

CHAIRMAN KERR: Thank you, sir.

MR. WYLIE: The results of the analysis that have been done by TVA and Mr. Concordia I think, are you convinced is adequate margin in the machines as they exist today?

MR. MARINOS: Yes. I believe so.

MR. WYLIE: All right. And that they can perform their safety function sequencing the loads and at the appropriate times in order to fulfill the safety analysis of the plant?

MR. MARINOS: Yes, I do.

MR. WYLIE: Fine. Any other questions?

CHAIRMAN KERR: Thank you, Mr. Marinos. The next question has to do with the test of diesel by TVA, is that

correct?

MR. RICHARDSON: TVA is going it make that.

MR. WYLIE: The next item has to do with the CO 2 fire suppression test that TVA ran. I believe TVA was going to--

MR. FOX: Doug Wilson, the chief of our new technology branch, will speak to this.

MR. WILSON: My name is Doug Wilson. Mr. Ebersole had asked a question in the Sequoyah the other day about the possibility of an earthquake causing an isolation of the diesel generator building and therefore loss of the diesel generator.

In a seismic event, the CO 2 systems at Sequoyah are not seismically qualified. The electronics is seismically qualified, what we call category 1L, which means that it won't fall down and damage other equipment. However, in an earthquake, it could cause an isolation of the systems inside the building that are used to have cooling through the diesel generator room that is used for cooling in the generator itself. To demonstrate that this wasn't a problem, well, let me back up for just a second.

We identified this problem at our Watts Bar station which has a diesel generator building that is very similar to that at Sequoyah. The result of that condition adverse to quality we did and ran a couple of tests on the diesel

generator itself and did a number of calculations. The tests themselves isolated the building, ran the diesel generator to see the timeframes that we would have to send people out to isolate that, and then we did calculations to extrapolate that test data up to the limited conditions on the diesel generator.

We immediately--on the initiation of the diesel generator, procedures require an immediate dispatch of an operator out to this, to that room, and we have on the neighborhood of 50 minutes to unisolate that room to restore proper diesel generator operation.

MR. MICHELSON: Could you tell us just briefly the results of the test, room temperatures?

MR. WILSON: As I recall, we ran two tests. The first one was with the dampers open, the dampers themselves open with the fan shut down, and we had like a half hour in that case, and the condition where we actually closed the damper, quite obviously we didn't want to get up near the temperatures where we could do damage to the equipment, so we ran it for like 30 minutes as best I recall, and then extrapolated from there.

MR. MICHELSON: What temperature at 30 minutes?

MR. WILSON: Believeit was 108 degrees.

MR. MICHELSON: Farenheit?

MR. EBERSOLE: You have not done it down in Alabama

or Tennessee where it starts out at about a hundred.

MR. WILSON: Starts out at 97. The actual test was run just on a day when like it was 75 or 80, in that neighborhood, and we extrapolated in our calculations that what would happen if the temperature was 97 and then--

MR. EBERSOLE: I see.

MR. MICHELSON: What would happen if it had been 90?

MR. WILSON: We would have had 50 minutes to get somebody out there. We have repeated temperature--

MR. EBERSOLE: Did you find the temperature in the sense there might have been solid state apparatus in that room that was--

MR. WILSON: We looked at, that limited temperature on the equipment that is in there now is the temperature of the generators themselves.

MR. EBERSOLE: It is not the solid state control?

MR. WILSON: We don't have very much solid state.

MR. MICHELSON: You will eventually if you put the new devices on, and then what will you do?

MR. WILSON: We will have to look at that.

MR. EBERSOLE: That's a good reason not to put the new solid state stuff in there.

MR. MICHELSON: You actually ran the room temperature to 108 at that point? None of the control, there were no adverse operations occurring in any of the control

equipment?

MR. WILSON: Carl, that's my best understanding from reviewing the test and having some other people review it for me.

MR. MICHELSON: This generator had the same kind of control panel at that time, the Sequoyah, with the sensitive resistor and so forth in it as well?

MR. WILSON: Actually the ones that were actually--run the test at Watts Bar I believe, already have the solid state exciters in them. Ones at Sequoyah have I believe mag amp and there is another different, ones at Watts Bar are actually 4400 kw units and the ones at Sequoyah are 4,000 kw and the same site, room, we actually, the tests we did at Watts Bar would, would be a bounding test for the Sequoyah.

MR. EBERSOLE: When you have actual--

MR. MARINOS: I have a clarification. You said 4,000 kw? The Sequoyah--

MR. LIAW: The--

MR. MARINOS: The Sequoyah are 4400.

MR. EBERSOLE: You have discharge. You let the engines run on, take care of things locally, too. You turn it off?

MR. WILSON: We don't need the power. I assume we turn it off.

MR. MICHELSON: On the other remarks, did you, what did you determine about the CO 2 system in terms of that versus inadvertent actuation during earthquake. Are you conceding it might happen? Is that what you are saying?

MR. WILSON: It might or it might not. We have looked at both cases.

MR. MICHELSON: If it were to happen from the cooling of the room viewpoint, you think it is a non-problem. How about from the release of the CO 2 viewpoint?

MR. WILSON: The diesel generators have, takes suction air from outside that room.

MR. MICHELSON: That's right. How about the auxiliary equipment within the room? That might be required?

MR. WILSON: The test was run with that equipment.

MR. MICHELSON: You didn't release the CO 2?

MR. WILSON: That is not evaluated.

MR. MICHELSON: That's a separate question. I am asking--

CHAIRMAN KERR: What sort of equipment, Carl? Do you mean equipment that uses oxygen?

MR. MICHELSON: No, no; equipment that, for instance, if you do build up a, put snow on the floor and so forth, you have circulating pumps or something that might be affected by the CO 2 storm and so forth. You have got to think about that, and again solid state device, you are going

to concentrate moisture in the cabinet potentially as a result of transporting it and the snowflakes that are coming down.

MR. WILSON: We have locked at it in the past, but I really don't recall what the results of if are.

MR. MICHELSON: In the case you say that the equipment is positioned and hung such that it won't fall down, is there a chance it could rupture? I mean could you have, break a pipe off, for instance?

MR. WILSON: Actually talking about the electronics is what I was talking about.

MR. MICHELSON: How about the CO 2 tanks, which are in a rather confined room? Have you looked at the rupture of that tank and the relief capacity of the room?

MR. WILSON: Yes, sir. As a result of a CAQR, as best I remember, in the original license at Sequoyah, there was a question about tank rupture, and where it is sitting and what would that do to the building, and we did calculations and showed that there was adequate relief capacity in the building to permit damage to structural capability of the building itself.

MR. EBERSOLE: What have you done about the old business of blowing doors off?

MR. MICHELSON: I think that's the relief capacity.

MR. WILSON: That is part of the relief capacity.

MR. WYLIE: Mr. Wilson, I missed it I guess. You

said the initial temperature was 95?

CHAIRMAN KERR: Seventy-five.

MR. WYLIE: You went to 108?

MR. WILSON: Yes, sir.

MR. WYLIE: In 30 minutes; full load on the machine?

MR. WILSON: Yes, sir.

MR. WYLIE: And that was measured where?

MR. WILSON: There were a number of thermalcouples in the room as I recall that was measured intake to the diesel.

MR. WYLIE: To the generator?

MR. WILSON: Electric generator itself.

MR. WYLIE: The 4400 is the continuous rating of the machine, is it not?

MR. WILSON: That is correct.

MR. WYLIE: Based on class B rises, insulation system I assume. Is it a class F insulation system or class B?

MR. WILSON: I am not sure. Bill, can you answer that?

MR. RAUGHLEY: Class B.

MR. WYLIE: And class B risers?

MR. RAUGHLEY: Yes.

MR. WYLIE: It doesn't have additional service factors then? What is the short time rating of the machine?

MR. RAUGHLEY: Short time rating of the generators--

MR. FOX: Bill, go to the microphone, please.

MR. RAUGHLEY: The short time rating of the machine is 5500 kvi.

MR. WYLIE: And that your analysis is based on the 4400, is that correct?

MR. RAUGHLEY: Yes, sir.

MR. WYLIE: You have that additional percent. Thank you.

MR. MICHELSON: One other question on the inadvertent release--you said you looked at it for various components. The CO 2 now I am thinking about.

Did you look at it from the viewpoint of the generator and its ingestion of the CO 2, snow, it is going to suck it in as it is coming down, part of the cooling function of the generator?

MR. WILSON: There is a--I am talking memory now, Carl. I didn't review this aspect of it. Intake for the generator itself is up in, near the area where the air actually comes in from the outside.

MR. MICHELSON: It is not coming in from outside now, of course.

MR. WILSON: Right, but I believe it is in an area that would have to suck, as best I recall, have to suck the CO 2 in.

MR. MICHELSON: I think it would be, because it is a rather large fan. I know it is in significant flow stream. I just wonder if the ingestion of CO_2, snow has been a real problem, namely, if it were, I think it would be a moisture problem. I have never seen anybody give me, you know, a good answer to whether that--

CHAIRMAN KERR: The moisture condensation in the air?

MR. MICHELSON: CO_2 re-evaporates, leaves the water behind, running through that nice hot--

MR. WILSON: If the generator is hot, the moisture wouldn't stand.

MR. MICHELSON: If would be driven to that extent except electrical terminals aren't quite as hot. It is the question-- Does anybody know? I mean, are we assured CO_2 ingestion would not be a problem? Apparently you are assured because you have looked at it.

MR. WILSON: They have looked at it, but it has been a long time ago.

MR. EBERSOLE: One aspect of this on discharge and CO_2, you have told me I think at one point at Sequoyah your solution would be to find relief vent so the doors don't flow off. I could imagine at least because of the, of lack of safety quality in the systems put out, part of the tank farm, small space that you could have a door someplace. It was

pretty strong and before it went you could have, enclose it in the critical apparatus. Do you follow me?

MR. WILSON: Yes, sir. About, I guess about a month or so ago, we got to look at the strengths of some of these doors from some other places, and it wasn't at Sequoyah. It was LMR or Watts Bar. I have forgotten where, but the assumptions that we have made in the strengths of those doors was something like 1600 pounds, and we had test data that actually shows that most of them actually fail around three to 400 pounds, so it was of concern to us.

MR. EBERSOLE: When you say pounds, I am talking about psi which is still a low--in other words, you know, you all have a reputation for boring holes in things that need to be protected. Have you had to bore any holes in the cabinet or enclosures that might be subject to the CO 2 problem?

MR. WILSON: Can't answer that. Not to the best of my knowledge.

MR. EBERSOLE: What about the doors being too--

CHAIRMAN KERR: There are a lot of squirrels in that area. Maybe you can get the squirrels to do that!

MR. EBERSOLE: You know what the problem is. I am not going to go further.

MR. WARD: You asked the question about whether the ingestion of CO 2 is a problem, and I don't, you know, have any opinion whether it is or not.

I found the answer, though, unsatisfactory that we looked at it but it has been a long time ago.

Were you happy with that answer or--

MR. MICHELSON: I'm, I think we planted the seed. I hope they go back and reassure themselves that it is a non-problem because we haven't reassured ourselves that we couldn't get inadvertent actuation. Clearly we don't know the seismic response of the electrical equipment, and therefore it is possible you will isolate and charge all four diesel rooms during an earthquake with CO 2 and clearly you have lost, I think lost off-site power also.

MR. WARD: No, I understand that, but well, I think I do, understand what you are saying, but are you satisfied with the answer?

MR. MICHELSON: I don't think I could get any further information at this time.

MR. WARD: Do you think we need, I mean do you think, do you think we need more information?

MR. MICHELSON: I think it is a generic question we are going to cover as part of our looking at fire in general. We just had our recent subcommittee meeting on it. We are going it look at a number of these questions, the effects of inadvertent actuation, particularly water, but CO 2 and halon are also in question. I am going to get my answers there.

MR. WYLIE: I have a question. Are these

conventional exciters slip ring and brushes?

MR. RAUGHLEY: Yes, they are.

MR. WYLIE: Thank you.

DR. MOELLER: Charles, will we hear later about the questions raised by Dallas Hicks on the capacity?

MR. WYLIE: That's what we have been discussing.

DR. MOELLER: Is this, has this addressed his question?

MR. MARINOS: I had it on the slide. We skipped over that. I can go back and address this if you are interested.

MR. WYLIE: Please do, or do you have--

MR. MARINOS: Yes, I can go over that.

DR. MOELLER: Although this is not my field, I realize you have been addressing certain of these questions. It seemed to me one of his basic questions was whether the diesel generators had adequate capacity, and whether they had every been tested with full load.

If we have heard that, I didn't, it went over me.

MR. MARINOS: When the plants were licensed, it was licensed, TVA had designated these machines as capacity of 4,000 kw. The machine, the kw is a variable thing depending on the power factor of the equipment that is being operated in the machine. If the equipment operated is more efficient, the kw could be larger. The set value for this machine is kva and

the machine is 5,000kv. This is something that does not change.

TVA discovered following the employee concern and allegations that--

CHAIRMAN KERR: Excuse me just a minute. Do you know what a kva is? Okay. Go ahead.

MR. MARINOS: They calculated their loading on the machine and they found that indeed they will exceed, the original tech spec exceeded 4,000 kw. It will exceed it by something like 350 or so kw.

How--they went back into the actual nameplate characteristics of the equipment that the machines drive, and they found that the power factor for those equipment is better than what the machine nameplate generally assumes as a power factor. The machine manufacturer generally assumes 80 percent for every one. The equipment had a better power factor, about average 88 percent, and that increases the capacity of the machine in kw to 4400. So TVA submitted a formal request for tech spec change. We evaluated that and we granted that change, and the machines now are capacity 4400, so that question is addressed that way.

(Slide)

CHAIRMAN KERR: A hundred percent power factor they would be even more?

MR. MARINOS: There is no such thing.

CHAIRMAN KERR: There is not such thing as a hundred percent power factor? Resistance is a hundred percent power factor.

MR. MARINOS: It will not be--inductive losses in the cable unless the resistive load is right at the--

CHAIRMAN KERR: I will settle for 99.8.

MR. MARINOS: Okay.

CHAIRMAN KERR: Does that answer your question, Mr. Moeller?

DR. MOELLER: Thank you.

MR. WYLIE: Well, I'm not sure. I think Mr. Hicks also raised the question of the adequate capacity in regard to the margin of switching loads on in sequence.

MR. MARINOS: I don't quite understand.

MR. WYLIE: Well, I mean one of his questions as I recall, I mean the ability of the machine to respond to the load switch, you go sequence of the loads on the loading with the machine, and the sequence--

MR. MARINOS: This is the area that we have addressed the other day.

MR. WYLIE: And I think he implied that the machine was not capable of doing that.

MR. MARINOS: TVA, of course, through the testing has demonstrated they can do it and through the analysis they, of course, compensated for the uncertainty of the full loading

requirement.

One of his questions was the requirements of Reg 108 which requires a 24-hour full load test. That is again part of the technical specification requirement that TVA routinely has to conduct the tests. They have done these tests and in fact they have done it for two hours at the emergency loading of the diesel generator which is a higher capacity than the continuous which is at a 4853 kw, and of course took the measurements of temperatures and required other measurements, and the additional 22 hours, they did the 4400 kv, kw.

MR. WYLIE: The calculations that have been submitted by TVA to the Commission that they performed show the transient loading of the machine, the margin. Now Dick, if you could give them copies of that for us?

MR. WARD: I am having a hard time hearing you.

MR. WYLIE: Dick is getting a copy of that for us if anyone is interested. I think TVA has a slide of the actual transient loading of the machine that they can show you.

DR. MOELLER: If you are satisfied, that's adequate.

MR. MARINOS: The other question you had, Mr. Wylie, about the, the sequencing, yes, indeed, TVA submitted a formal request for change of sequencing in containment spray. Containment stray was to start at 30 seconds, and they moved it to 180 seconds. We evaluated the consequences on the accident analysis basis for that delay, and we find it

acceptable, so that was a change in their sequence, and also there was another minor change in between component cooling water pumps and auxiliary pumps.

The component cooling water pumps were to actuate in the previous sequence within 20 seconds, and they moved it to 25, 30 seconds, and fuel pumps were actuated 25 seconds, were moved to more conservative, to 20 seconds, so to aid their response of the machine, so this was an acceptable change in the sequence, and there may have been another question that Mr. Hicks has raised.

And they also accounted for time in relay drifts in the timers. The timers that they have for the sequencer, they drift larger drifts than what they anticipated. From something like 5 percent that was anticipated previously, it has gone up to about 16 percent, and they have accounted for that. They have evaluated any potential overlap of components that may be accelerated or starting at the same time if the drifts were moved in the opposite direct, and they have demonstrated to our satisfaction that the equipment will perform adequately.

MR. WYLIE: Any other questions?

MR. MICHELSON: On what?

MR. WYLIE: On this. No? Well, I guess we are at the break.

CHAIRMAN KERR: This is a good time for a break,

ten-minute break. We will reconvene at ten after.

(A brief recess was taken.)

CHAIRMAN KERR: Mr. Wylie, what is the next thing on the agenda?

MR. WYLIE: Before we proceed, I would like to say that you know, we have received the allegation on the fire protection and the responses by TVA on the Sequoyah plant, and we have only recently received that, and we have looked at it in the time we have had.

We think that there are generic implications on that, and that what we propose to do is to refer that to our fire protection subcommittee for further consideration. We don't see that it is an item that would impact the start-up of Sequoyah, but there are some questions that need clarification and further discussion in this letter.

MR. MICHELSON: I think we would assume that TVA would be supportive of coming in and discussing those at that time, which would be somewhat later.

DR. REMICK: I assume we are investigating allegations?

MR. MICHELSON: No, I don't think so, as such.

MR. WYLIE: No. We are undertaking to consider the issues that are raised, but not allegations.

MR. MICHELSON: Since they may be generic--

CHAIRMAN KERR: What is the next presentation?

MR. WYLIE: The next presentation has to do with the discussion of the electrical cable installation practices at TVA, and I believe Mr. Marinos is going to address that.

MR. MARINOS: In the cable issue, again employee concerns regarding the TVA's cable installation practices and cable procedural deficiencies compelled TVA to investigate the installation of cables at the Sequoyah.

In fact the employee concerns were raised at Watts Bar. The TVA felt that similar concerns may be applicable to Sequoyah, so they engaged an investigation of the cable installation practices and the NRC reviewed TVA's documentation, and hired consultants. This was prior to the establishment of the Office of Special Projects, and this was a project that was carried by the Office of Nuclear Reactor Regulation. NRR hired Franklin Institute as consultants to evaluate TVA's cable practices, cable installation practices. They issued a technical evaluation report which they submitted to NRR. NRR transmitted that technical evaluation report to TVA and asked TVA to evaluate the recommendations made in that technical evaluation report and prepare a course of action to establish the integrity of the cables.

Of those, there were eight recommendations, three of which were considered important to be addressed prior to restart of Sequoyah 2, and I have identified these concerns here as cable jamming, and this relates to cables that are

placed in a conduit there generally, and the overall diameter of the cables may be too close to the diameter of the conduit, and as the cable is pulled through bends, the cable may fall in line and cause jamming as you pull it through and affect the cable integrity, the cable insulation integrity.

Another concern relates to cable pull-bys, and that relates to cable pulled through conduits with cables already existing in the conduit. In the process of pulling these cables through, cable insulation damage may occur to cables that are already present in a conduit.

A third concern was cables that were resting on a very sharp 90 degree condolet they call it, and the sheer weight of the cable may have damaged the insulation at the point of contact at that 90 degrees.

In order to address these concerns and resolve the issue, TVA and NRC met on March 13th of '87 to discuss a method for resolution. The NRC staff proposed that TVA conduct a high voltage testing, put a high voltage surge through the cables at 300 volts per mil of insulation thickness, and observe the response of the cable. If the voltage was not held, and the cable shorted, that will be an indication of cable, of insulation damage.

TVA countered NRC's proposal to conduct these tests at 240 volts per mil rather than 300.

CHAIRMAN KERR: What is the working voltage of these

cables?

MR. MARINOS: These cables are 600 volts rated cables. They may be operating on 480 volts or a 120 volts AC.

CHAIRMAN KERR: Thank you.

MR. MARINOS: The genesis of this test is first of all, the recommendation by NRC was based on cable tests conducted by, routinely by the venders that produced this cable as final qualification of the cable. Each cable is, goes through this 300 volts per mil test before it is shipped to the plant.

TVA's 240 volts per mil recommendation was based on an IEEE Standard 383 which requires a qualification, prototype qualification for cables before they are accepted for service in nuclear service.

This is 80 percent of the manufacturing test. The staff accepted TVA's proposal, and TVA conducted some tests on silicon rubber insulated cables in the containment on April 8th. On April 8th, they gave us the, their proposal for conducting the tests.

(Slide)

MR. MARINOS: The tests, actual tests were conducted on April 22nd on 16 single conductors in one conduit of silicon rubber insulated cables. Of the 16 cables tested, they observed three failures. Three cables actually shorted the ground.

TVA following those plants, evaluated the cable test program and they decided that perhaps that was too severe of a test. They came back to the staff and proposed a revision to that cable test program, essentially reducing the actual voltage applied to the cables from then on.

The basis for the reduction, the request for reduction on voltage was that TVA research industry had discovered that in the cables of similar design, they were qualified to 240 volts per mil, but a lower nominal thickness than what the actual nominal thickness of TVA's cable is. The rationale in that is that although TVA has purchased cable with 45 mils insulation thickness, it is, it was a choice that was not necessarily safety-related. There was no, it had no significance in the integrity of the cable. It just purely was a choice of thicker insulation, not necessarily needed for the service, while other utilities had purchased cable with less thickness by 30 mils, and the cable was accepted by the staff, qualified at that nominal thickness, so we accepted TVA's revised cable test program. TVA continued to apply for additional tests, 240 volts per mil, but the multiplier now was not 45 mils. It was 30 mils, so the voltage, the actual test voltage was reduced by that amount.

CHAIRMAN KERR: Seventy-five hundred volts?

MR. MARINOS: That is correct--7200 volts; the original voltage was 10,800 and reduced down to 7,200.

Using the new criteria, TVA conducted tests outside containment on cables that had other than silicon rubber insulation, and all tests as I have listed them here for pull-bys. There were 878 cables tested. For jamming there were 45 cables tested. All passed the test.

Additionally, TVA, of course, conducted a test for, on silicon rubber insulated cables inside containment, and I have listed here samples for the three different manufacturers--AIW, American Insulator Wire Company, Anaconda and Rockbestos. For the AIW, they recorded four more failures as the earlier test of the 16 that were done on the original program were also AIW.

In the Anaconda they registered no failures. In the Rockbestos, they registered three failures. Since that time, they reclarified that actually one failure of the three in Rockbestos was legitimate. One failure that they reported to us was merely an error on the part of the instrument engineer, that he had not set the instrument on the proper range, and it went out of scale. And the other, another failure was disputed because of the fact that it was based on polarization index and not on an actual short to ground, so since then, TVA has indicated that only one failure in the Rockbestos cable was, has occurred. Any questions here?

MR. LIAW: Let me add a couple of clarifications here. First, the voltage, Mr. Marinos is talking about DC

voltage. Earlier Mr. Kerr asked a question about the service voltage, AC.

Second, the selection of conduit we tested for different concerns was based upon the configuration of the conduit, the bends, that kind of thing, so for jamming, pull-by and voltage property, they have different sample so we are not talking about the same population.

CHAIRMAN KERR: Thank you.

(Slide)

MR. MARINOS: Following these additional cable tests, TVA issued a preliminary ten CFR Part 21 report and indicated that the silicon rubber insulated cables may have a generic defect and indicated to the staff it may not be just unique to TVA, and not related necessarily to the cable installation practices of TVA, but it may be a generic problem with anyone's practices, so the staff should evaluate the broader aspects of this problem. And at the same time, TVA initiated a test at Wyle Laboratories and in that test, they have taken uninstalled cable that they had on a reel at the plant, they shaved insulation to various thicknesses that they anticipated might have, cable at the plant may have been damaged to, and they put it through a LOCA test.

Following those tests, TVA had taken the cables out of the autoclaves at Wyle. They performed high pot tests just like they have on the installed cable, and the cable passed

the tests.

They measured the thickness of the cable that was put into the autoclave, and they measured the cable to have thicknesses as low as 4 mils and up to 6 mils for the various manufacturers as I have listed down below here.

TVA met with the staff and presented those results and determined from those results of the Wyle tests that--let me find my other slide.

(Slide)

MR. MARINOS: TVA in connection with the test resykts from Wyle, they evaluated some industry standards, ASTM Standard D-149 and ASTM 3755 in an attempt to explain discrepancies between the high potential withstand of cables following the Wyle tests and the inability of cable in the plant to withstand lower voltages during tests.

They determined in evaluation of these standards that materials behave, insulated materials behave differently as the thickness increases. The unit values that they can withstand at the particular thickness of insulation is different as the insulation is diminishes. The lower thicknesss of insulation can withstand higher per unit values than thicker insulations can withstand. So on that basis, TVA proposed no further work to be done on cable at the plant, and they declared the cables in the plant adequate to perform their safety service.

At this time, TVA has replaced, however, all the AIW cables in the containment, and has retained the cables of Rockbestos and Anaconda insulation.

We have accepted TVA's conclusion for restart at the plant at this time, but we are evaluating the long-term requirements for cable that remains in the plant.

Any questions?

MR. WYLIE: What do you mean you are evaluating the long-term?

MR. MARINOS: The Wyle tests were conducted, the cable was irradiated for only ten years before it was put on the autoclave and applied at, LOCA conditions applied to it. As a minimum, we require that the cable, of course, be qualified for the remaining life of the plant.

MR. WYLIE: The original cable was qualified?

MR. MARINOS: The original cable was qualified, yes.

MR. WYLIE: For 40 years?

MR. MARINOS: For the 40 years.

MR. WYLIE: Using IEEE 323?

MR. MARINOS: TVA qualified these reduced thicknesses of insulation as the 4 mils and 6 mils to a ten-year irradiation. They put it in the autoclave and ran the LOCA test on it, so for these thicknesses of insulation, there is only, the only data for ten years. There is no 40-year data for that, for that level of insulation, so

therefore, if the cables at the plant have reduced insulation as a result of the practices at, the bad cable installation practices, we only have confidence now that they are good enough for the ten years, so TVA would have to establish the confidence for the remaining life.

MR. WYLIE: Well, do you plan any further in situ testing or does TVA plan any?

MR MARINOS: TVA, they have not told us yet what they are planning to do. We are investigating that with them right now.

MR. WYLIE: I mean is it the intent to do anymore testing?

MR. MARINOS: I don't know.

MR. FOX: TVA has no intent to do any further in situ testing.

MR. WYLIE: Any testing at all?

MR. FOX: We will go ahead and qualify the silicon rubber cables for the remaining life of the plant. We established based on the failures that we observed in the silicon rubber cables, the lowest thickness of insulation that we observed in seven post mortems that we did on failed conductors, 8 mils was the thinnest insulation that we saw. That was the basis for taking the cable off the reel and qualifying at Wyle.

MR. WYLIE: So you intend to go ahead and complete

that test?

MR. FOX: We will complete the qualification for the remaining life of the plant, yes. It had been our intent to take cable off the reel as we had done for these Wyle tests, thin it down to the minimum insulation thickness that we observed in the failed conductors that we took out of the plant, and then qualify that for the full 40 year. That was our intent.

MR. WYLIE: That is still your intent?

MR. FOX: That's our intent at this point in time. I understand that there may be some request from someone at staff, NRR as part of the generic resolution is considering having us remove installed cable and test it.

MR. WYLIE: Is that right?

MR. MARINOS: Yes. This is a possibility. We are--

MR. WYLIE: Why remove installed cable?

MR. MARINOS: The premise that TVA has based their decision not to do anymore tests is that they have decided that having thinned the cable insulation down to 4 mils, this has got to be the worst case. We could not have damaged cable beyond 4 mils of insulation. This is the premise that they have used in order to validate their conclusions.

We have no basis to argue with that. However, this is, the testing done was on the cable that was not installed. It was an uninstalled cable and they translate their results

to the cable that is installed. There are sericus concerns about their practices, so the cable may have 4 mils of insulation, may not have 4 mils of insulation.

MR. WYLIE: When you pulled out a bunch of cable, what did you find?

MR. FOX: We carefully removed the cables that had failed, the conductors that had failed, and examined the vicinity of the cable. That's how we came up with 8 mils minimum used thickness. We did not examine all cables that we took out of the plant when we were replacing AIW. The reason that we replaced all the AIW was that we had to make that call at that time, in order to protect what at that time appeared to be the schedule. We did not have the Wyle test results at that time. Had we had the Wyle test results, we would not have removed the AIW cable since we qualified it with 4 mils of insulation.

CHAIRMAN KERR: How much cable will you want to have them remove to demonstrate that 8 mils or 4 mils or whatever is an appropriate figure?

MR. MARINOS: We decided if TVA were to remove a cable configuration, the conduit, that the worst case--what I mean by that, a conduit configuration where it has many bends, long runs, and take pieces of that cable, ten pieces perhaps, and put it through the, through the LOCA test without any reduction in insulation, just as the cable was taken from the

plant, and tested at Wyle, at the same conditions as they tested the uninstalled cable, it would increase our confidence that the cable as installed has the capability to withstand the conditions that are expected at the plant.

MR. WYLIE: Isn't it highly probable you are going to damage it taking it out?

MR. MARINOS: This has to be done carefully, that is correct.

MR. WYLIE: If it is done, put in, now you are going to take it out, it seems to me like there is a high probability you will damage it when you take it out. Then you will prove nothing.

MR. MARINOS: TVA gained experience when they removed the first 16 cables at the plants where it occurred. The three failures did not indicate that they had any damage added to these cables from their removal, so I believe that they can do that.

MR. FOX: Well, we knew that those cables had failed and we knew within just a foot or so exactly where those cables had failed. We homed in with successive high pots on the area where these plants occurred. We knew where they were and we could carefully remove and examine the section, the short section where the failures had occurred. That was easy to do. We are, we share your concern, Mr. Wylie, that we might induce damage by removing the cable.

MR. WYLIE: All passed the tests now?

MR. FOX: Yes, sir. We feel like our cable installation practices were vindicated by the test program. There was no evidence of cable damage due to vertical, unsupported vertical cable, pull-bys or jamming, and we have tested thousands of conductors that way and found no evidence of any damage due to any of the three concerns or any of the three restart considerations in our cable test programs. We felt like our cable installation practices were shown to be satisfactory by that test program.

MR. MARINOS: The unresolved questions that the staff still has for TVA's installation is the fact that cable when tested to full withstand capability, it goes up to fifty, between 50,000 to 80,000 volts before it breaks down. The cable at the plant is tested at 7,000, and it fails, so we have really no good answer for that happening.

MR. WYLIE: This is cables that are left in there you have tested and they passed.

MR. MARINOS: The cables that were also removed, as Mr. Fox indicates, and they actually tested, had to break down the good portion of the cable, not the one that failed already. That cable when it came out of the plant also was able to withstand between thirty-five and 50,000 volts.

CHAIRMAN KERR: Mr. Marinos, you don't need the cable to withstand 7,000 volts. You only need it to withstand

something like maybe a thousand volts at most.

MR. MARINOS: That is correct, but this voltage is a gauge of thickness of insulation is the--we have no means to establish how much thickness there is in isolation, and the voltage test is a good conventional way to do it it.

CHAIRMAN KERR: Assume insulation evaporates over the years?

MR. MARINOS: No, doesn't evaporate. It gets brittle and loses it dyelectric strengths. Technically when moisture is attacking the insulation, you can lose it, it doesn't matter how thick it is.

CHAIRMAN KERR: That will occur whether it is in the plant or on a spool, won't it, if it is just a matter of aging? You don't have to get in-plant cable to determine that, do you?

MR. MARINOS: But we are talking about cables that may have been mishandled during the installation, mishandling of cable during installation that may have lost the dyelectric strength through physical damage.

CHAIRMAN KERR: Won't you see that in, in the tests that have just been done?

MR. MARINOS: The test that has been done is on cable that was not installed.

MR. WYLIE: No. You tested up to 7 kv and spliced, did you not? They passed.

MR. MARINOS: Some of them passed.

MR. WYLIE: All of them passed that were left in there.

MR. MARINOS: They didn't test them all. That's all--they tested the ones that we are talking about.

MR. WYLIE: I am confused.

MR. FOX: We tested--Ken Brown, our electrical test engineer, is here. We tested approximately 90 conductors of silicon rubber?

DR. MOELLER: What percent of the total were tested?

MR. MARINOS: The cables at--TVA can answer that.

MR. FOX: I will let Ken Brown, assistant branch chief of the electrical discipline, speak to that.

MR. BROWN: Yes--just got a promotion. I am senior electrical engineer.

MR. FOX: You did a good job on it!

MR. BROWN: See what he says after I answer the question!

The name is Ken Brown. I am senior electrical engineer in the Electrical Engineering Branch involved with the cable testing.

In Sequoyah Unit 2, the silicon rubber insulated cables in 10 CFR 5049 service, there are approximately 180 of those cables now. Conductor count, that would be approximately 900--we tested I believe it was 91 or 92

conductors.

MR. WYLIE: What was your criteria for selecting the ones that you tested?

MR. BROWN: Initial tests that were done for the silicon rubber cables were with regard to a lack of vertical support, so we went out and found our worst case installation configuration. That is where we had a, the longest vertical drop and also a high percentage of fill within that conduit, meaning that the bearing pressure would correspondingly respond the highest, so we looked for a conduit in containment commensurate with the containment environment that would have a long drop, 90 degree condolet at the top, and a large percentage of fill. That was our initial silicon rubber test. That was the test Mr. Marinos referred to being conducted at 10,800 volts.

Subsequent to that one, we had determined through an isolation process after our initial failures that we would continue to isolate. We found that failure point, and we conducted with the failures isolated, but with the cable still bearing on that condolet at the top of the run. We established conclusively that it was not due to lack of vertical support for which these cables failed. They passed the test without it ever changing configuration at that point.

MR. MARINOS: The staff has no contention about this.

MR. BROWN: We agree with that, so at this point, we did our post-mortem, we established that it appeared that some other mechanism was involved, postulated that it could be some kind of impact phenomena that had occurred.

We expanded our sample of silicon rubber testing. The criteria at that point was set to evaluate cables based upon length and number of bends. What we were looking for in that regard, we said that if we believed that it was some kind of impact and it could perhaps, it could have been at the factory, could have been shipping, could have been in storage, could have been in handling before we put it in, or perhaps during the installation process, pull it halfway in, let it hang out of the conduit overnight, something, we don't know, but we said in order to find problems if they are there, what would be the scenario that we would follow?

So we said the longest length because whether you are talking about cables on reel, cable spool, out on the floor in the cutting process, or cables that might be left hanging out of the condolet overnight, the length again gives you an increased chance to find any damage if it is there, so that was the scenario that we followed for the supplemental silicon rubber testing involving I would say about 75 conductors, and those were the ones which had the additional failures that Mr. Marinos has described.

By the way, just one point of clarification, we

talked about test voltages earlier as either being initially 10,800 and subsequently at 7200--we will note that the AIW cables, their subsequent tests were conducted at 9,600 volts.

If I might also add one point, discussion about why would cables pass at one voltage at the factory and pass at another voltage or fail at a much lower voltage at Sequoyah, again, the lowest breakdown that we experienced was 7,000 volts in a conduit. Mr. Marinos mentioned our discussions regarding a couple of standards, ASTM 149 and D-3755 which were the subject of some discussion back in the November meeting.

In that meeting, we pointed out that this standard recognized as well as we, and industry experts were there supporting us, that a test of a cable in a dry conduit may in certain instances be actually more severe than a test in a wet conduit due to the distribution of voltages or distribution of stress in the absence of a uniform ground plane. At that meeting, we accepted temperature from one cable manufacturer and one industry test expert who indicated that it was possible in a dry conduit situation to see two or three times the voltage stress at localized points due to the absence of uniform ground plane, and in recognition of that, we believed that this could account for some of the breakdowns at levels between 7,000 and 10,000 volts.

MR. MARINOS: However, that voltage corresponds to

an insulation thickness even with all those conservatisms and uncertainties that you place, of insulation level about 4 to 5 mils. These cables in the plants had nominal insulation of 45 mils, and it is not easily explainable how this cable in spite of all this concentration of charges that you place, can fail with 45 mils insulation, at 10,000 volts or 7,000 volts. That is not explainable by these standards or any analysis that you provided, because the nominal insulation is 45 mils. And if you were to divide by 45 mils, that cable fails at a hundred volts per mil or even less.

MR. WYLIE: Well, do you expect it to be linear? I don't.

MR. MARINOS: I don't expect it to be linear, but this far non-linearity I believe--

MR. WYLIE: Low voltage cables, right?

MR. MARINOS: Low voltage.

MR. WYLIE: They are not designed for high voltage. They have no strand shielding, no external shielding. You don't get uniform voltage.

MR. LIAW: Can I respond to what you say? Yes, I do not expect behave linearly. However, from the removed cable that TVA took the first time, tested 16 cable, and some of the cable was tested by Connecticut Laboratory, averaged out something like 1700 volts per mil thickness, AC test. I'm sorry--DC test. We will talk about DC tests.

MR. FOX: These voltage anomalies are very confusing.

MR. LIAW: Roughly 1700 volts per mil DC, so I guess what Mr. Marinos is saying is you pick a number and we were about 7,000. The best you can say is you have at least roughly 3, 4 mil thickness remaining. I know that kind of discussion, there isn't much to it. That's the reason why we are saying that despite all uncertainty, TVA has done additional test at Wyle, qualified the cable for ten years period as low as something like 2 to 4 mils, and that will be the basis we approve to restart.

However, licensed condition because of the remaining Rockbestos Anaconda cable that are left there with regard to damage, possible damage mechanism, something to what Mr. Brown was saying, Mr. Marinos in his slide shows three principal damage mechanisms--jamming, pull-by, and voltage. You look at TER, there was one additional concern which could be causing damage. That is the lack of control for tension which our consultant, Mr. Garner, indicated several times to us and to TVA that because of that, by not controlling the pulling tension, and as you pull through bends, a corner, you could damage the cable, and I think to some extent that is not fully addressed.

MR. WYLIE: What you are concerned about then is to, trying to establish you have other cables damaged physically

by pulling them, not whether or not insulation--

MR. LIAW: That is correct. I don't believe there is such thing as scientific precision in this business in terms of pulling the cable.

MR. WYLIE: Are you concerned, though, that there is damage in the cable or that there is damage--

MR. LIAW: We--possibly some damage. What we tried to do is even if there is damage, remaining thickness is good enough.

MR. WYLIE: How much are you talking about?

MR. LIAW: Pardon?

MR. WYLIE: How much sampling are you asking for?

MR. LIAW: Like Mr. Brown, say for silicon rubber cable we roughly took sample.

MR. WYLIE: The additional testing.

MR. LIAW: Additional test, what we are talking about, before we talk about that--let me explain one thing for clear.

Mr. Fox say something about AIW cable were removed, and just for record, TVA is the only one that used AIW cable. We have recently conducted shop inspection at AIW facility. We were told that they have not or they have not supplied silicon rubber cable to any other utility, nuclear utility I mean, than TVA. That's another piece of data there.

CHAIRMAN KERR: Actually this testing, it seems to

me that you are putting a lot of emphasis on the voltage per mil of thickness and what you want to establish it seems to me is the capability of this cable to withstand the voltage, not a voltage per mil.

MR. MARINOS: For additional test that we are proposing, that addresses exactly that question that you are posting.

CHAIRMAN KERR: You are worried about the fact that you have got a different voltage per mil in cables of different thickness. This is not necessarily indicative of anything it seems to me unless you are certain that that insulation is very uniform. You could have non-uniformity.

MR. LIAW: I agree wholeheartedly. You might recall--

CHAIRMAN KERR: Seems to me the argument is based on poorly--

MR. LIAW: Now wait a minute, please.

CHAIRMAN KERR: You wait a minute. It seems to me if the argument is based on voltage per mil, you don't have a lot of significance.

MR. LIAW: I agree with you. If we had to start over again, we probably would not agree to TVA with that. You recall TVA was the one that proposed that. When OSB took over, we said pick it up and go from there. It is up to them. They had seen restart, you know, revisit the issue, and the

only thing we really have to hang our hat on is for them demonstrated that indeed they had cable there which are able to meet regulatory or design function, okay, so in answering Mr. Wylie's question, Rockbestos, Anaconda which were left there, we were talking about something like 5 inch, 5 inch, and irradiated segment, five segment each of the kind, and irradiated to the full remaining life of the plant, and then hit with LOCA environment.

MR. WYLIE: How many cables?

MR. LIAW: Five segment each, sample.

MR. WYLIE: Out of? One circuit or five circuits?

MR. RICHARDSON: We would go into the conduit that looks from a physical arrangement to represent the worst case with geometric bends and vertical runs. We would open that up and take out five different samples that we would then subject to--

CHAIRMAN KERR: We will discuss this testing in the future at some other time. It certainly seems to me that we ought to give some thought to what you are looking for.

MR. LIAW: We understand that. The concern originally came from Watts Bar and we were talking, we are talking with TVA to the extent that possibly get some cable out of Watts Bar site rather than at the Sequoyah 2.

CHAIRMAN KERR: I think all of us agree that cable capability to do what the cable is designed to do is

important. The question here is how you want to try to achieve the confidence.

MR. LIAW: That is correct.

MR. MARINOS: I want to add another point, Dr. Kerr. For the record, these cable tests, techniques are not wrong. They are a good rule of thumb. The electrical industry has used it for many, many years, and just because it has not served TVA's purposes at this time, we cannot just throw it away. We don't throw the baby away with the bath water. It is used routinely for tests.

MR. WYLIE: What is used?

MR. MARINOS: High pot test.

MR. WYLIE: Not on low voltage cables.

MR. MARINOS: It is used--may not be used o low voltage cable, but it is used for medium.

MR. WYLIE: Use a low voltage test. These are low voltage cables. And do you not agree that high pot testing is a destructive test?

MR. MARINOS: TVA established that it was not a destructive test.

MR. WYLIE: I disagree with TVA. If you put--

MR. FOX: It has not taken that position.

MR. WYLIE: It is a destructive test.

MR. MARINOS: TVA stated to us in a public meeting--

MR. WYLIE: These cables are not designed for high

voltage, and all it takes is like 2,000 volts per mil in there to start corona and you could burn the cable.

MR. FOX: The IEEE, some of the authors of IEEE 383-1974 have told us that that was never intended for testing installed cable, and it was, it was created as a type test.

MR. WYLIE: Let me make one other comment as far as testing installed cable goes.

The NRC Research Branch has spent millions developing techniques for non-destructive testing of electrical equipment in service, and they have at least three programs going in that area, and some of which are commercially available today for testing, and it is low voltage high frequency testing to assess the condition of the complete electrical circuit, including the cables and motors and the whole works. It seems to me before you go to high pot cable and other equipment in plant you certainly couldn't--

MR. MARINOS: This is not a breakdown voltage, so I don't believe that, and I want to correct the record. Mr. Fox on September 10th in the public meeting in Chattanooga, TVA reported to us that they conducted a number of high pot tests on cable, and they measured the current on the cable. They found there was absolutely no change, and they reported to us they believe that these high pot tests that we have all agreed upon to test the cables at TVA were not destructive of the insulation, and this is on the record at the September 10th

public meeting.

MR. FOX: That is correct, Mr. Marinos, but a lot of things have happened since September 10th. We were very active in the October, November timeframe with industry experts on table testing. Mr. Brown and Mr. Raughley spent an extensive amount of time with the IEEE, ICC Committee, and you know, we, our judgments have changed somewhat.

MR. MARINOS: That was based on cable testing.

CHAIRMAN KERR: Just a minute. Are you finished, Mr. Fox?

MR. FOX: All I am saying is that we have since been, since we made those statements in September, we have been been advised the IEEE standard was never intended for use that way. And IEEE ICC Committee has said that there is no accepted industry standard from their perspective for testing in situ cables, and they are in fact working on such a standard. I believe, Mr. Raughley, they indicated sometime this summer they hope to have such a standard. So we stand corrected.

MR. MARINOS: It was engineering judgment by TVA. It was an actual test conducted on a number of cables from which you decided that there was no cable damage from these high pot tests.

MR. WYLIE: How do you know?

MR. MARINOS: I beg your pardon?

MR. WYLIE: How do you know?

MR. MARINOS: They reported that to us.

MR. WYLIE: I know, but how do they know?

MR. MARINOS: They measure leakage currents.

MR. WYLIE: They don't know whether they are damaged or not.

CHAIRMAN KERR: Any further comments or questions on this topic? Does that complete your presentation?

MR. RICHARDSON: If I could just summarize, we understand that we do have to do some more work in defining the final test plan that TVA has to use, and the bottom line is we did find a situation in Sequoyah where there was reduced insulation thickness. TVA has conducted a test program at Wyle to give us and the short-term acceptable results of the installed cables are acceptable looking at the long-term resolution of that.

CHAIRMAN KERR: All right. Further comments? What is next, Mr. Wylie.

MR. WYLIE: Okay. We have additional questions in the, attached to our agenda. I believe TVA is going to address those. How do you want to do--do you want us to ask questions and you respond or are you ready to respond as the attachment shows?

MR. FOX: We are ready to respond. The first question is on PRA, and Doug Wilson, chief of our Nuclear

Technology Branch is the speaker.

MR. WILSON: The question was, that we received is has PRA, PRA insight used in the safety evaluation of TVA's operations, has this met methodology combined with the deterministic method--I'm sorry--deterministic design practices and analysis?

As you can see from the slide, TVA has conducted an independent plant evaluation, or an IPE, for Sequoyah nuclear plant, and Sequoyah is not an outlier plant as a result of this IPE.

At this time, TVA does not have a PRA for Sequoyah. Therefore, PRA uses on site for safety evaluations are limited to those cases in which we develop a specific analysis for a specific case.

Sequoyah as well as other nuclear plants used deterministic methodology as laid out in 10 CFR 50, Appendix A, and developed design practices and analysis, and we used PRA to augment this process by evaluating the, between choices or alternatives.

This allows us to enhance availability, maintainability, but it as pointed out earlier, we did not have a PRA for Sequoyah. Therefore, there is a limitation on the combination of deterministic and PRA at this time.

The TVA in the near future will make a decision on whether to develop a Level 3 PRA for Sequoyah depending on

some of our internal process and on guidance that we receive from the NRC and positions that are shortly to be focused, as we understand.

Are there any questions I can try to answer for you?

CHAIRMAN KERR: Do you have a Level 1 PRA for Sequoyah?

MR. WILSON: No, sir. We have what our PRA experts call a Phase 1, which is basically very similar to the IPE where we looked to see if there were any outliers in the Sequoyah design, but at this point, we do not have a Phase 1 design, PRA.

CHAIRMAN KERR: Do the, do you plan to do a Phase 1 independently of what NRC may require?

MR. WILSON: Now you mean Level one, right?

CHAIRMAN KERR: Right.

MR. WILSON: I called it Phase 1 so I got you mixed up. That decision, Dr. Kerr, will be made by TVA based on the decision that the NRC comes out with--supposed to be soon--plus our own internal.

CHAIRMAN KERR: My question was are you planning to do one independently of what NRC may require?

MR. WILSON: Mr. Fox may correct me, but at this point that decision has not been made whether we will or not.

MR. FOX: We brought in Westinghouse over a year ago to do this IPE and also to deal with the questions that were

raised by NUREG 1150 as they pertained to Sequoyah. We feel like that was a good assessment and we have no plans at this time to do a PRA for Sequoyah.

CHAIRMAN KERR: Do you have an in-house group that would understand the implications of a Level 1 PRA and its possible application and operations?

MR. FOX: Yes, sir.

CHAIRMAN KERR: It would seem--

MR. FOX: We have done PRA work associated with the Browns Ferry plant.

CHAIRMAN KERR: But you haven't found it useful enough so that you want to do one for Sequoyah I take it?

MR. FOX: The PRA that has, was done at Browns Ferry was, has not at this point in time been completed. This PRA was done using combination of TVA in-house people plus Pickard, Garrick and Lowe, Mr. Garrick and two or three people, that TVA has pointed out that the January '86 PRA that they were principally involved in was unfinished, and was not up to their standards, and was never intended for submission to the NRC. So that's incomplete.

Now our staff has in fact done a September--

CHAIRMAN KERR: Let me, my question is not aimed at what the NRC will require or want. I am trying to find out whether TVA has found PRA to be useful or not worth the effort.

You have already done, spent a lot of money let's say on Browns Ferry. You must have decided that either that money was well spent or it is a waste of money, and I would judge what you do at Sequoyah depends a little bit on your judgment about whether the Browns Ferry PRA was useful.

MR. FOX: The Browns Ferry PRA has not finished its review process. The January '86 PRA was never finished. Our staff did turn out a September 1987 PRA. That PRA is being reviewed internally, management, by management and the technical people, and it is being given a peer review. In fact, we have discussed possibly using another national laboratory to help us conduct that peer review with NRC staff. We have not made a judgment about the use of that PRA since it has not been complete. PRA in our opinion is a very useful tool for--

CHAIRMAN KERR: Up to now in the process of preparing it you didn't find out anything about Browns Ferry that was useful I take it? Because you seem to be waiting until it is all finished before you make any decision.

MR. FOX: I don't want to make a judgment on the usefulness of that PRA. Certainly it would be useful for sparing, for prioritizing maintenance, and this is, the PRA people have done some work to help us prioritize maintenance. This particular tool is still not reviewed and cleared or released for use within TVA. Our intent is to finish that

review, and to submit it to the NRC and to use it internally in our corporate maintenance programs for all the sites.

CHAIRMAN KERR: But you haven't found it useful. As you say, those things you might emphasize in training, possibly even in changes in the plant that you might want to make in the future, or things of this kind, which at least in other, at other installations have occurred during the process of preparing a PRA. That hasn't occurred as far as TVA is concerned I take it?

MR. FOX: It has been, that technology, the model has been used at Browns Ferry for doing maintenance priorities. And that technology is being used.

CHAIRMAN KERR: That's the only use you have found for it at Browns Ferry?

MR. FOX: And also determining sparing philosophy.

CHAIRMAN KERR: Okay. Thank you.

MR. EBERSOLE: Can I ask a question?

MR. WILSON: Yes, sir.

MR. EBERSOLE: Are you contemplating doing an ISAP in the longer term for your TVA plants?

MR. WILSON: We just recently received a communication, and I really have forgotten who it is from. Dick, do you remember who that ISAP was from? Anyhow, there was a question on ISAP, and we responded to that ISAP questionnaire and indicating our interest in all four of our

plants, and with Browns Ferry being our first priority on ISAP. Tom, Joe, do you remember who it was?

MR. ZIEGLER: Joe Ziegler out of Chattanooga TVA--it was a generic letter just recently published by NRC. It was a survey. I believe that survey was in the response from--the staff made the presentation, just to seek, I think the Commission is trying to make a decision as to what the, probably the question was being asked here is PRA worth it? And if we pursue this endeavor, for NRC to pursue it, will the utilities participate? And that's why the questionnaire was sent out, and I think we--I don't know our response is in yet. I think we have said some things like we are interested.

MR. WILSON: Our preliminary response said we are interested. Our first answer is Browns Ferry plant.

MR. EBERSOLE: In the absence of such a documentive effort, how do you exhibit the fact that you are doing appropriate and adequate system integration in your plants?

MR. WILSON: Mr. Kirkebo, would you answer that? There is a questionnaire, I believe.

MR. FOX: Number 3.

MR. WILSON: Mr. Kirkebo will try to answer that for you.

MR. EBERSOLE: One would answer that you would be doing something like an ISAP to so illustrate.

MR. WILSON: Yes, sir.

MR. EBERSOLE: Answer it now or later, doesn't matter to me.

CHAIRMAN KERR: It is related to number, slated for No. 3.

MR. EBERSOLE: I will wait on that. Let me take a case in point in ancient history. I pick a case where a localized PRA might present a fascinating basis for doing needed changes.

You all well remember--you know what I am going to dig up. It is these three critical lines that exist in your plants that intercept a variety of critical equipment, that is pressurized and in one case they are working. That's the HPCI line, the 10 inch supply, the RCIC steam line reactor water clean-up.

CHAIRMAN KERR: Are we talking about Sequoyah now?

MR. EBERSOLE: I am talking, I can talk about this in the context of Sequoyah reactor water clean-up and also the RCIC steam supply, but I want to point out--

MR. WILSON: Jess, that's Browns Ferry.

MR. EBERSOLE: Well, wherever.

MR. WILSON: I don't mind trying to answer it, but it was Browns Ferry.

CHAIRMAN KERR: I was hoping we would stick to Sequoyah.

MR. EBERSOLE: There were certain pressurized lines

at Sequoyah.

MR. MICHELSON: Auxiliary feedwater turbine steam lines.

MR. EBERSOLE: And it is easy to extrapolate this to anywhere. As late as last Monday, we were given a rather convincing evidence that the hope that interceptor valves, isolation valves, would function under the duress of full open circuit flow, would have marginal deficiencies in the order of 30 to 40 percent, not being able to close in the event they were faced with the problem of intercepting steam flow such as you might have experienced some years ago on the HPCI line at Browns Ferry, I am picking that in a generic case.

It would appear to me that it would be not merely conservative but perfectly rational and required that you would look at the, that particular situation of PRA context and satisfy yourself you wouldn't be led into a really terminal disaster case of unimaginable proportions where you would first destroy the primary integrity, discharging the fluids into working equipment spaces, and then be unable to close the discharge of that fluid, thus leading regressively to the loss of pumping equipment that would restore your coolant system.

Have you in fact looked at any plant in the PRA context whether you hope to get those valves shut against the very low probability that you are going to have to, but

against the very large consequential potential?

MR. WILSON: Jess, to the best of my knowledge, we have not looked at such a consideration at Sequoyah, in conjunction with those valves, but as you know, that whole system going to the turbine driven aux feedwater pump at Sequoyah, there are a number of sets of valves in it that are required to isolate, and I recall in the past that we looked at those valves to make sure that they, that there was enough data to show they would close on the appropriate flow characteristics, and the fact as you recall, we even have temperature detector in that room that will automatically close those valves if we get a steam leak into the room.

MR. EBERSOLE: They should close early on. What has been, your method of verification has been almost entirely done analytically, and the classic equations that have been used to illustrate your closing capability have been found to be at least I heard Monday, deficient by a factor of something like 30, 40 percent.

MR. WILSON: I am not aware of that.

MR. EBERSOLE: You can't show me any experimental results that you can do this? You are relying on these apparently inadequate and ancient analytical formuli?

MR. FOX: Could you elaborate on when this problem came to light and is it an industry problem?

MR. EBERSOLE: As an industry problem, came to light

about 20 years ago at TVA.

MR. FOX: Can you elaborate on the problem?

MR. EBERSOLE: I will have to use Browns Ferry. You have a 10 inch main that runs through the HPCI pump. You unlike the other people, that there are also others who do this, maintain this 10 inch line in the full steam pressure. At '74 you almost lost this line when a tornado came along.

MR. FOX: I wasn't there so I am not familiar.

MR. EBERSOLE: It was just an interesting evolution that took place that did introduce the challenge. You could just say that the challenge of losing it, just a spontaneous and unexpected event.

If you lose it, I think the least you need to do now is examine the consequence of prolonged discharge in the event your valves are shut. And I say that against this new information I have had just last Monday, that the classic formula that you will probably use to illustrate these valves will be, is deficient by 30 or 40 percent in the aspect of closing forces.

CHAIRMAN KERR: Mr. Ebersole, isn't the concern the forces that exist if you have a completely severed line and full flow?

MR. EBERSOLE: That's the classic case.

CHAIRMAN KERR: That's a concern I think.

MR. EBERSOLE: You can, first you want to show that

it doesn't matter. You can survive that, and you could if you design the plant configuration to discharge it to outer space, but you don't, so it regressive. It comes into the machine, machinery spaces, and as far as I know, it might even progress to the oil-free members up to 565 and downward and so on. Anyway--

CHAIRMAN KERR: Mr. Ebersole, can we show this is the problem at Sequoyah or it isn't a problem?

MR. EBERSOLE: At Sequoyah it is a more modest problem, the fact that you don't have the steam supply on the side.

CHAIRMAN KERR: I think I want to stick to Sequoyah.

MR. EBERSOLE: Many of these matters have been thought about in recent years, put these equipment in isolated slots where you will actually lift the roof or somehow discharge as you do, for instance, the main steam line blow-down, but that was not true in the era of Browns Ferry. So the discharge goes right out into the equipment areas, and I have very much doubt you can survive that for prolonged discharge with ten inches.

MR. KIRKEBO: This is John Kirkebo--on previous projects, in my experience we have run actual tests on valves, and full flow tests on steam valves and demonstrated the capabilities of those valves to close under those conditions.

Obviously every valve that one utilizes for that

application is not tested, but I certainly participated in test programs that demonstrate that systems used for steam isolation service similar to the ones that we are talking about have been tested under full flow steam conditions.

MR. EBERSOLE: Have your valves been type tested for this at TVA?

MR. KIRKEBO: And again I was talking from a generic industry perspective that that is unusual in the industry. I cannot correlate that experience which was on a non-TVA job to the hardware that we have, but I will make an effort to do that.

MR. EBERSOLE: I think that is very interesting because the consequence as you know is kind of like Chernobyl levels.

MR. MICHELSON: You do appreciate the flows we are talking about here are not full flow. They are several times full flow normally.

MR. KIRKEBO: They are not design flow.

MR. MICHELSON: They are beyond the normal design flows by a factor of ten, that order.

MR. KIRKEBO: Yes, I do understand.

MR. MICHELSON: Let me say if you are aware of large-scale valves that have been so tested, it would be nice to inform the NRC of the data because we are thinking of embarking on a program to spend a lot of money to get such

data since it appears not to be available.

MR. KIRKEBO: This data was not collected in this country.

MR. MICHELSON: We also have access to most of the international work, of course, as well. We are aware of some of the work that was done in Germany, mainly in Germany.

MR. EBERSOLE: Get back into the PRA in the absence of good statistics to show where you are.

MR. MICHELSON: It should also be made very clear that all the inch situ testing you do is based upon, and its value of verification is based upon the idea that one knows what stem thrust is required to achieve the function of these conditions. That stem thrust comes generally from the valve vender. I don't think TVA tries to dream it up. The valve vender turns it out use using some interesting formuli.

That's what Jesse is really talking about. When you establish that the vender says you need 2500 pounds of thrust, you verify and you can do it fairly well now with Bovatts equipment, you are getting the desired thrust. That doesn't mean that that will then assure the valve can close because unfortunately, the vender doesn't have good data to know what thrust is really required to close the valve under these conditions. And that's a thrust of our concern.

MR. EBERSOLE: That was on the PRA topic.

CHAIRMAN KERR: Any further questions on PRA? Think

you, Mr. Wilson.

MR. WILSON: Thank you.

CHAIRMAN KERR: Who is responsible for the next question?

MR. KIRKEBO: Doug Gridley, our Director of Safety and Licensing, will speak to this and dealing with corrective action associated with concerns and issues that arose and various mechanisms for TVA or even outside TVA.

MR. GRIDLEY: As I understand the question, as I understand the question, it is how does TVA track the corrective actions and how do they maintain file on closure?

This is a very quick and simple answer. I will just take any questions. All of our corrective actions are put into the tracking and reporting of open item system which is a proceduralized system which TVA has, in addition to the use of our quality assurance conditions adverse to quality reporting system, which is also proceduralized, and through the both of these procedures, all of the conditions that require corrective action are, must be resolved, and if not, they go through a mandatory escalation process which assures management that they cannot be left open by line organizations, so we feel confident that employee concerns and issues are tracked through two very disciplined procedures that have a mandatory escalation requirement, and then, of course, as part of our new employee concern program, we

maintain those files and if they become NRC commitments are tracked, of course, through another proceduralized tracking system called corporate tracking system, so I hope that gives you the assurance that individual employee concerns and issues are not lost throughout the organization for lack of management attention or procedures.

DR. LEWIS: Typically about how many items are there on these lists?

MR. GRIDLEY: Specifically for concerns and issues raised by employees, I don't have that number, and if someone does I would--

DR. LEWIS: Ten?

MR. GRIDLEY: Let me tell you these three proceduralized systems are also used for all of our normal regulatory reporting and tracking.

DR. LEWIS: Within a factor of ten you can't tell me how many items?

MR. GRIDLEY: Let me try this--as you appreciate, the restart of Sequoyah has identified a lot of concerns and issues that had to be resolved for the staff's review. We had over a thousand employee concerns and issues that had to be resolved that were kept in this tracking system, and so if the question is how many of these are employee raised issues, I don't know that.

DR. LEWIS: I didn't ask that.

CHAIRMAN KERR: Within a factor of ten.

MR. FOX: That is, on employee concerns, that had to be addressed at Sequoyah prior to restart. We have another index, conditions adverse to quality and CAQR reports. John Hosner, our project engineer from Sequoyah, can speak to that and tell you the number that we have and in general against Unit 2 of Sequoyah and the number that were restart and the number that remain as restart.

CHAIRMAN KERR: Would that be satisfactory, Mr. Lewis?

DR. LEWIS: Oh, yes.

MR. HOSNER: Let me--I think a way to look at the volume of this is what we see in the past, are going to see in the future is we see 20 new conditions adverse to quality a week--very active system. Now we have, I can talk numbers about backlog and the fact very little in Unit 2, but I think that 20 a week is a measure of what we have seen and will continie to see for the time to come.

DR. LEWIS: That's--all I wanted to know is how big the system was.

MR. MICHELSON: Clarification--the condition adverse to quality is not necessarily an employee concern as such, is it? Employee sees a condition potentially adverse and it has got to be reviewed. He is not, not that he is concerned. He just is trying to identify one that needs to be thought about.

MR. FOX: One of the healthy symptoms that we are seeing particularly as it relates to Sequoyah and the overall system is that the number of employee concerns in the employee concern program is going to, employees are going to management. They are using the CAQ process, the process that TVA has identified for additional identifying conditions adverse to quality and raising safety concerns about the plant. They are more comfortable using that system, going through the management now with the concerns than in using the formal employee concern program.

MR. MICHELSON: It was not an adversarial process at all, just making sure that it was taken care of?

MR. FOX: Correct.

MR. MICHELSON: Let me ask another question which I puzzled about in looking at your process.

If a problem begins to come up through the employee concern process, and it appears to be significant to safety, is there a point in the escalation process at which it gets some kind of an independent peer review from outside of TVA and what would that be if it does?

In other words, do you bring in somebody that is not a part of the system to try to help in judging the importance?

MR. FOX: That would depend on the issue. The intent is to get safety-related concerns out on the table and get them dealt with as promptly as possible.

MR. MICHELSON: Who deals with them other than internal people? Does it ever--I could see if it got to the Safety Review Board it would start getting external input because you have got external members. Is there any internal input before that point?

MR. FOX: Not necessarily.

MR. GRIDLEY: Charlie, that goes, Charlie Fox, that goes to the response to question five, and Mr. Michelson, if you would like, we could--

MR. MICHELSON: I will be happy to wait. Thank you.

CHAIRMAN KERR: Other questions forthcoming on this? Thank you, sir. Who is next?

MR. FOX: Next speaker is John Kirkebo, our chief engineer. John will speak on systems integration.

MR. KIRKEBO: The question basically deals with the lack of possible design controls or the adequacy of controls in the past, especially with respect to systems integration.

The question acknowledges that TVA has modified the way we do business and the question is for business done in the past, for original design or for modifications to Sequoyah, what assurance do we have that systems integrations issues have been evaluated?

This vugraph touches upon the major activities that TVA has undertaken as part of its restart program for Sequoyah that provide the assurance that systems integration type

problems or issues would be identified, captured within our quality assurance program, the CAQ, condition adverse to quality, and resolved.

As you can see from the vugraph, the final activity listed was the integrated design inspection accomplished by the Office of Special Projects last fall, and I think that the breadth of the types of activities shown on the vugraph provide assurance that previous designs and previous works were adequately reviewed.

MR. EBERSOLE: Mr. Kirkebo, let me go back. I see, you know, you will give us, for an example, the system essential raw water, you found that this has been apparently pretty well done. I think that the Committee would like to hear not just that, but how do you go about doing this now since it was not done before? A hundred years ago or nearly that, TVA had a process they called squat checking. The sole object of squat check was to be sure you didn't invade physical space on which somebody else had a claim.

MR. KIRKEBO: That was a 3D check, as we all know.

MR. EBERSOLE: In the advent of the nuclear base, it was realized that space has had a larger significance. You might be in the wrong place because you had adverse potential for creating damage, but in the era that I am familiar with, that was discouraged as being unnecessary process, and in that era when it was being discouraged, there may have been

produced system interrelationships much beyond that in essential raw cooling water at Sequoyah, which are funny.

MR. KIRKEBO: I think the question that you, that you just pointed out deals with how is TVA doing business now, or in the future, and the thrust of the question I was trying to answer is what TVA has done is to talk a lot which it has done in the past to give us assurance that it is all right, but I would like to address your question.

The fundamental changes in the way TVA is doing business today is that we know, we have, now we prepare a stand alone design plant modification package, which is a complete design package which is prepared in a multi-discipline fashion, by the civil engineers, the mechanical engineers and the electrical engineers, working together with the nuclear engineers and materials engineers, to prepare a modification package.

This package is walked down physically in the plant to provide additional assurance that the geometry and the physical configuration, the physical aspects of it are adequate. It is reviewed from the perspective of safety reviews, determinations of the lack of--unreviewed safety question is done on a package. The package is transmitted, and here again I am talking about TVA's new processes which I think are representative of the best practices in the industry.

And the package is issued as a package. It is installed as a package. Any lack of completion of the package is documented prior to final closeout so you know that issued a scope of work, that the engineers buy in if something less than the entire scope of work is implemented.

MR. EBERSOLE: Let me tell you what--I have a small problem with that. You call it a qualification package for some sort of modification. That doesn't tell me if I don't contemplate a modification that I go back and confirm the standing project without modification is what it should be.

MR. KIRKEBO: That is correct, and that's what this vugraph addresses is the standing project. The standing plant is what was subjected to an environmental qualification program at Sequoyah. The standing plant is what was subjected to a design baseline verification program, including physical walk-downs. The standing plant was represented in the moderate energy line break work that was recently done at Sequoyah. The standing plant is what the restart test program challenged from a performance perspective, and I would, you know, I think it is the standing plant, Mr. Ebersole, that was subjected to these itself.

MR. EBERSOLE: Looking for system interactive investigation, that's all, which I believe was never really accomplished in past years.

MR. MICHELSON: Just so I understand the scope of

what you look at when you do the integration, for instance, in looking at a given system, do you integrate in the environment around the system in terms of is it adequately cooled for whatever equipment might need cooling? Is it protected against unwanted intrusions such as perhaps fire spray water or whatever? Are all these things each time you say you are, you do integrated look, you really integrate the total picture including all of the interfaces?

MR. KIRKEBO: Absolutely. I think to do anything less than that would not be appropriate.

MR. MICHELSON: I tend to agree with that without doubt. I did, and I don't want to raise too much of an issue on your fire letter, but it said in there, for instance, when you looked at fire, you didn't integrate HVAC, and that bothered me a little bit in the sense of the concept of integration. I certainly--not that you had to look at interfaces as they related to the equipment required to, for safe shutdown under under that condition. It certainly showed that there was less than full integration of the thought.

MR. KIRKEBO: I wouldn't debate that.

CHAIRMAN KERR: Any further questions on this issue? Thank you, sir.

MR. KIRKEBO: Thank you.

MR. FOX: Now the next one I would think we would defer to the NRC staff. Is that correct or--

MR. WYLIE: I think TVA is going to answer it, aren't you?

MR. FOX: We are prepared to support staff should they--or answer if they would like.

CHAIRMAN KERR: Is staff prepared to comment on No. 4?

MR. LIAW: Other than those TVA specific programs, we haven't treated TVA differently from any other plant. The general communication we issued to the industry like information notice, generic letter, or the bulletin.

CHAIRMAN KERR: Excuse me. Let me see if this is enough. What you have said so far is that you treat TVA the way you treat any other plant.

Does the questioner want more detail than that?

MR. LIAW: Let me add something to that. We, because of the schedule consideration, sometimes we provide TVA advanced copy of the upcoming bulletin or advanced notice for them to assess the applicability to the Sequoyah plant and other plants that they are scheduled working on.

CHAIRMAN KERR: You treat all plants equally but some a little more equally than others?

MR. LIAW: That is correct. I call Mr. Fox from time to time--Charlie, have you looked at anything, and if you have determined it is applicable to you, I think you better start, you know, earlier. That's the way, additional things

we do with TVA.

CHAIRMAN KERR: Thank you. Further questions or comments? Next issue, No. 5.

MR. FOX: Dick Gridley, our Director of Safety and Licensing, will address this question.

CHAIRMAN KERR: Perhaps the first question would be to answer as well in your view, if there are any such things?

MR. GRIDLEY: Excuse me, Dr. Kerr?

CHAIRMAN KERR: I say the first question you might want to answer is whether in your view, there are those things that involve significant risk but are not covered by NRC regulation.

MR. GRIDLEY: All right. Thank you. There are none that I would put in a category that are significant risks that are not part of our communication with the NRC.

However, I think that the question as I viewed it was how does an employee initiate concerns or issues, but--concerns that could potentially be significant risks, but not yet understood, and we, I think we are in pretty good shape at TVA. At least I believe we are, a lot better shape than we were several years ago.

Certainly the first opportunity for the employee to have a discussion with his supervisor, we are encouraging that very strongly, and we see results taking place. Part of that is because of the second program, the employee concerns

program, has been effective. It is working. We have monitored the program. We believe it is working well.

Much of the audit work that we do now tells us the people feel more free to raise significant risk questions without fear of being intimidated, without fear of being penalized in their job.

The employee concerns program certainly is a multi-faceted way for individuals to deal with areas of significant risk that they think should be looked at. We have site representatives at all of our locations. They are quite free to use a call-in system. They also can deal directly with the NRC staff residents at the site, and they do that quite frequently if they want to, so that seems to be working well.

The quality assurance program, you have heard a lot about the conditions adverse to quality reporting system or procedure we put in place. We are really pleased with the results of that program. As we have testified before with you and also with the Commission, we had a myriad of ways that QA conditions adverse to quality were handled in TVA, the very important decision made to just put it under one program, make a single program, make it work throughout the system and procedurlize it so that people knew, and train people in it so they knew how to work with the procedure.

We were skeptical in early '86 about the ability to

do that, but through, through training and error correction, through experience, we are, the program is working, and I'm pleased to report, and I think John may still be here, John Hosner, if not, certainly John Kirkebo and others know that the CAQR as we call it program, conditions adverse to quality report procedure, more than, well, more than 60 percent of those are coming from line organization now rather than the quality assurance organization.

MR. MICHELSON: How long has that process been functional?

MR. GRIDLEY: I believe February of--

MR. KIRKEBO: Eleven months.

MR. GRIDLEY: So we are very pleased with that. It has got a low threshold. The line input is very high. It is tracked, as I said earlier. It also has the mandatory escalation process, so individuals are finding that as an outlet for raising significant risk issues.

MR. FOX: Admiral White pointed out last week at the Commission meeting that almost 70 percent of the CAQRs come from outside of the QA organization. He pointed that out last week. That shows that the line organization outside QA is heavily using that process.

MR. MICHELSON: I kind of sense that it is a low profile process. In other words, people can initiate such without feeling that they are sticking their neck way out?

MR. FOX: Yes, that's correct.

MR. MICHELSON: How much noise then do you get into the system because people are so free to use it?

MR. FOX: Quite a bit at this point in time; maybe due to the past and underreacting maybe as appropriate, and we feel it is appropriate to have a low threshold at this point in time, but most recently, we find the noise level seems to be diminishing, that we seem to be focusing on the safety-related type issues.

MR. MICHELSON: So it is, it is a filtering job now to try to figure out, but I guess you feel that in time this will work out?

MR. FOX: That is correct.

MR. EBERSOLE: This Nuclear Safety Review Board is an advisory board, am I correct?

MR. GRIDLEY: Jess, let me talk about that a little bit. You see it is on my chart there, and I would like to maybe just quickly talk about the independent safety engineering group and then we will put that aside.

MR. EBERSOLE: All right.

MR. GRIDLEY: As you know, that the only point I want to make on that is, which I think is really important to know, is that that's a proceduralized system, progress. That it was very independent; that it happens to report into my division. The manager of that, of that, reports directly to

me, but I give him a lot of independence in that he establishes his own program. He identifies the issues he wants that group to evaluate. He also is available to review any safety or significant risk issues that come up, so he has got time factored into his resources, too, and does at the request of site director, or request of other division directors, can do reviews, unplanned reviews throughout the year.

MR. MICHELSON: Is this something that we heard about but maybe with a different name? Is this those few people at the site that report directly back or something?

MR. WYLIE: You don't remember the acronym ISEG?

MR. GRIDLEY: This is called the ISEG group. Maybe that's what you are thinking of. This was an outcome of TMI, as you know.

MR. MICHELSON: Yes.

MR. GRIDLEY: And TVA was the first, was the pilot utility to establish this group.

MR. MICHELSON: Now are these set up at each site separately?

MR. GRIDLEY: Yes, sir.

MR. MICHELSON: They report back to you separately? That was the ones you talk about here?

MR. GRIDLEY: Yes, sir.

MR. MICHELSON: I just didn't connect that. I knew

about it.

MR. EBERSOLE: As a case in point, why is it that I have to bring up a matter like I did a while ago and not find in place a disposition of your already having considered this and reached a conclusion?

CHAIRMAN KERR: I can't hear your question.

MR. EBERSOLE: I said if you, this is a functional working group and it has substantive products of its work beyond those necessary to fulfill regulatory requirements, why do I have to bring up a matter like I did a while ago about the steam lines, and not find at ready hand a standing analysis that you all are fat and happy?

MR. GRIDLEY: I think I will answer it this way, Mr. Ebersole--this group has concentrated, the initial, the initial implementation of this program was at Sequoyah to meet the restart conditions. The group has been functioning there. They I think have issued, they have been issuing monthly reports for Sequoyah. They have issued one formal review to Admiral White.

The organization is implemented at Browns Ferry. They have to date not done a formal review of a particular generic issue like on a BWR main steam line, and I can't tell you that they won't. We need time for this group to do some of those more generic reviews that are, that have been industry known for sometime. We would expect them to look at

the A list. I don't know how many we have left.

CHAIRMAN KERR: I would have thought your answer to that question was we can't have Jesse Ebersole on site to raise the questions!

MR. EBERSOLE: No, and that has been laid out and presented for 20 years.

MR. MICHELSON: Could you give us a couple of examples of sorts of things you have looked at which are beyond regulatory requirements, and for which you have been doing some thinking, for instance?

MR. GRIDLEY: I'm sorry, I can't, Carl. I can get that answer for you, and I will do that.

MR. MICHELSON: Do they publish periodic minutes of their meetings or something that one can read, the kind of thinking they do?

MR. GRIDLEY: They publish a monthly report for each site that they have been implemented. Right now it is just two sites--Browns Ferry and Sequoyah.

MR. MICHELSON: Might make interesting reading to see how they view the safety issues beyond regulatory concern.

CHAIRMAN KERR: Questions on this issue?

DR. REMICK: All the time.

MR. GRIDLEY: Yes, sir.

DR. REMICK: I think that's a requirement of NTOLs after Three Mile Island started. Mandatory requirement, is

this something that you implemented voluntarily or was it required at Sequoyah?

MR. GRIDLEY: Prior to my time at TVA, I was told that Mr. Denton requested TVA to consider a pilot program and we agreed, and we were the first to put it in place.

DR. REMICK: Is this part of the restart or was this prior to that time?

MR. RICHARDSON: This is prior.

MR. GRIDLEY: This, that has not been a restart issue at all because we committed to have that in place.

MR. MICHELSON: Has the NRC ever audited the functioning of this group?

MR. RICHARDSON: Yes, we have.

MR. MICHELSON: What judgment did they reach?

MR. RICHARDSON: They found the operation satisfactory.

MR. MICHELSON: I guess I could come to you and you could give me a few sample kind of things that, the documentations on which you base this?

MR. RICHARDSON: We could provide inspection reports that cover the interaction of all of the four groups.

MR. MICHELSON: I don't care how this group functions, the mechanics. I am interested in the kind of issues that it really brings up.

MR. LIAW: Just give you one example, in the NSRB,

Dr. Lena's group--

MR. MICHELSON: I am on the first one. I know how NSRB works, I think. I have not dug into how this other group works, which might be more interesting.

CHAIRMAN KERR: Further questions on this issue?

MR. EBERSOLE: Yes. There was a point in history where there was an extremely reluctant attitude toward doing anything that wasn't in the book on the grounds that that would be inflicting potential discord with our fellows in the field. Why the hell should we do this when nobody else does? You know, it costs more money and the rates go up. I believe that's not popular anymore, that attitude. I hope it isn't at TVA.

MR. GRIDLEY: It is not.

MR. EBERSOLE: And you would be able to cite particular instances where you did what you regarded as prudent things to do, not being forced to do so by the presence of regulatory standards? I should think that the staff would look at the product of these safety-related activities in the substantive sense, what have they really accomplished beyond what they had to accomplish because you point your finger.

MR. GRIDLEY: Mr. Ebersole, if I can comment on that kind of in a broad view, I hope it then can be shown to come down through the system. When we looked at the requirements

that the staff had placed on us to restart Sequoyah as a result of the 5054 F letter on September 17, 1985, staff's list wasn't that long. It was 20, 25 items. I can't remember exactly the number. There was a corresponding list for Browns Ferry, three units.

We prepared the performance plan for corporate to restart Sequoyah and then we prepared the Volume 2 for Sequoyah.

That, those two plants taken together, considerably went beyond anything that the NRC felt we needed to do.

MR. EBERSOLE: That's good evidence.

MR. GRIDLEY: If you look, they have audited us and inspected us against both programs, and we are quite proud of the progress we have made in that area.

MR. EBERSOLE: I remember the old creed don't answer questions which you haven't been asked.

MR. MICHELSON: Let me leave a specific one on the table which we will find out at a later date.

I would be very interested to see if the ISEG group has looked into fire protection at Sequoyah, raised issues which go beyond normal Appendix R requirements, because that is the focus of much of the reply from TVA.

CHAIRMAN KERR: We need to be a little bit careful. If we are going to have the staff require that the applicant go beyond the staff requirements, then this becomes a staff

requirement.

MR. MICHELSON: Dr. Kerr, I didn't say that at all. I said that this group presumably looks beyond regulatory requirements, and I was curious to see if it had looked beyond in the area of Appendix R.

CHAIRMAN KERR: I would think the staff would look primarily at those things that it does within the regulations.

MR. MICHELSON: I was, I understood that the staff has audited the operation of ISEG, for example. I was going to ask the staff had they come across anything on--I didn't quite finish--on Appendix R in the process of looking at how ISEG, for example, functions.

MR. RICHARDSON: I am not prepared to answer that right now. We can provide you subsequent information.

MR. MICHELSON: At a later time.

MR. GRIDLEY: Thank you.

CHAIRMAN KERR: Further questions? Thank you, sir. Next question which has to do with a specific concern about cable performance in a LOCA situation.

DR. MOELLER: Not a LOCA, is it?

CHAIRMAN KERR: I had thought a LOCA might be one situation in which the cables--these are cables outside?

MR. EBERSOLE: Hypothetically some years ago, including all of the output cables in the diesels.

MR. FOX: Does the staff wish us to address this?

We are prepared to. Ken Brown, senior electrical engineer, from the Engineering Branch will speak to this. In fact, Ken will speak to the next two questions.

CHAIRMAN KERR: Question 7 has been dealt with, with Charlie already, unless there is additional question.

MR. MARINOS: Clarification to be made for question 7.

MR. WYLIE: What is that?

MR. MARINOS: Question 7.

CHAIRMAN KERR: We don't need any further clarification unless something has been said in error.

MR. MARINOS: It has not been said in error.

CHAIRMAN KERR: Please go ahead.

MR. BROWN: Okay. Question 6, there is an electrical cable at Sequoyah which normally is in a dry condition but which will be submerged in water during a design basis flood. I want to talk about those conditions for just a moment.

This is a situation which has been recognized really since the day No. 1 in Sequoyah design criteria. The design basis flood is estimated that it would top out at about elevation 700. Grade level at Sequoyah is elevation 705, so estimates are that the design basis flood would come some five feet lower than grade level. Of course, the cables we are talking about are in underground duct banks.

The plant procedures require that the units be shut down if that flood level reaches elevation 685 and you bring the unit down and you de-energize circuits that are not necessary for operation. In recognition of the fact that there are some cables which are required for operation which are in these underground duct banks, the same design criteria invoked requirement that cables be specified for service in either wet or dry environment, and that has been done.

The significant thing that I want to talk about, though, is the fact that the mechanism which would lead to concern for cables in a flooded condition simply isn't present at the cable service is if they are normally either de-energized or they are very lightly loaded during normal plant operation such that there is no thermal aging of significance which takes place throughout the life of the plant.

I think the significant point to see then is that when, when that design basis flood comes, if it comes, that the cables would be in an as new condition at that period in time, and there should not be any cause for concern of jeopardy for cables which have been procured in accordance with the fashion that I show.

MR. EBERSOLE: Go back to the original statement you made? I read here that of course, the flood is up to, design basis flood elevation 729.5. That's a great deal above grade.

MR. BROWN: Well, I would have to go back and check your numbers and I can do that, but the argument would hold the same even if I quoted the numbers incorrectly.

MR. EBERSOLE: I understand that, but the situation is considerably more spectacular.

MR. BROWN: I can check those numbers.

CHAIRMAN KERR: From what are you reading, Mr. Ebersole?

MR. EBERSOLE: Well, pardon me. I am having trouble coughing here. You invoke the original condition of the cable being maintained.

MR. BROWN: Yes, sir

MR. EBERSOLE: Original condition will be maintained.

MR. BROWN: Yes, sir.

MR. EBERSOLE: You don't think over 30, 40 years that will increase?

MR. BROWN: Given that No. 1, the cables are either de-energized or very lightly loaded.

MR. EBERSOLE: I understand.

MR. BROWN: Thermal mechanism is simply not there.

MR. EBERSOLE: I don't know the aging mechanism that--well, I wouldn't argue with it. I would hope, you know, in fact--

MR. BROWN: That last bullet, a good example of

another reason I have confidence, for instance, let's take the medium voltage cables. In the medium voltage arena, if we look across all of Sequoyah, we will see nine different types of medium voltage cable supplied.

Now in the harsh environment, there are only four, but when we redid a lot of qualification work here a number of years ago, we qualified all nine of those types, so they have all been through the process of thermal aging, radiation, and an accident with the normal bend and end water high pot, so I am confident because I know what the cables perform like at the end of that scenario, that when they are put out there in underground duct bank, not saying all the other parameters that influence these cables, they are going to perform.

MR. MICHELSON: Clarification--that EQ was for inside of containment conditions?

MR. BROWN: Yes, sir.

MR. WYLIE: What are these insulation material?

MR. BROWN: We have crosslengths polyethylene, ethylene propylene rubber.

MR. WYLIE: Underground?

MR. BROWN: Yes, sir. They are in duct banks.

MR. WYLIE: What kind of jackets?

MR. BROWN: They are either PVC or nylon.

MR. WYLIE: All moisture resistant material?

MR. BROWN: Yes, sir.

CHAIRMAN KERR: Other questions on this issue?

MR. EBERSOLE: I have none.

CHAIRMAN KERR: Okay. Thank you, sir. Now unless there are further questions on 7, I am going to assume that we have treated that in sufficient detail.

Are there additional questions on 7 that were not raised in our earlier discussion?

MR. MARINOS: There is a point in--not the whole question--the area where you request that has the technique been used in the new utility industry to test conditions of cables? That part I can address, was not addressed earlier.

It was Grand Gulf, at the initiative of the utility, tests were conducted, high pot tests on cables. Grand Gulf applied 8,000 volts across the board in all the cables that they had questions about the installation.

CHAIRMAN KERR: Thank you, Mr. Marinos. Question No. 8? Is TVA providing an--I assume that is a question for the staff. Would you answer that?

MR. LIAW: Yes. The simple answer is yes, we believe that description adequate.

CHAIRMAN KERR: Okay. Does that answer that?

MR. MICHELSON: Clarification from TVA--you have indeed written system descriptions at least for all safety-related systems?

MR. FOX: We prepared design, revised design

criteria for the Chapter 15 safe shutdown accident mitigation systems. We can have Tony Capozzi elaborate on that if you like.

MR. MICHELSON: Maybe we need to understand what is meant by system description. Would you tell me what you think a system description is?

MR. FOX: A system description in TVA's reactor is a set of updated, revised system design criteria that rationalizes the modified condition with the as designed, as analyzed condition.

MR. MICHELSON: That's what some people might think a system description--some people think system description is a description of the system. That is not, of course, a description of the system.

MR. EBERSOLE: Let me go into the history of this from way, way back.

CHAIRMAN KERR: Do you have a question?

MR. EBERSOLE: Yes, I have. I am hearing that there are system descriptions.

CHAIRMAN KERR: The question was--

MR. EBERSOLE: There are design criteria, a long list.

CHAIRMAN KERR: Does the NRC staff believe that the descriptions are adequate? There are further questions apparently than that--

MR. LIAW: I was responding.

MR. EBERSOLE: The question should have been is TVA providing system description information? And it should really say, left out the word "information" which could have been taken as the criteria.

CHAIRMAN KERR: I thought the question was whether the NRC staff considers what they are getting from TVA to be adequate. The answer I heard was yes.

MR. EBERSOLE: It may be the NRC--again, this is a question of whether you pick the regulatory interpretation as adequate or not.

MR. RICHARDSON: We believe the updated, revised system description information that is coming out of the various TVA programs design baseline review program, number of other programs, is adequate.

MR. EBERSOLE: Let me give you a little bit of picture about how this comes about. TVA was--

CHAIRMAN KERR: Do you want to find out if the NRC staff believes they are, or are you trying to convince them that they are wrong?

MR. EBERSOLE: I am trying to find out if they are adequate at least in the way I think, we would think they were adequate.

CHAIRMAN KERR: That's another question.

MR. EBERSOLE: I know. Let me go on. Originally,

from way back, there were system descriptions put together by the parties that designed the plants, the several systems, to go to the operating people who were separate bureaucracy to be expanded into actual valve switch numbers and the usual horrendus detail that expressed factory design people except they it never did return was a throw-over-the-fence process, how the plant was going to be operated.

But the origins and birth of how to do that was in the form of a rudimentary narrative support to the design drawings, the P and IDs, the elementary and schematics, but the strengths of the old independent burearcracy was such that it was particular at Sequoyah--no. Yes, at Sequoyah, at one time, it was said I don't want any narrative coming my way, I want the P and IDs, the elementaries, and the diagramatic representations of plant and criteria list, and it is my job to run the plant as I want to run it.

That was the old philisophy which is a non-integrated operation, not supposed to be present today. So the question was all right, do you now have a flowing process on the, from the design department or whoever is the parental organization that I understand there exists, to develop narrative which is always required to support diagramatic and tabulated information, to provide a point of beginning for operators to write operating procedures, and they in return complete a circuit? It is a process. That's

all.

CHAIRMAN KERR: It seems to me that is a rather different question than the one that is here now. You are asking whether the systems descriptions that exist are adequate for operators I think, not for the NRC. Is that the question?

MR. EBERSOLE: I am not worried about what is adequate for NRC.

CHAIRMAN KERR: The question--

MR. EBERSOLE: I didn't develop the question.

MR. MICHELSON: It is not a very well written question from the viewpoint of the-

CHAIRMAN KERR: What is the question you want to address to TVA?

MR. EBERSOLE: I want to ask them do you now have that flowing process in which the operators have some substantive information other than, you know, P and IDs, and schematics and so forth from which they can start?

MR. FOX: The answer to that is yes, and probably the root cause to the attitude problem that you had before was that the autonomy of engineering and operations?

MR. EBERSOLE: Was it?

MR. FOX: That autonomy doesn't exist anymore. We have dedicated on site--well, it is diminished greatly. We have dedicated on-site project engineering. The technical

responsibilities, technical ownership of the plants has been given to engineering. They are on site. They are support organization to the plant manager, and to the site director, and they report back, in order to ensure that they are doing business to the highest technical standards, those engineers report back to John Kirkebo.

They take their day-to-day priorities, and their work requests and so on from work direction, day-to-day work direction from the site director himself. Engineering is providing a service. We have a new plant manager at Sequoyah, Steve Smith, who recently jointed us from Davis-Besse. I think Steve is pretty well satisfied when he asks for something from D and E to help his operators better run that plant, I think he gets good support from Mr. Haas. This was pointed out in great length. The NRC might want to comment on whether they think that Engineering is adequately supporting the operating plant from--

MR. MICHELSON: I don't think that is even the question on the table, and I would like to get back to the question on the table.

MR. FOX: Well, I would like to understand the question on the table.

MR. MICHELSON: The question on the table I believe is whether or not there is a reasonably comprehensive, fairly simple description that the operator has of the system he is

operating or does he have to go through a number of feet of documents, drawings, pages, and whatever? I asked this question--

CHAIRMAN KERR: Do you think you understand Mr. Michelson's question?

MR. FOX: Yes. I believe I do.

CHAIRMAN KERR: Can you answer it?

MR. FOX: Yes. I have Tony Capozzi prepared to answer that question.

MR. CAPOZZI: Mr. Michelson, you asked a very good question. First let me say it this way. Within the engineering organization, we have somewhat a similar problem. Okay. We started bringing design control. One of the first things we did was we created a design basis document, and I want to explain what that document is. It is not a system description per se, but it has all the elements really of the kind of things that Jesse was talking about really.

The design basis document lists for every safety system specific system criteria. It has--

MR. MICHELSON: I am acquainted with it. I did ask for and got it for the compressed air system. That's not the concern or the thrust of this question. It is what does the operator have at his end? Because I hope he is not trying to read that design basis document and figure out how to operate the system.

MR. CAPOZZI: All right. I was trying to point out first of all, what we did was we tried to bring within that document flow diagrams, control diagrams, for each system so it takes the first step of what Jesse was saying rather than having all the pieces--

MR. MICHELSON: Didn't happen to even contain the flow diagrams, for instance, for the compressed air system. It only contained the design criteria of the design requirements for the system. Didn't describe the system because it was a designer's document, not an operator or user's document.

MR. CAPOZZI: First of all, you know, the system is described briefly in the FSAR. I think--let's start with the real basic basic. Then if you add that is given to the operation, they have that. Okay. And in addition to that, we have given them the design basis document. We have given them the pre-op test documentation, and we also give them approved vender documents which they need as well, including vender manuals.

What we are basically saying is, okay, we are providing them I think the necessary information that they need to do their day-to-day business.

MR. MICHELSON: I don't think there is any doubt that you have provided them all the information. That is the problem. You provided them literally two feet of information

on the compressed air system and from that the operator is supposed to have the time to deduce down to the things he needs to know.

We were just asking do you have a process of writing system descriptions for the operator? I think the answer is know.

MR. HERMANN: One of the things that TVA has done, and they have, we aren't talking about this right now, is one of the things that Engineering has done, very recently just put a systems engineering group right at the plant site with--how many are in I don't know what the numbers are.

MR. HOSNER: Forty total.

MR. HERMANN: Kind of do what you are asking for; they are really part of the plant staff right now, the interface with the, where things are coming from.

MR. MICHELSON: I didn't sense that was their function.

MR. EBERSOLE: That sort of close relationship, it might--

MR. WYLIE: It is not initially.

MR. MICHELSON: Is TVA going to write system descriptions to the backfit?

MR. FOX: If our plant managers feel like they want them; I mentioned to you privately after the last meeting that we were studying the possibility. We have not made any such

decision.

I happen to have, my past experience, have had detailed system design descriptions on all of the Chapter 15 systems. We have not had a request from our plant manager at Browns Ferry or at Sequoyah. John Kirkebo and those people will be studying that in the future. We have at this point in time not made a decision to do so. I know of no regulatory requirement to have them.

MR. MICHELSON: There is none. There is none.

MR. EBERSOLE: Just the notion the operator should attempt to learn to operate the plant by the deductive process.

MR. KIRKEBO: We are doing it at Watts Bar.

MR. MICHELSON: They are writing position descriptions?

MR. KIRKEBO: As I understand it, on Watts Bar and Bellefonte.

DR. MOELLER: Although it is not on the agenda that you came prepared to discuss, I had read the SER, Volume 2, Part 1, and under Section 4.13 it covers radiological controls, and it said that additional staff positions established on site for professional physicist.

Could you tell me how many positions, if you have that information?

MR. FOX: I will have to get back to you on that. I

guess you also want to know the status of those positions being filled?

DR. MOELLER: Yes, sir.

MR. FOX: We will get back to you with the answer in question.

DR. MOELLER: Just two other quick ones--it says the health physics person participates in maintenance planning. The implications of the SER is that he or she did not formally participate and now he or she does.

I am somewhat surprised if he or she did not formally participate.

The last thing is that a training position has been established in support of radiological controls. If you could just find out what that entails or what that person does, I would be interested. Thank you.

MR. FOX: Okay.

CHAIRMAN KERR: Mr. Remick?

DR. REMICK: Going back to the recently, the figure on site systems engineering group of roughly 40 percent, do those individuals adopt certain systems as systems to follow? Have you adopted that system?

MR. HOSNER: Yes, that is correct.

DR. REMICK: You could have called it system engineer.

Another question--do you have a current

configuration management program for all that equipment up to date?

MR. HOSNER: Yes, it is.

MR. FOX: Absolutely, and in fact we feel like we have a configuration control policy which is being implemented which is as good as any in the industry.

CHAIRMAN KERR: Further questions?

MR. EBERSOLE: Nope.

MR. WYLIE: I have one of the staff. This is the last one. Any other question first? Okay.

I understand that the staff has received today a letter, another letter from Mr. Drallis, and I would ask the staff provide us a copy of that letter.

MR. RICHARDSON: As soon as I get back, we will have it FAXed out.

CHAIRMAN KERR: Any further comments or questions? I think Mr. Wylie needs some guidance from the Committee, and I would expect that the first question we should, with which we should deal is is there something that we have discovered or not explored which would lead us to recommend to the Commission that they not proceed with their decision on Sequoyah restart?

MR. WARD: I don't think so. I think that we have heard the story, and if issues aren't resolved, they are on the way to being resolved.

CHAIRMAN KERR: The Commission has asked for comments from us, and I would assume we say that we see no reason for the Commission not going ahead with the process.

Secondly, are there things that we want to put in the letter which we do not think should preclude restart but which we think should be looked at or investigated further or whatever?

If you have those, Mr. Wylie I think will need them to formulate the letter.

MR. WYLIE: If you have some, let me have them.

MR. EBERSOLE: I guess one aspect of the letter is when they get down into the older plants, Browns Ferry, the different kind, whether the Committee would want to hear what they have done or wanted to do or found at that point as much as what they found here at Sequoyah.

CHAIRMAN KERR: It seems to me we probably should deal with that--I agree it is a good question--but deal with that in a separate letter.

MR. EBERSOLE: Oh, yes. But this letter could be almost, you know, carry on, start Browns Ferry 2. I don't know about that.

MR. MICHELSON: That is not the letter we are writing.

MR. EBERSOLE: That's not the letter I thought we were writing.

CHAIRMAN KERR: Any further comments?

DR. LEWIS: Just a question--this may be improper because I missed the first part of the meeting. I have in my possession tnis letter from Henry Meyers. Has that been coped with by the staff?

MR. RICHARDSON: I am not sure which letter. We have had several letters. We believe all of them we have addressed the issues, and--

DR. LEWIS: This is March 9.

MR. MICHELSON: Can you tell us in an approximate fashion how you are dealing with the Appendix R questions in terms of heating start-ups?

MR. RICHARDSON: We have reviewed the Appendix R issues which have just come up, the allegations that we have gone through and decided which of those need to be resolved from a safety perspective, impact on systems required for safe Mode 2 operations, and specifically the spurious interaction, that is critical, RCS letdown path.

MR. MICHELSON: You said something about having to do a walk-down and so forth.

DR. LEWIS: Had you not seen this letter beforehand?

MR. RICHARDSON: I have not seen that letter.

DR. LEWIS: You can't answer the question of that it is being coped with?

MR. RICHARDSON: That's true. I was commenting, we

have a number of Dr. Meyers' letters that we are--

DR. LEWIS: I understand that.

MR. MICHELSON: What is your schedule for the Appendix R walk-down or whatever you decide to do?

MR. RICHARDSON: The team starts on site Monday morning, and there is exit meeting scheduled Thursday or Friday, depending on how long it takes the team to do the review. We have a commitment to keep the commissioners informed of the progress of the inspections so that they know how to plan their voting.

CHAIRMAN KERR: Any further questions or comments? I want to thank TVA and the staff for it seems to me rather complete answers to our questions, and we will adjourn for lunch and reconvene at 1:15.

(Whereupon, at 12:15 p.m., the meeting was adjourned, to reconvene at approximately 1:15 p.m. the same day.)

A F T E R N O O N S E S S I O N 1:20 p.m.

CHAIRMAN KERR: The afternoon session is now in session. The first item is NRC regulatory guides. Mr. Shewmon is the cognizant subcommittee chairman. Mr. Shewmon?

DR. SHEWMON: We had a metals component subcommittee meeting a few weeks ago, and both of these items were covered from there. The first one has to do with Reg Guide 1.99, Rev. 2.

Reg Guide 1.99 defines the nil ductility temperature of reference NDT shifts that must be used by the licensees for radiation. This impacts operating limits, when you can pressurize, PTS accidents; you postulate about the low temperature, overpressurization, and so on. Rev. Guide 1 which came out about ten years ago, with the Revision 1, was based primary on test reactor data, not surveillance data, and it now concluded that these are indeed different.

This may well get back to the flux rate effect that we talk about later, but independent of the mechanism, it is different. They found now that welds in the plate of pressure vessels are different, and before we assumed they were the same. In the previous version, it ignored the effect of nickel, and indeed it is significant.

This interestingly enough, affects some venders more than others because some put nickel in because it helps the heat treatment response of the welds, so the line-up of who is

on first is going to change when he gets down to what utilities are there.

I think Rev. 2 is now out, or has been out for comments, and has come back, and this is the final version that we are being asked to concur with now.

It clearly is better. I think everybody, including the staff involved, would say that there are ways that they might improve it some day, but this is clearly enough better than what is there now is Rev. 1, so that I think we ought to approve it going out.

It will cause some pain. I have alluded to this earlier with regard to the nickel. There is a question of how this is going to be factored into the pressurized thermal shock question, and we can get to that later.

What we have asked the staff to do is to come up and tell us a little bit about what they are doing and how they got that way, and we can then ask what it impacts from here. And are you it?

DR. SIESS: May I ask you a question? You can let them answer it if you want. I assume this is based on new research?

DR. SHEWMON: Yes, and also a lot more surveillance data than there was before.

DR. SIESS: Was the new research paid for by NRC or was it--

MR. RANDALL: I'm sorry?

DR. SHEWMON: Was the new research paid for by NRC?

MR. RANDALL: It is really based on surveillance data that came from the power reactors.

DR. SHEWMON: There was also a certain amount of number crunching that was a research project.

MR. RANDALL: That the regression analysis of the data were certainly done on the NRC contracts, that's right.

DR. SIESS: Now one other question--you weren't here when Dr. Kerr was asking about calculations that were not excessively conservative, calculations, you know, analyses to tell us what was actually happening.

Is this reasonably, I hate to use the word best estimate. Dr. Lewis doesn't like it, but you will know what I mean. Is that conservatism built into this?

DR. SHEWMON: He will get into that in the course of the talk.

MR. RANDALL: Yes.

DR. SHEWMON: Are there, are there other questions?

MR. RANDALL: I will address that.

DR. SHEWMON: Fine. Go ahead then.

MR. RANDALL: ' right. My name is Neal Randall, and I am here to get Rev. 2 published in final form and to get the ACRS approval to do so.

As Dr. Shewmon pointed out, the general subject is

certainly reactor vessel integrity, and the mode of failure is fracture of the reactor vessel beltline, and the questions to be addressed are how do we estimate the amount of the embrittlement of that beltline as a result of the high energy neutrons that escape the core, penetrate the wall, and how do we factor that embrittlement estimate into our fracture analyses that we do [illegible]gulating the vessel integrity?

This is a [illegible] of things I plan to talk about.

(Slide)

MR. RANDALL: I explained how Req. Guide 1.99 fits in with Appendix G and the boiler code in [illegible] regulatory context, tell you about the safety significance, describe the technical base for it, explain how it relates to Rev. 1 and how it relates to a similar formula that is in the PTS rule, what we intend to do about the public comments. Response to them was fairly simple, but I will go over that, the only exception being there is an impact on operating flexibility and we have had quite a few interchanges with the owners group on that point. I will talk about that.

Finally, if there is time, and if you want to it, I can talk about the impact of amending the PTS rule to be consistent with this guide, but you will hear about that another time, so it depends on whether or not you want that.

MR. EBERSOLE Why did you say high energy?

MR. RANDALL: The high energy neutrons?

MR. EBERSOLE: Why did you say high energy, implying that the low energy neutrons didn't amount to anything?

MR. RANDALL: We actually now are beginning to use a weighting factor so that we include the low energy ones, but with a weighting factor on them.

MR. EBERSOLE: You mean all neutrons?

DR. SHEWMON: Like a baseball hitting a bowling ball; it has to hit it hard enough to knock it off its side. Otherwise it is a no never mind.

MR. EBERSOLE: High energy then.

DR. LEWIS: Why is it a megavolts?

DR. SHEWMON: He will get into that. There is a transition.

DR. LEWIS: I am sure that's what the experience is.

DR. SHEWMON: That was the way they used to keep count, and now they are modifying especially as you get out into this vessel support thing and out further.

Go ahead.

MR. RANDALL: A little more background, Rev. 1 was issued in '77. We didn't really think there was anything wrong with it. We were using it, and going along confidently, until this time period when in the process of doing the pressurized thermal shock analyses, two things happened. We began to look at the new surveillance data that was then coming in from the power reactors, and we found that some of

that laid above the curve that was Rev. 1.

Furthermore, to do probabalistic analyses, we needed mean curves. Rev. 1 gave bounding curves, and so we began the process of analyzing the new data. We hired George Guthrie at HDL to do regression analyses on that data, and he gave us the formula which got included in SECY 82-465 in the the PTS rule, the formula for calculating the number that gets matched against the screening criterion PTS evaluation.

Well, that rule then got fixed in place because a lot of plants set out to do flux reduction based on how they, how they were evaluated with that formula, but George Guthrie kept on working and the data kept on coming in, and so in this time period, early '84, he had an improved formula.

We also had available the work of Professor Odette from the University of California at Santa Barbara, working for EPRI, which looked at petty much the same data base and gave us another technical basis for the guide, so using the two of them, I put together what is now Rev. 2.

It went out for public comment on this date. It has been looked at by the Metal Components Subcommittee of ACRS, of course, before it went out in mid-July, mid-'87, and again just a month ago. It has also been reviewed by the CRGR Committee, and I have their approval as of December 9th to publish it in final form, so that's the history of the thing.

(Slide)

MR. RANDALL: With regard to the fact that this guide does address safety issues, I have here a very schematic pressure temperature limit diagram which shows first off that as everyone knows I think, there is a region at which pressure and low temperature, that is hazardous to vessel integrity. In other words, we must warm these vessels up before we pressurize them, particularly after they have had a fair exposure to neutron environment.

There is another variable involved. That's cooldown rate, thermal stress, and so you have to show the boundary of that region as a family of curves for different cooldown rates. To make sure the operator keeps its vessel out of that region, every tech spec has a pressure temperature limit which gives him not only warning, but as much time as possible to manage transients like low temperature overpressurization, or rapid cooldowns, i.e., pressurized thermal shock.

Now as the vessel embrittles, I think it is clear this region expands. It moves up scale and it drops down in pressure. When we got the data base for the Rev. 2 and got it analyzed, we realized that the region is larger than we thought it was. There is more embrittlement than we had predicted using Rev. one, and I have shown that schematically at that set.

I guess it is clear also that you don't have unlimited freedom to place this P-T limit farther and farther

to the right, because the operating zone will get very narrow, squeezed as it by the saturation curve requirements for pump operation, cavitation problems, there, pump seal problems there.

(Slide)

MR. RANDALL: Well, in doing our regulating, there are four kinds of fracture analyses where we need embrittlement data. I mentioned the pressure temperature limits. There are occasionally flaw indications found in non-destructive examination. Those have to be evaluated. There are occasions when the operator transgresses the pressure temperature limit and we then have to make an evaluation to see if the potential for having popped in a big crack in the vessel is so high that we need to shut down, inspect, do more analyses and so on. So for that, obviously you need good information about the state of embrittlement of the vessel.

For all these three, we use the reg guide. Number 4, in the PTS rule, we set down an screening criteria which is really a limiting degree of embrittlement beyond which they cannot go, they cannot operate, without further analysis to justify it, and the PTS rule, this is a different formula that I will talk about again in a little while.

DR. SHEWMON: That is Rev. 1 and a half in a sense. It is either one or the other, is that right?

MR. RANDALL: It is intermediate.

DR. SHEWMON: The equation is different from Rev. 1 and Rev. 2.

MR. RANDALL: Was a precursor of Rev. 2 you might say.

(Slide)

MR. RANDALL: Still on the background here, show how we get into our fracture analyses; clearly you need to have an allowable value of fracture toughness when you make this calculation. The boiler code gives us well known K1R curve. It is in terms of T minus RD NDT, T being the metal temperature at tip of the crack, RT NDT being the reference temperature of that same material after accounting for the radiation damage. The initial RT NDT for unirradiated material is measured according to the boiler code Section 3 using first call dropway tests and checking that with Charpy tests in a prescribed method to get RT NDT for medium material.

We add to that initial value a delta RT NDT that is defined in our regulations as the 30 foot pound shift between an unirradiated and irradiated Charpy curve. Now if a plant has been operating long enough that it has two credible surveillance data points, two values like that, we let them use that to establish delta RT NDT for that plant, and the NUREG guide, the Rev. 2, prescribes how to use those data

until they have two capsules, and that is at least six for a PWR and perhaps 15 for a boiler, or if they don't have credible data, and some don't because they didn't put the right material in the capsule by our present understanding, they have to use this formula which is calculation based on the copper and nickel content of the material and the neutron fluence. So This is the guts of the guide.

We say delta RT NDT is a product of chemistry factor, and a fluence function. Chemistry factor is a function of copper and nickel, which you get from Table 1, for weld metal and Table 2 for base metal. I think, I think you all have a copy of the reg guide that was given to you earlier in the week I believe. And those two tables are the chemistry factors. The numbers in there are essentially the delta RT NDT for fluence of one times ten to the 19th as a function of copper and nickel.

I come now to the question of where did we get those tables? Where did we get that fluence function? As I mentioned earlier, Guthrie and Odette working separately but with essentially the same data base, Odette did have more boiler data in his, I was able to take their work and combine it. They agreed--

DR. SHEWMON: Are we waiting to see that or--

MR. RANDALL: Sorry.

DR. SHEWMON: I thought you were going to keep us in

suspense for a while!

MR. RANDALL: This is a classified slide! Luckily they agreed on several basic things. They said separate correlations are needed for welds and base metal. As Professor Shewmon told you earlier, they agreed the form of the equation could be a simple product of the chemistry factor and fluence factor; in other words, that we didn't have to have chemistry term in the exponent of the fluence, for example.

They agreed after quite a lot of work that copper and nickel were the only two elements we had to have. Phospherous was, of course, in Rev. 1 but they didn't get any better fit when they put phospherous in their analyses.

DR. SHEWMON: Is it partly because of the limited range of phospherous that you have in the country?

MR. RANDALL: We--it is. And we don't say that it doesn't have any effect anywhere. We, for the data base, we couldn't find it.

And finally, they agreed on the fluence factor at least in the range of about near one times ten to the 19th where the data are sort of concentrated, so I was able to take their work and combine it and as proof that I didn't do too much violence to their work, I will show you two or three plots of the residuals observed or measured value minus the calculated value, in this case plotted against fluence to show

that we do indeed have a reasonable fluence function.

And the data points are pretty well evenly divided above and below zero for welds, here for base metal, and that's my demonstration of what that, what we have fits the data ba3e.

(Slide)

MR. RANDALL: You asked well, what about the copper function? There is the same residuals plotted against copper. The only place where it wanders off is where I deliberately put in a 20 degree cutoff and very little copper. I didn't want the formula to go, to show zero shift for zero copper, and that actually made these points droop 15 degrees or so.

(Slide)

MR. RANDALL: Similarly for nickel, one thing very obvious here is that the nickel contents are clumped. Either there was no deliberate addition which meant that the points show up down in this range, or for the plates, there was a nominal six tenths nickel added, spec calling for a five tenths minimum, so it ends up just a little above that. Quite a few of the welds; it is similar, but there was a time when they deliberately put in 1 percent nickel, so we have a few weld points at a little over 1 percent.

(Slide)

MR. RANDALL: Now that formuli that I showed I said was the guts of the guide, that was for mean values, best

estimate values delta RT NDT, so in the guide, we then required that they add a 2 sigma margin term initial plus the delta, plus 1 sigma which we obtained directly from the regression analysis that Guthrie and Odette did on their data, and this is simply a plot that I drew up to see if we should be at a constant value for all calculated values or whether we should add a percentage, and I chose to make it a constant value except for very small calculated values.

Well, that's the basis for the guide, being a little repetitious, but to summarize the fact that we have three formulas on the table, Rev. 1, PTS rule and Rev. 2.

I talked about several of the comparisons here. Rev. 1 was upper bound curves, and these two were mean curves. Rev. 1 had phospherous. These have nickel. Rev. 1 had a steeper slope on the log log plots which we typically use for the trend curves, largely as a result of the fact that it was about, two thirds the data base was about two thirds test reactor data. There was--ten to the 19th is now .27,.28.

DR. SHEWMON: How big does log F get at end of life?

MR. RANDALL: Well, F, we say F cannot get more than ten to the 20th. You are wondering does this ever start to reduce in value?

DR. SHEWMON: My father says, would say did it ever amount to a hill of beans or whatever, yes.

MR. RANDALL: We--yes. This, this function passes

through a maximum at about two times ten to the 20th, so we have to say in the guide we are limited to, to fluences no greater than one times ten to the 20th.

DR. SHEWMON: Hope nobody gets up there for other reasons.

MR. RANDALL: Well, right. The data base goes to about seven times ten to the 19th, so that's one of the fringes of the data base that we need to explore in the future.

(Slide)

MR. RANDALL: Most of these points have been covered in comparing Rev. 2 to Rev. 1. One dimension, Rev. 1 did not talk about how to calculate attenuation through the wall. We had procedures, but they weren't actually spelled out in the guide, so that's one thing that Rev. 2 adds is in the attenuation procedure, and there we do use DPA in consideration of the fact that the energy spectrum does change a lot when you go through the wall of the vessel.

DR. SHEWMON: Say what DPA is, will you?

MR. RANDALL: DPA means displacements per atom. It is the number of atoms displaced as a ratio by a given fluence. For example, ten to the 19th neutrons of E greater than one MEV in the spectrum, it is typical of the inside wall of the vessel, means that about 1.6 percent of the atoms were displaced, ion atoms were displaced.

Well, because of the attenuation of the neutron energy going through the wall, we needed this weighting function to take account of those that have fallen below one times ten to the 19th but are still significant, and we used DPA as the best available. It is in ASTM standard. It is physically related to the extent that that's what neutrons do is displace ion atoms, but we don't use it to derive formulas from first principles. We just use it as a weighting function to get the spectrum effect.

The reg guide also describes how to use plant surveillance data, what the criteria are for credibility, and then how to use it to delta RT NDT, and that's something that is new in Rev. 2.

(Slide)

MR. RANDALL: Well, public comments generally were quite supportive of that basic equation in the guide, the tables and the fluence function, and this is illustrated by the fact that those now appear also in ASTM Standard E 900, and they appear in or will appear in Section 11 of the boiler code, so there is general public acceptance of that.

There is less complete acceptance about how to calculate that attenuation through the wall, and a few other things. If you--this is the comment, and this says whether or not we accept it. Particularly the British, but overseas comments were to the effect that we should have a phospherous

term and we should be more precise about the low copper end of the field you might say, and we agree when we get surveillance data that gives us a basis for doing that, we probably will have to refine the chemistry function in the table and we may some day have a phospherous factor particularly for low copper material.

There were some other corrections made. Here we had said when delta RT NDT is small, that they should add one half of the measured value of the inside surface. We should have said or calculated value. We should have said within half of the calculated value at depth in the wall. Things like that were fixed.

A number of comments asked for more credit for the plant-specific data. We weren't able to really honor those requests very much. There is a--because of the amount of scatter, we are fairly reluctant to use the very small number of data points. We tend to take refuge in the overall regression analysis where we had a hundred points or so. If they had their own plant-specific data then we give them credit, largely because at least those data saw all of the ups and downs in power and temperature that the vessel valve water saw, so That's a plus for a plant data.

There were comments about our impact on plant operations which I will come to.

(Slide)

MR. RANDALL: For the PWRs, if they were using Rev. 1 as the base for their pressure temperature limits and they go to Rev. 2, these are our calculations of how much the pressure temperature limits will have to move up scale. It is done for all the operating PWRs. As you can see, the bulk of them will have to move those limits 50, 75, even a hundred degrees.

To illustrate that, the impact of that, this is another pressure temperature diagram, still a little bit schematic, that shows the complications brought on by the low temperature overprotection system that all PWRs are required to have.

(Slide)

MR. RANDALL: After having some 30 incidents back about ten years ago, the NRC required a low set point relief valve to be in place, quote, at low temperatures to protect pressure temperature limit automatically as well as by administrative procedures.

That's illustrated by this heavy line. This is the set point on that valve. Some plants have a system that adjusts that set point as the temperature rises so that they track this curve fairly regularly, but some don't, and as a result of that, instead of having an upper limit backed on considerations like so, they have a square corner limit which gives them a problem with the operating window temperature

when this corner gets out close to the limit based on subcooling function.

We have tried to address this by defining in our standard review plan what we mean by the requirement at low temperatures, and from fracture considerations, we have said well, if the metal temperature at the tip of the flaw that is controlling in this calculation is RT NDT plus 90 or above, you don't have to protect the P-T limit automatically. You protect it administratively, and that actually moves this vertical line or establishes a vertical line. It was roughly 60 degrees below this. This line was drawn by some utilities who interpreted our regulations to mean you had to protect the the whole curve clear up to the pressure at which the code protected it, 2400 pounds. We never did say that, and so we clarified things by saying what we did mean by the low temperatures, and that gives some relief on this window closing.

That doesn't solve the whole problem, however, because you see, by having a relief valve set point here, this pressure window is reduced by the fact that you have to have a set point a little bit below the Appendix G curve so they don't violate it, and then they have to operate 50 pounds or so below the set point because they don't like to lift that valve and blow down a lot of water and maybe drop the pressure below this pump seal requirement, so there is a window and

pressure that also gets constrained and that we are not able to do very much about from a regulatory standpoint.

We have had a number of meetings with owners groups from Westinghouse and Combustion venders and these are the remedies. I already mentioned this one, and this, and that's a minor one there, but to--the big issue is would it be possible to justify having the set point above the Appendix G curve based on considerations of probability of occurrence of the LTOP event or the expected severity of the LTOP event? And for this, of course, I have to work with the systems people in NRR and they have told the owners groups that the key thing is to get the probability of occurrence down below the number that defines normal operation or anticipated operational occurrences; in other words, down below one in 40 per reactor year, once in the lifetime of a plant, which comes out a probability of one in 40.

To get that probability down there, almost certainly it requires that they establish a bubble, nitrogen bubble or steam bubble in the pressurizer at the very beginning of the start-up, not later on in the start-up, so that's still going on. Resolution will have to take place with discussion with individual utilities for their own system.

(Slide)

MR. RANDALL: For the boilers, a normal operation, normal start-up, they don't have any problem because having a

vapor space in the top head of the vessel, they ride this curve, and so for normal start-up, when they are not water solid, they have no way, have almost no way to approach a fracture limit since they are constrained to be over there.

However, for hydro test, where they can't use nuclear heat, and they have to be water solid, the time required to get the temperature gets longer and longer as the temperature gets up toward a hundred degrees, and that they say is an economic impact on the plant.

They also have a problem because the tech specs say that when the water temperature exceeds hundred F, the containment must be closed and the safety systems operable, so that makes it harder to get in and do the inspection for leaks that is required by the code.

DR. SIESS: What is the basis for that requirement?

MR. RANDALL: Well, I can only give you a general answer. It is simply that someone felt when the water temperature was above 212 Farenheit, if there was a rupture or a bad leak, they would flow a lot more material overboard than if it was below.

DR. SIESS: Was the 200 set as 12 degrees below boiling to be conservative or was it related to boiling at all?

MR. RANDALL: It was related to boiling. It is nominally 212. Most of them actually wrote the tech spec as

200F just for cons·rvatism.

CHAIRMAN KERR: Is that the case even when there is no fuel in the vessel?

MR. RANDALL: This is with fuel.

CHAIRMAN KERR: Is the hydro run with fuel?

MR. RANDALL: Yes, it is. Well, initially, when the plant is new, there is a system hydro before the fuel is put in, but after that, every time they take the head off, there is a leak test run at operating pressure, so that's about one a year, and about every ten years, there is a more severe hydro or when they have made repairs.

CHAIRMAN KERR: You say that they can use nuclear heating or at least they can use fission heating?

MR. RANDALL: They can't be critical.

DR. SIESS: Pump?

MR. RANDALL: So they rely on pump heat plus whatever residual heat there is from the core, depending on how long they had been down.

(Slide)

MR. RANDALL: Well, so this is a hydro test problem. We have had a two reports.

CHAIRMAN KERR: What would happen if you did this fission heat?

MR. RANDALL: Well, we have another requirement that before they go critical, the water level has to be in the

normal, in the normal range, and that means that to get the pressure, they would be at 550F, and which means they would be doing hydro test with 550F steam.

CHAIRMAN KERR: That is not proper.

MR. RANDALL: We just don't feel that is.

DR. SHEWMON: System has to be solid to do a hydro test, is that it, since there is no pressurizer?

MR. RANDALL: If there is a bubble in the, if there is a vapor space in the top of the vessel, you have to get 550F pounds pressure. That was my first--

DR. SIESS: What is the objection? You require the, you don't require--cold hydro, don't want it at 550, is that it?

MR. RANDALL: Right. We want it to be water solid.

CHAIRMAN KERR: Why?

MR. RANDALL: For safety reasons, in case there is something that ruptures when you have the test.

DR. SIESS: Hydro, you don't want a steam bubble.

CHAIRMAN KERR: It is safer to have water coming out than steam?

MR. RANDALL: Right, a lot lower energy.

DR. SHEWMON: Less energy pumping up all that gas.

MR. MICHELSON: Comes down faster, too.

MR. RANDALL: The remedies we really aren't able to provide a very good remedy for that. The two-step hydro has

been proposed. That is being debated at the ASME Section 11.

CHAIRMAN KERR: What is two-step hydro?

MR. RANDALL: At two-step hydro, they would go following all the rules, to the highest pressure consistent with the 200F limit. They would go in and do the visual inspection for leaks and then come down and put the water level normal, go to hot standby, repeat the leak check at 550F, not by visual inspection, but by reading the leak test instrumentation.

Well, this isn't quite consistent with the way the code is written, and the code may get rewritten to make it available to us, but right now, it is not, so I did ask for information about the costs of auxiliary boilers. It turns out that almost half of the BWRs have an auxiliary boiler that could be used to provide heat to supplement the pump heat so that they don't have to grind those pumps for 20 hours or whatever to get to the 200F or 220.

MR. MICHELSON: How are you going to get heat input from an auxiliary boiler?

MR. RANDALL: It gets plumbed into the system. I'm sorry, I can't give you a good systems answer.

MR. MICHELSON: Danger or something?

MR. RANDALL: Yes, but as to which ones they use and exactly how the piping goes, I don't know.

Well, from a cost standpoint, we asked for numbers,

and I was given numbers from two utilities that had looked into this situation, and it looked to me that the amount of time saved in power costs resulting from that, power costs saved, would easily pay for the auxiliary boiler system, and I, I think when we are all done working all the other options, that some plants will probably come to the auxiliary boiler. There is one now that has it, though I am not sure they have actually used it, has it, you know, in place with all the plumbing to do this job.

(Slide)

MR. RANDALL: Well, this is the final story on the guide, how to get it implemented. There will be a generic letter that goes out to each utility, a cover letter on the guide, and it says, of course, first off we are now going to use Division 2 to review any pressure temperature limit submittal or other fracture analyses.

It then says be advised that many plants will have to change their pressure temperature limits, and asks them to do their analysis, also do the analysis of the impact on their LTOP system or whatever, and within six months, give us a plan and a schedule for when it is going to be accomplished.

And finally, the letter says that whatever actions are required, including changing, updating the P-T limits, they must be accomplished within two refueling cycles or roughly three years. So that's the story on the guide.

CHAIRMAN KERR: What is the European reaction to this?

MR. RANDALL: Well, to my knowledge, most of them now are using guides of their own, most of them. I don't have standards. I have knowledge on that, but I believe most of them are using guides of their own.

CHAIRMAN KERR: I don't know. I don't understand that answer. What I am trying to find out is are they using components that would be similar to ours? If they are not, why not?

MR. RANDALL: I'm afraid I don't have the full answer on that.

DR. SIESS: Do they make distinction between base metal and weld metal?

MR. RANDALL: Yes. From the comments I have got, they have lower chemistry factors for low copper material. Many of them have a phospherous term. By many, I say the British, the French do.

CHAIRMAN KERR: I would think that on an issue of this importance, you would at least want to know what they are doing and why. Is there some reason that you don't trust them or is it proprietary data that is difficult to get?

MR. RANDALL: Some of the data is proprietary. I think we felt we are justified in doing what we are. We are using our own plant data.

CHAIRMAN KERR: I mean you have to draw your own conclusions, but essentially if information exists that might bear on your decision, it wouldn't be a bad idea to have it.

DR. SHEWMON: I think everybody would agree with that. One of the things that makes more variability is that this is caused by trace elements, and the variability of trace elements differs enough from country to country with how they make their steel and where they get their ore so that the pressure vessel steels they use in one country don't provide the same universe of things to work with or the same residuals as another, and so there is likely to be less compatibility of data than you might have expected from say everybody using steel pressure vessels.

CHAIRMAN KERR: I got the impression we didn't have the data, and so it seems to me it is difficult to draw any conclusions from it if you don't have it.

MR. RANDALL: Most of their data are industrial test reactor data because they don't have as many plants with as many years as we do. Now their surveillance data is hard to get. I only have three or four.

CHAIRMAN KERR: Do they have our data?

MR. RANDALL: They could have. It is not, it is not classified.

DR. SIESS: Would our data do them any good? Is their steel the same as ours?

MR. RANDALL: No. Oh, I am sure they study what we do, and because of the comments that we get. As I say, I don't think they use it directly, partly because our steels are that much different.

DR. SHEWMON: What do the Japanese do? You didn't mention them.

MR. RANDALL: You know, I don't know.

DR. SHEWMON: Any other questions? Okay. Thank you very much.

There is a very brief letter which we will have, is available this afternoon if somebody wants to read a short letter and get a feeling of accomplishment. If not, we can do it tomorrow morning.

The other item then has to do with low flux embrittlement of structural steels. We have written two letters to Stello on this.

The basic question is given that the low flux or effects do exist, is it a matter of safety concern? The second letter indeed got people's attention, and it also got publicized as an article in the Wall Street Journal and there has been some inquiries from the Hill about really what is the status of this difference of opinion at this point, and so we can discuss later whether we write a letter on this or not. There are some arguments for it, just to let people know where we stand.

DR. SIESS: If we don't know by now--

DR. SHEWMON: I guess that's where we stand with regard to the staff's program, and so the staff is now looking at the types support, the stresses in these supports, and the indeed consequences of the failure of the supports even though that's very unlikely for reasons that they will go over. I think all of these things indicate that there is not a safety issue at this point.

One of the things they will be getting over a longer period of time is better data on what the transition temperature is, but Mike Mayfield will go over this. Why don't you go ahead?

MR. MAYFIELD: I am Mike Mayfield. I am going to spend a little bit of time this afternoon telling you about what we are doing on the low temperature, low flux embrittlement question for reactor support structures.

As I looked at how best to put this story together, and summarize what we told the Metal Components Subcommittee, I decided that perhaps the best way to approach it was to start by describing the issues, and the staff's current assessment of the matter, then turn to a brief description of the low temperature, low flux problem and how we characterize that damage, and then end by describing for you the research program that we have in place to deal with the issue.

So we have elected to pose this as a question. Is

there a current or future threat to the safety of nuclear power plants due to the more rapid than expected embrittlement of reactor pressure vessel supports resulting from low temperature irradiation at a low flux level?

In considering that question, there are three critical factors to keep in mind.

First, you must have enough neutron irradiation to embrittle the supports. That seems a statement of the obvious.

Secondly, you must have a crack in that support in the embrittled material.

Now finally, the stresses in the support must be high enough to produce a critical stress intensity for the crack in the embrittled material.

Now as we go along, you will see a little bit where those factors come into play.

Current assessment in the staff, we are currently seeking documentation and data to determine whether the NDT temperature for any of the plant supports exceeds the operating temperature for that support. Now as I looked at this, going into it, it seemed like a fairly straightforward problem, not necessarily an easy one. We started collecting data.

DR. LEWIS: The thing you flashed by us so quickly a moment ago said something about current supports reliability

is judged to be accurate.

MR. MAYFIELD: I would like to come back to those if I could. I will deal with these bullets in turn.

DR. REMICK: One of your earlier slides you had from low temperature irradiation, why the stress on low temperature? Is that because--

MR. MAYFIELD: It turns out to be more damages at temperatures in the 120, 150 degree range than at 550 degrees, so the temperature is one of the critical variables.

DR. LEWIS: More damage or just less self-annealing?

MR. MAYFIELD: The net result is we get a greater shift in the nil ductility.

DR. LEWIS: Immediately after or only after you had time for self-annealing?

MR. MAYFIELD: Immediately after.

DR. SHEWMON: Self-annealing.

DR. LEWIS: As it goes, it has got to be self annealing feature.

MR. MAYFIELD: Okay. Oak Ridge is the primary contractor we have working on this problem. As they have looked at the support types for all of the U.S. light water reactors, we have grouped them into five categories, and I have a series of slides to illustrate what these supports look like.

First category is skirts. We have all but one of

the boiling water reactors supported on a skirt, and approximately 10 percent of the PWRs. This is the, nominally all but one of the B&W PWRs set on skirts. Long columns in about 10 percent of the products. This is principally the CE system 80s. There are a few other plants apparently that sit on long columns.

Shield tanks, these are the Stone and Webster plants. Where we are, Stone and Webster has an AE and we pick up about 10 percent of the PWRs. The largest category is for what we are calling short columns, and that I will show you a couple of examples. There are a lot of things that we have classed as short columns for want of anything else to call them.

Finally, we have one BWR, Big Rock Point, that hangs on suspension studs.

DR. SIESS: Short column includes nozzle support?

MR. MAYFIELD: Yes, sir. All of these are nozzle support.

DR. SIESS: Meaning?

MR. MAYFIELD: I will show you. Looking at a couple of examples of skirts, GE BWR--push this up so you can see the skirt. Skirt is nothing more than a cylindrical shell welded to the lower head and then bolted to the shield wall or in other cases, the base mat.

DR. SIESS: This is a typical BWR?

MR. MAYFIELD: This is a typical BWR, yes, sir.

DR. SIESS: All the way up through the BWR 6s?

MR. MAYFIELD: Yes, sir. The only one that doesn't set on some version of this skirt is Big Rock.

DR. SIESS: That ain't typical anyway.

MR. MAYFIELD: No matter what you do with it! The B&W PWRs again set on skirts, nothing more than a cylindrical shell welded to the lower head, anchored to the base mat.

(Slide)

MR. MAYFIELD: Now long columns are pretty much just what the name implies. It is a long forging that at the upper end is attached to an assembly that the nozzle sets on. The lower end, you again have an assembly that anchors you to the shield wall and in between is nothing more than a long forging. These tend to be A 508 forging material. They will be 30 inches wide, somewhere between 11 and 13 inches thick, solid rectangular beam. And it plainly passes the mid-plane of the core.

(Slide)

MR. MAYFIELD: Now shield tanks, I must confess the picture that was presented by the Stone and Webster engineer during the subcommittee meeting I liked a whole lot better than the one I had, so I thought it made it a little easier to see what shield tanks really look like.

You have an inner cylindrical drape and shell that

comes up to the nozzle level and anchors to the base mat. There is an outer shell that is welded to the inner shell, water circulated through the annular region. The loads are transmitted to the base mat through the inner shell. There i , it is a nozzle support design, and there are slider assc s to accommodate the thermal expansion.

DR. SHEWMON: That would have all kinds of internal cross-members?

MR. MAYFIELD: Yes, sir. Internal baffle, plus the Stone and Webster fellow pointed out there are typically a grout to the concrete shield wall, so that you provide some additional stability here between the shield wall and the outer shell.

DR. SIESS: How many of these do you have?

MR. MAYFIELD: Thirteen.

DR. SIESS: Which ones?

MR. MAYFIELD: The Stone and Webster designed plants--I'm sorry. I don't have the list with me.

DR. SIESS: That's all right.

MR. MAYFIELD: Apparently Stone and Webster is the only AE that used this design as far as I know. Okay?

(Slide)

MR. MAYFIELD: Short columns, it is kind of a large category, and there are, 70 percent of the PWRs are set on what are loosely called short columns. There aren't quite

that many different designs, but it pushes it. Short column normally or what we have taken as a short column, you have a nozzle slider assembly, sets on a fabricated box beam, and then depending on the exact design, the fabricated box either sets directly on the shield wall, or sets on intermediate steel structure that then sets on the shield wall.

DR. SHEWMON: Would you show me where the core, upper core level is?

MR. MAYFIELD: Upper core level is just about here.

DR. SHEWMON: So actually there is not a lot of difference in flux outside the core between the bottom of that short column and the nozzle, is that right? I mean--

MR. MAYFIELD: That is not quite correct. We are finding that in some of the cavity, we get some streaming that originally which hadn't been anticipated, so the higher flux comes up or higher fluence comes up a little bit higher in elevation than we used to think, but we do have some of these short column designs where the lower end sets just about the core mid-point, so there are some plants in this category that have elements of the support that are at the, within a foot or so of the core mid-plane.

DR. REMICK: What is the purpose of the box-like structure?

MR. MAYFIELD: It just is, is the--you mean here?

DR. REMICK: Yes.

MR. MAYFIELD: It is simply the thing that the slider assembly sits on.

DR. REMICK: Why that design?

MR. MAYFIELD: I'm sorry. I don't know.

DR. SIESS: Have to have something that will let it move.

DR. REMICK: I was thinking why couldn't it just be a column? Why a box-like structure.

DR. SIESS: Ask the Structural Engineer Society.

DR. SHEWMON: Sliding of this is actually radially, as it heats and cools?

MR. MAYFIELD: Yes. Another variation on what we have called short columns, here is the slider assembly, sets on this fabricated box beam. That then bolts to some horizontal wide flange beams. In this particular design, there are three of them that span the box beam. The horizontal flange, flange beams then attach to some vertical columns. Those vertical columns then are either attached to or embedded in the shield wall. Again, it varies a bit from plant to plant.

This beam has a positive bend and moment from the day they set the pressure vessel during construction. This vertical stud has a tension or vertical column has a tension element. It may not actually be in tension. It may just have less compression than this column, and that's part of what our

stress analysis is going to lead us to determine. I can't tell you for certain today whether this is in tension, but there is a reasonable prospect that it is.

DR. SIESS: How many have you got like that?

MR. MAYFIELD: Somewhere between one and three.

DR. SIESS: Who does those?

MR. MAYFIELD: It is a little bit different. It is with--this particular one comes from Turkey Point.

DR. SIESS: These are all PWRs?

MR. MAYFIELD: All PWRs.

DR. SHEWMON: He is a civil engineer. Make him feel right at home!

DR. SIESS: I am not very proud of it!

MR. WICKMEN: It should be pointed out those two columns are set in concrete. They have got Nelson studs on them. They are embedded in concrete, those two columns on the left.

DR. SIESS: They look like concrete columns to me.

MR. MAYFIELD: They are steel columns, but they are embedded, this particular, they are embedded in the concrete.

MR. WICKMEN: Whether or not they are in tension or compression, those particular columns, being set in concrete, doesn't make an awful lot of difference.

DR. SHEWMON: Got enough stress risers.

MR. WYLIE: Probably very heavily reinforced, too,

isn't it?

MR. MAYFIELD: We are not talking about a lightweight structure here.

Finally, our friend Big Rock, the only one of the plants that is like this, has 24 studs that surround the vessel. There is a flange welded to the outside of the vessel. There is another flange that is embedded in the shield wall, and there is a stud that runs between those two and supports the vessel. The top of the core sets just about here. Mitigating considerations, this is probably hot temperature-wise, so we are not really looking, at the least the initial assessment of it is that we are not really looking at a low temperature embrittlement problem.

DR. SIESS: Is that Big Rock?

MR. MAYFIELD: Big Rock.

DR. SIESS: How many years has it been there?

MR. MAYFIELD: I'm sorry, I don't know.

MR. WICKMEN: It is '60 something I think.

MR. RANDALL: More than two.

DR. SIESS: I have been around 20. It was licensed long before then.

MR. WARD: Chet, the same thing.

DR. REMICK: How big are the studs?

MR. MAYFIELD: I'm sorry, I don't know. That is part of--That's what makes it interesting. Every time you

want to go look at something in detail, then you find yourself out talking to the utility, and then you end up talking with the AE and it just compounds, so I'm sorry, I can't give you the exact answers.

So again, what we have found when we started trying to get documentation to put a firm number on the NDT today for any of the supports is it got a little messy trying to get detailed information.

However, in the process of looking at the supports, and all that is associated with them, we have come to be of the opinion that today, support reliability is adequate. Now what has led us to that judgment?

DR. LEWIS: And what it means we will find out.

MR. MAYFIELD: Several factors that we have considered--first, the stresses are generally compressive, although plainly there can be areas of tension. For Mode 1 loading--I'm sorry, sir.

DR. LEWIS: I just want to pursue my education at everybody's expense.

Stress is a tensor we physicists believe, and therefore dividing it into compression and tension is really not an adequate description of the stress field.

DR. SIESS: It is to an engineer.

DR. LEWIS: Well, let's go beyond that. At the subcommittee meeting, I was treated to a very beneficial

education in the meaning of Mode 1, Mode 2 and Mode 3 so that whereas a few weeks ago I didn't know what the terms mean, now I speak the language fluently, but even so, even that is an inadequate description of a stress field which really is a tensor, and therefore, the stress, compressive actions are shear stresses along across another plane, and when I teach this subject to physicists, you know, who don't know Mode 1 from Mode 3, we make a big to-do about the fact that most of the failures are in the maximum shear plane, even though under compression, so I find myself insufficiently impressed by argument No. 1, and perhaps you will fix that as we go along.

MR. MAYFIELD: I was prepared to deal with it.

DR. LEWIS: Good.

MR. MAYFIELD: Okay.

DR. LEWIS: That's the end.

MR. MAYFIELD: Unfortunately, I can't give you a quantified answer today, but we have, we heard your question. We heard this same question from Dr. Shewmon Monday, and we have set Oak Ridge to looking at it, and I would just as well deal with it now.

We have stress intensity factor solutions for Mode 2 which is the sliding shear mode, and Mode 3, which is a tearing shear mode.

We have looked at those solutions for cracks and it is principally of interest I think for the column, the long

columns which are most notably in compression as opposed to some mixed mode fracture.

DR. LEWIS: They are also most specifically anisotropic in the stress field.

MR. MAYFIELD: What we are finding is that again without being able to quantify it for you, Oak Ridge told me as late as four o'clock yesterday afternoon that no, we still don't think Modes 2 and 3 will be controlling factors because it tends that that shear failure, shear loading tends to want to make the cracks turn. It requires very high loadings and compression which generally we don't get. These are qualitative arguments.

DR. LEWIS: That's what I was going to say. It is all very convincing except that things break for quantitative reasons, not qualitative reasons.

MR. MAYFIELD: Yes, and we are in the process of getting more information. We thought after the subcommittee meeting that we could send Dick Sheverton home, have him get with his colleague and put this to bed. Wasn't quite that straightforward. There is not, there has not been a lot of work in steel structures for compression loading and dealing with the Mode 2 fracture. There is some, and we are looking at it now.

DR. LEWIS: There are two alternatives. Either I learn your language or somebody translates the results into

physics for me.

MR. MAYFIELD: We will attempt to translate.

DR. LEWIS: Thank you.

MR. MAYFIELD: All right.

DR. SIESS: Have you worked brittle, nobody has worked on brittle fracture in compression of steel?

MR. MAYFIELD: Not extensively; Neal Randall and I had something of a conversation yesterday afternoon for Mode 2 failure. The Mode 2 loading is cleavage. Cleavage fracture is a misnomer. Can you have cleavage when you are talking about shear? It is not entirely clear that that's makes sense.

DR. SHEWMON: If it is, the only brittle fracture mode is cleavage, that is implicit, assumed.

MR. MAYFIELD: Yes. Okay. All right. Looking at skirt supports, the skirts simply do not receive sufficient fluence to become embrittled, and we have lost one of those three factors that I mentioned as critical factors, so skirt supports by and large are out of the consideration.

The one other factor that I personally have found most persuasive, fractures, if you can get them, the fractures in one section or one component of the support structure are not likely to result in complete failure of the structure because first of all, they, the support structures include redundant load paths, and secondly, they are over design.

Now to show you what we mean by over design, we have pulled up some information from earlier studies looking at the margins for heavy component support, pressure vessel pump, and steam generator. We have summarized here in terms of factor of safety on the SSE, and again, Mr. Lewis in the early presentation asked well, why haven't you described this in terms of a total factor multiplied by normal plus SSE on that sum?

We went home, looked at the data that we had from the report, found that we couldn't, couldn't easily come back with that factor. The observation we can offer you is that the seismic loads vary from 50 to a hundred percent of the normal loads, so these numbers, these factors will not translate to very small numbers expressed as a total margin. Does that make sense? We are still not, we are not going to end up with a little number out of all of this.

DR. SHEWMON: FOS may stand for factor of safety?

MR. MAYFIELD: Factor of safety; I couldn't get it all on my chart.

DR. SHEWMON: I still don't know what 73 factor of safety is or what we are talking about, so maybe you will tell me if I shut up.

MR. MAYFIELD: Well--

DR. SIESS: 37.7 times the stress.

MR. MAYFIELD: Let me--

MR. EBERSOLE: In pursuit of my general reputation as a complicator, I want to ask you a few questions.

Your focus is on the big, massive supports.

MR. MAYFIELD: Yes, sir.

MR. EBERSOLE: Pressure vessels are surrounded by all manner of critical paraphernalia. They are supposed to be seismically competent level protection devices, transmitters, the whole works, just a rat's next of stuff. I hope to heaven these are not getting to be a glass-like consistency, come apart when you shake them and thus be unable to measure the necessary plant parameters.

MR. MAYFIELD: It is my understanding that is not what is at issue. The primary concern as it has been posed and as we have looked at the problem, is my belief that still what we are concerned about is the failure of the large supports.

MR. EBERSOLE: I bring this up because I know that's, of course, the primary focus of the structural engineer, and I invite in the context of the, perhaps the instrument--

CHAIRMAN KERR: Jesse, are those things inside the biological shield generally?

MR. EBERSOLE: I think they are.

DR. SHEWMON: Talking about instrument tubes or pipes?

MR. EBERSOLE: Paraphernalia; I can't tell you at the moment, Paul, where all this is, but I think some of it is inside. You know, the odds and ends and paraphernalia that you measure primary process with.

MR. WYLIE: In-core instrumentation?

MR. EBERSOLE: In-core instrumentation is another case in point; in other words, just the fine structure.

DR. SHEWMON: There is no flux problem in core. That is high flux.

MR. EBERSOLE: All right.

MR. WARD: In BWR, the level instrumentation or piping or something, is that what you are talking about?

MR. MICHELSON: I wasn't in the context--

MR. EBERSOLE: We are talking about embrittlement of iron materials.

MR. MICHELSON: That is stainless steel mostly.

MR. EBERSOLE: The boilers?

DR. SIESS: I am not sure what I am listening to, Jesse and Carl talk, or--

MR. MICHELSON: He just wanted--

MR. EBERSOLE: I opened the subject. Don't just focus entirely but at least raising t. . question, dismissing it, there may be other things around.

MR. MAYFIELD: Our focus, initially our focus at this stage has been on the heavy component supports. That's

where we started, and--

DR. SHEWMON: The other thing, it also has to be on the ferretics because they are the only ones that do this, and you don't use ferretics except for these heavy structural things.

MR. EBERSOLE: I think so. You are right.

DR. SIESS: The factor of safety on the SSE, is that because the postulated failure is under earthquake?

MR. MAYFIELD: Yes, sir. That's why it was originally phrased that way. We have stayed with it because it kind of turns out to be kind of a tough problem given the reports we have available to us. It is kind of a tough problem to express it the other way.

DR. SIESS: And this is the ratio of the strength minus the dead load stress to the seismic stress?

MR. MAYFIELD: That is correct.

DR. SIESS: Hope you will stick with it. It took me two years to get people to do it that way instead of the way Dr. Lewis asked for.

MR. WARD: It seems to me Jesse may have a good point. There may be just a simple answer to it, but it is, even though let's say instrumentation, there may be structural supports for that, some critical level, instruments or something, I don't know how to get a handle on it.

DR. SHEWMON: Inside the vessel or outside the

vessel?

MR. WARD: Outside the vessel.

DR. SHEWMON: Do these things come out of the only copper bottom or try to bring them out of the main pressure vessel as additional penetrations?

MR. MICHELSON: Some of them are moving out the side.

CHAIRMAN KERR: There is someone here who thinks he can add to our store of ignorance.

MR. WICKMEN: Keith Wickmen--if you are talking about level instrumentation, you are talking about a BWR. The BWR, we are not talking about BWR skirt types supports here. They are well out.

DR. SHEWMON: He is not talking about supports. He is talking about whether the, what other things might come outside the supports that are in this region outside the vessel and--

MR. WICKMEN: They are not ferretic. They are all stametic.

MR. EBERSOLE: Are the pipes on the BWR ferretic, the reference pots?

MR. MICHELSON: The Yarway level indicators require long vertical columns, for instance. I don't recall the material. They are de minimis--

MR. WICKMEN: They should be stainless steel.

MR. WARD: How are they supported, though?

MR. WICKMEN: That I am not sure. They may have, may have some others.

CHAIRMAN KERR: Surely must not be, be under high stress.

MR. WICKMEN: That stuff is pretty small and pretty stiff. There may be--

MR. MAYFIELD: If I might, for the cavity region of the BWRs, we are simply not getting enough damage for it to be an issue.

MR. MICHELSON: There must be a region of de minimis flux, you don't worry about it. I don't know how much we are talking about where we no longer worry about it.

DR. SHEWMON: Basically anything outside a BWR pressure vessel has got enough water and steel between it and the core so that it is a no never mind.

MR. MAYFIELD: That is right. And I will show you some numbers on it.

DR. SHEWMON: It is only the PWRs that--

MR. MICHELSON: Even there, there must be a region beyond which we are concerned. Do you know roughly how far that is? Beyond the biological shield or inside?

MR. MAYFIELD: Once you are outside the biological shield, you are down very low.

DR. SHEWMON: Once you are down where the skirt

would be below the vessel, you are apparently--

MR. MAYFIELD: Yes.

MR. MICHELSON: There isn't much inside that shield, though.

MR. MAYFIELD: Some of these have in fact very small clearances, so physically there can't be much in there.

DR. SHEWMON: I realize that if I were any kind of a structural engineer, I would feel very comfortable with those numbers, but I'm not, and I don't.

Can you convert those stresses into psi's or--are we talking about one thousand or 10,000?

MR. MAYFIELD: John O'Brien is my expert on this, so I--

MR. O'BRIEN: The answer is no.

DR. SHEWMON: Thank you.

CHAIRMAN KERR: I want to compliment you on a succinct, a direct answer to a question. I am not being facetious.

DR. SHEWMON: Go ahead.

MR. MAYFIELD: All right.

(Slide)

MR. MAYFIELD: I would finally like to turn to one point that has been suggested as a consideration and something people are very concerned about--support failure.

Pressure vessel support failure does not lead to

failure of the primary coolant loop piping.

DR. LEWIS: That's failure of one support or failure of all at once?

MR. MAYFIELD: I will deal with that. Failure of all at once; the pressure vessel--sir?

MR. EBERSOLE: Is that worse or better than failure of one?

MR. MAYFIELD: Turns out it does--let me get through a couple of slides here and I think I can answer you.

MR. WARD: That is one that is not intuitively obvious. Go whether ahead.

MR. MAYFIELD: Again, as part of earlier work--this slide is a bit larger than the screen I am afraid--we have done finite element analyses of the piping system, the hot leg, cold leg crossover, looking at relative support displacement. Pressure vessel moves relative to the steam generator, relative to the pump and so on. I am showing you here plots of, or a plot of pipe effective plastic strain as a function of relative displacement. I have chosen the hot leg because it gives us the largest strains.

The reactor pressure vessel end, the pipe near the nozzle showing you then effective plastic strain using the ADINA code; we have also used the PIPLIN code. We have used this code because it includes effects of internal pressure where ADINA does not. We get slightly higher strains. This

code is also more expensive to run, so they did most of the work with the ADINA.

DR. LEWIS: I hate to sound like a repetitious person, although I am and sometimes I have trouble concealing it--because strain is also a tensor, and I wonder which strain it is we are talking about.

MR. MAYFIELD: Axial strain.

DR. LEWIS: Axial elongation, not shear?

MR. MAYFIELD: Axial elongation; there is no reference to shear strain in this plot. John?

MR. O'BRIEN: You are right.

MR. WARD: Are you going to congratulate him again?

DR. SIESS: That was two words.

MR. MAYFIELD: What I have here which you can't see very well is relative displacements of 7 inches between the pressure vessel and the steam generator, and the strain, axial strain in the pipe is in the range of 2 to 4 percent. Failure strains for this class of materials, based on uni-axial tensile bars, is in the 20 to 40 percent strain range, so for a 7 inch displacement, we have a substantial margin between axial strain in the pipe, and the kind of strain we would expect at failure based on uni-axial tensile bar.

DR. SHEWMON: We aren't dealing with these elastic conservative calculations we always deal with. Here we have gone into it is fully plastic or gone plastic and worth

hardening.

DR. LEWIS: I understand that. That doesn't, non-linearity doesn't give me as much pain as loss of three dimensions, but when you say uni-axial--I just want to understand--when you say uniaxial, you mean a pull and break experiment, so that is not uni-axial.

MR. MAYFIELD: Uni-axial loading, it is being pulled on one dimension.

DR. SHEWMON: Uni-axial loading.

DR. LEWIS: A very special test.

DR. SHEWMON: Bending the beams and what, the pipes is beams.

MR. MAYFIELD: That is correct.

DR. LEWIS: That's a completely different stress.

DR. SIESS: A strength based on a uni-axial test.

MR. MAYFIELD: That is correct.

DR. SIESS: Uni-axial load test.

DR. LEWIS: Which results in unisotropic strain, and then translating to a different set of stress conditions. I think there is weakness.

DR. SIESS: Well, the whole ASME code is based, whole AISC code is based on, whole ACI code is based on always use uniaxial tension tests, tensile strength of material, applied it to bending and everything else--large body of experimental evidence.

DR. SHEWMON: Trust us.

DR. LEWIS: I wouldn't otherwise be on the tenth floor of a building!

DR. SHEWMON: Go ahead.

MR. MAYFIELD: John O'Brien in particular has done what I have called a simplified plastic analysis of coolant loop piping, and he has looked at the minimum total load resistance, the ability of the pipe to support load, and he has taken, doing this analysis, he has taken the smallest diameter pipe with thinnest wall for these plants. He has then looked at the heaviest pressure vessel for these plants, and we are comparing those two situations, so we have the minimum load resistance compared to the maximum load.

Now he has looked at dead weight plus a quarter G earthquake, all but one case down here. Westinghouse, we were looking at a minimum load resistance of some 3,000 KIPS.

DR. SHEWMON: Is that minimum load resistance is not to go plastic but actually break plastic strain?

MR. MAYFIELD: Break the pipe.

DR. SIESS: I have got a little problem. I need some help. I can't quite visualize the piping configuration where the pipe is holding up the vessel. Have you got a sketch that shows that, what is holding up the piping?

MR. MAYFIELD: Shield wall, biological shield wall; let the vessel come down, completely eliminate support

capacity. Let the vessel come down until the pipe sets on the shield wall.

DR. SIESS: Pipe sitting on the shield wall instead of the nozzle being supported on the shield wall?

MR. MAYFIELD: yes, sir.

DR. SHEWMON: I thought we heard at the meeting that indeed in some cases the shield wall was low enough that it would spring back to what was supporting the pumps or the steam generators?

MR. MAYFIELD: We got off into that. You start getting into a very detailed systems analysis. That's not the analysis John performed. Rather we have looked at plastic hinges as they form--John, you better jump in.

MR. O'BRIEN: I think what we did was we calculated the loads transmitted to the steam generator and the cooling pump in the initial phases of the motion downward of the vessel. It takes only about a half inch or an inch of the vessel before the system goes plastic. You see the elastic limits on the piping. Thereafter, you get a mechanism with two hinges at either end, continues to move down here with no additional resistance until it hits the barrier.

In some cases there could be a shield wall. In some cases, there may not be a shield wall, but there is always another concrete wall around and then that wall tends to resist the motion of the vessel downward and then you can

continue to resist additional loads to form another hinge at the wall.

DR. SIESS: Can the pipe take the transverse loading?

MR. O'BRIEN: Transverse--

DR. SIESS: Without snapping?

MR. O'BRIEN: At the wall?

DR. SIESS: Yes.

MR. O'BRIEN: Yes.

DR. SIESS: You account for that.

MR. O'BRIEN: The walls that we are talking about are like 2 to 5 feet thick. They are very thick walls. We even, I did a little calculation on the ability of the walls to sustain the weight of the vessel. There would be no crushing of this piping which is 2 inches thick and--minimum 2 inches, maybe 2 and a quarter inches thick.

MR. EBERSOLE: Is the reinforcing steel affected in the concrete?

MR. MAYFIELD: No--sufficient attenuation.

DR. SIESS: The wall is designed for shielding and is probably--

MR. EBERSOLE: Here they are holding the vessel up with it.

DR. SIESS: Five-foot concrete wall.

MR. EBERSOLE: Hardly a load.

DR. SHEWMON: Okay. Go ahead.

DR. SIESS: John said he calculated that.

(Slide)

MR. MAYFIELD: With that, I guess I would like to turn to a brief description of the embrittlement problem for low temperature, low flux, and how we are characterizing that damage.

I suspect many of you have seen this not. This comes from Oak Ridge, and it really is the figure that got us off on to this.

I am plotting shift in nil ductility temperature as a function of what they describe as integrated fluence. Now this plot is on the basis of neutrons greater than 1 MEV. This is the same basis that Neal Randall was using a bit earlier. These data come from term test reactors. These two points come from the Oak Ridge high flux isotope reactor. They are surveillance capsule data, and it came as something of a surprise to everyone when they tested the samples and got this kind of shift in NDT.

Oak Ridge in trying to decide what to do about that took some of the same material,irradiated it in the ORR test reactor, and indeed it comes back over and is consistent with the rest of the test reactor data.

The principal difference between these two points and these points is the flux for test reactors. You are

talking on the order of five times ten to the 12th neutrons per square centimeter per second for E greater than 1 MEV. For the HFIR reactor, you are rougly four orders of magnitude below that.

Based on this well-controlled data set, we came to the conclusion that indeed there is a flux effect. The question was posed I believe by Mr. Shewmon, okay, what implications could that have on reactor pressure vessel supports? In looking at that question, we can't use E greater than 1 MEV anymore because the number of neutrons in the cavity where there are greater than 1 MEV is a relatively small number.

Rather to characterize that damage, we are using displacements per atom as the damage parameter. Now Oak Ridge had Bob Odette take a look at how best to characterize this, and he has plotted the shift in NDT versus DPA for those material test reactors, so he has taken, has taken these data and now instead of plotting versus fluence for E greater than 1 MEV, we are going to plot versus DPA.

DR. LEWIS: Are these DPAs calculated?

MR. MAYFIELD: They are calculated.

DR. LEWIS: From the known spectrum?

MR. MAYFIELD: Yes.

DR. LEWIS: Mostly S wave scattering?

MR. MAYFIELD: I believe that is true. Neal?

DR. LEWIS: It must be. That's okay. I feel all right putting some of my language into this discussion.

DR. SHEWMON: All right.

MR. MAYFIELD: All right. So plotting NDT versus DPA for the test reactors, we are able to calculate the DPA in the cavity for typical plants from each of the venders for 32 effective full power years. This rate affects Professor Odette's suggestion if we multiply the cavity DPA by ten, we will have adequately accounted for the rate effect, and then one simply determines the shift in NDT for any steel that is in the core, in the general vicinity of the core mid-plane, in the cavity. If we had steel in that region, we can determine the shift in NDT by simply reading off of the plot.

The analysis really is that simple in principle. This is professor Odette's plot. He choses to plot shift in nil ductility temperature as a function of the square root of DPA. We compute the DPA in the cavity region. We multiply by ten. You take the square root. You come into the plot and you read off shift in NDT.

DR. REMICK: Where did the ten come from?

MR. MAYFIELD: To account for this rate effect, that shift.

DR. REMICK: Okay.

DR. SHEWMON: The Oak Ridge people could say it is 20 or something. Is that why the old HFIR points don't fall

on the scatter band?

MR. MAYFIELD: The 20 is based on--this, this distant or shift is nominally a factor of 20, but it is on the basis of E greater than 1 MEV. Odette argues that the number really is more like a factor of ten when we consider it on the basis of DPA, accounting for the soft spectrum. The number really should be more like ten.

DR. REMICK: Is that factor ten based on two data points at Oak Ridge?

MR. MAYFIELD: Factor of ten is based on two data points. This, as I will point to later, this really is a sparse data base.

DR. SHEWMON: To what extent is the fact that Neal Randall came in here an hour ago and said surveillance capsules always give you more shift or the mean does than test reactor data and therefore we are redoing Reg Guide 1.99 also an indication of a flux rate effect with a much larger data base?

MR. RANDALL: Yes, I think it is, at low fluences it is bigger.

DR. SHEWMON: So there is a lot of evidence of that sort? It is not at this temperature, but it is--

MR. MAYFIELD: There is a lot of evidence of this sort that suggests a flux effect or dose rate effects.

DR. SHEWMON: Rate, yes, okay.

MR. MAYFIELD: A rate effect; the reason this is a bit surprising is the magnitude of the rate effect at these temperatures. All right.

(Slide)

MR. MAYFIELD: Now Odette took his analysis and these typical cavity DPAs for each of the four venders. Now again, when we look at these shifts in NDT, the thing you must keep in mind is that these are not analyses of a reactor support. These are analyses of the shift in NDT you would get if you had steel in the high fluence region in the cavity, so it is a bounding analysis in that sense.

B&W would predict very low shifts if we don't include the flux effect. When we include the flux effects, they are talking somewhere in the 80 to a hundred degree C shift range.

GE for the BWRs, we simply aren't predicting much effect. The question about anything that might be in that cavity region, if it is ferretic, it is still not going to receive any appreciable irradiation damage.

DR. SHEWMON: Whose numbers are Centigrade whereas always before we have been talking Farenheit.

MR. MAYFIELD: It is simply the way that his analysis was done, and I took his numbers exactly.

All right. For Westinghouse, and CE, again without the flux effect, we are talking in the 70 to 90, 95 degree C

shift range. With the flux effect a big factor, we are now talking in the 200 to 130 degree shift.

So again, these are the upper limits on the numbers that we would expect to see for shifts in NDT if you had steel in the cavity near the core mid-plane.

(Slide)

MR. MAYFIELD: I would like to turn finally to a description of the research program that we have in place looking at this issue. We have defined an approach to try and at least what I have described as resolve this question. We have already identified the various types of supports for all the U.S. light water reactors. We are going through this information now, trying to identify one or two plants that are the limiting cases, the limits designs.

We are focusing now on the short column category because we at this stage really do believe that will become the limiting design in terms of irradiation damage. Once we have identified these plants, then we will perform detailed fracture analyses for them to look at the potential for failure of the support system due to the low temperature, low flux irradiation problem.

Now we can do a reasonable job we think of estimating loads and stresses. We can certainly hypothesize a crack to look at the potential for embrittlement. We are simply going to have to use the HFIR results. We believe

those results are limiting the upper bound of what we might see, so we will estimate degree of embrittlement based on the HFIR result.

However, parallel with these analyses, we are trying to strengthen the basis for the low temperature, low flux soft spectrum embrittlement problem. We are doing that principally by acquiring material from decommissioned reactors in the support structures. In particular, we are getting samples from the Shippingport shield tank. Bill Schack made a presentation to the subcommittee talking about his plans and program that was in place to acquire samples from the Shippingport shield tank. The Belgians as you may know are shutting down the BR 3. We are looking to see if we can get some of that material, and we will analyze those data, those material samples, to determine the degree of embrittlement first of all, in terms of absolute nil ductility data and then start working backwards to look at what kind of shift i NDT we may have had.

We are looking to evaluate other analyses of support embrittlement. EPRI has performed an analysis that is somewhat different than what Oak Ridge did. We have other people that have been interested in the problem, have looked at it. We don't necessarily believe that we have a corner on the market on how best to do this analysis. We have a way that we are reasonably comfortable with and that we are pretty

ure gives us conservative answers.

As other folks come up with other analyses, we are certainly interested in taking a look at them, and perhaps we can put things together and come up with the best analysis.

Finally, as I indicated, the data base for this is for low temperature, low flux embrittlement. Data base is sparse, about two data points. We are out pushing on the literature, foreign as well as domestic ssources, trying to find out pertinent data to try and strengthen the data base.

All of this work has one goal, and really only one goal and that is to work with the licensing staff to define the appropriate regulatory actions.

And with that, sir, I have nothing else to say. Any questions?

DR. SHEWMON: The bottom line is that if they were brittle, it wouldn't be a safety issue?

MR. MAYFIELD: You have got to have three elements-- a brittle material, crack, and a high enough stress.

DR. SHEWMON: Given the welded bolted structure of this, I am reluctant to go to that but if it was brittle, it has still got this to support and the piping or the concrete walls or whatever at least are long enough for people to know they have a problem.

MR. MAYFIELD: Yes.

DR. SHEWMON: And in addition to that, we don't know

if they are brittle or not, but we are looking into it and we will find out?

MR. MAYFIELD: That is exactly the case.

DR. LEWIS: What would be the indication that they have a problem? If one of them were to sag on to the biological shield, how would they know that?

MR. MAYFIELD: Well, periodically you are looking at the things. If it sags very much, you are going to know because it simply tips over. It will be an obvious visual indication if you are inside containment.

DR. LEWIS: How periodically is periodically? The thing sinks an inch, you said satisfy few inches I think, it is not a big sink.

MR. RANDALL: Remember the top planks when you take the head off to refuel, the top flank is sealed. It is a giant wall.

DR. LEWIS: See it in a year or so?

MR. RANDALL: Certainly see it every refueling.

DR. SHEWMON: If it sagged an inch or two, they would know when they next took the head off.

MR. RANDALL: Yes. That is my initial reaction to the question. Are you--

DR. LEWIS: I wonder if that is really a satisfactory situation.

MR. WARD: I mean to say that this isn't a safety

issue, maybe it is a little bit cavalier. I mean you know, I guess I have to agree that you can't say out of hand collapse of supports would lead to an obvious catastrophy, but I mean this would be something pretty exciting. You know, it is hardly a routine event. It would probably rate an LER or something.

DR. SHEWMON: It might not violate the tech specs.

DR. LEWIS: It might rate an LER after a year or two. I am wondering, even if one looked, one somehow doesn't look for things having sagged an inch or as to when there is as an enormous structure as they are, and sure, if you go and take the head off, you are bound to notice, but this could be a thing which could go on for a long time.

DR. SHEWMON: Sam Brown didn't do a fatigue study. He did a collapse study.

DR. REMICK: Has anybody looked to see that the flux wire penetrates load would be affected by such a movement, that you can detect it by other means?

MR. MAYFIELD: We haven't looked at that level.

DR. REMICK: PWR, the control rod drive piping and things like that--I realize it is not a PWR. We are saying what if.

DR. SHEWMON: Where would you--

MR. WARD: Will the rods go in?

DR. REMICK: Would you see it otherwise?

DR. LEWIS: It would be nice to be clear that one would detect this if it happened.

DR. REMICK: The point I was trying to make, next time you ran your flux wires, that might be some indication you have got a crimping in one of the small lines and resulting shift in the vessel.

MR. WICKMEN: If we saw an inch or so move, you would probably see it on the reactor coolant pipes because if that vibration--

CHAIRMAN KERR: The recorder can't hear you. Would you use the mike? Otherwise we are going to invent some sort of laser system!

MR. WICKMEN: I think if you saw that significant amount of deformation that--

CHAIRMAN KERR: I don't believe that microphone is on.

MR. WICKMEN: I think you would see it on the reactor coolant pump supports. The vibration instrumentation on the reactor coolant pump, if you saw that significant amount of deformation, I think the vibration instrumentation would pick that up.

DR. SHEWMON: Call it vibration instrumentation, but--

MR. WICKMEN: Vibration monitoring instrumentation.

DR. SHEWMON: Suggests it really has to do with

levelness or placement.

MR. WICKMEN: If you--this might cause a permanent set in the reactor coolant pump, and if that happened, you would, it would be picked up when the vibration instrumentation, you know, your shaft, you are talking about displacement there.

MR. O'BRIEN: I think the issue that Keith is raising, if the pump is not vertical in its shaft, it will process and that will cause vibration, so when the vessel goes down, even the small amount, the pump supports which are pretty flimsy will probably rotate the pump and get vibrations as it is going around.

MR. WARD: I would like to think that the first order of defense is that there won't be enough embrittlement to cause collapse and the falling back on the argument that even if the supports collapse is a distant kind of last-ditch argument.

DR. SHEWMON: The awkward part of that is that at this point at least we don't have that information well enough put together to make the argument I think. Is that--

MR. MAYFIELD: That is correct.

MR. WARD: But I mean I think the fact that that distant last-ditch argument is there means it is reasonable to take the time without any sort of emergency measures to develop the other argument, but I am just saying I think the

other argument needs to be developed.

MR. WICKMEN: May I make another comment? One thing you are forgetting about the support site business is you need the load. For example, the loading condition is normal plus the SSE. The SSE ever occur, you would be shutting down regardless.

MR. WARD: Yes.

MR. WICKMEN: The regulations require you to, anything exceeding the OME you shut down and inspect.

DR. LEWIS: The scenario that you, at least I am envisaging is one which you have this magic, sudden collapse doesn't occur, but the thing sort of breaks and sags over a period of time in which case there would be not much vibration, and not much--

MR. WICKMEN: You know, you are talking about something that is almost next to impossible to happen because--

DR. LEWIS: Do you know that, or are you guessing?

MR. WICKMEN: No, I am not guessing. I mean you have got, you have got stresses so low as to be almost insignificant in the shear tanks. They were only 6 ksi, either tension or, either tension or compressive.

DR. LEWIS: I am not quite clear what you said.

MR. WICKMEN: Really low; they are not going to run a crack.

DR. SHEWMON: Don't swallow it, please. Move it away. He is saying that the average stresses, not taking any account of what happens with residual stresses of welds or reinforcing things, are very low, and these are also primarily compressive.

DR. LEWIS: He is summarizing the whole thing by saying it can't happen, if I understand him.

DR. SHEWMON: Because of the very low stresss.

DR. LEWIS: I see. But you know, then this has been a very long briefing for something that can't happen.

MR. WARD: That is our fault. I don't know that is true, but if that were true, we could say it was our fault.

DR. LEWIS: I was not saying that because I believe it can't happen. I have seen it break.

MR. WARD: I think this is a little--

DR. SHEWMON: Do we have any other questions for the staff?

Thank you very much.

CHAIRMAN KERR: Do you conclude that the approach we are taking is a reasonable one?

DR. SHEWMON: Yes.

CHAIRMAN KERR: It appears reasonable to me.

DR. SHEWMON: Yes.

DR. REMICK: I think both of the presentations by the staff this afternoon I thought were exceptionally good,

very logical and so forth. I would just like to point that out.

DR. SHEWMON: I agree. I think they did a very good show job.

CHAIRMAN KERR: I wish they had the value of that. That left me a little bit derived.

DR. SHEWMON: I am sure Mike could have done it in tensor for the rest of us. It just would have confused the engineers.

Since I have given you, picked up 40 minutes, can we take a break until the, at least a part of that?

CHAIRMAN KERR: Wait until the vice chairman and I confer. That's a relative decision. I don't want to make it by myself!

Let's come back at 25 after.

(Whereupon, at approximately 3:10 p.m., the recorded portion of the meeting was adjourned.)

CERTIFICATE

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

Name: Advisory Committee on Reactor Safety

Docket Number:

Place: Washington, D.C.

Date: March 11, 1988

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear ulatory Commission taken stenographically by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

/S/ Catherine S. Boyd

(Signature typed): Catherine S. Boyd

Official Reporter

Heritage Reporting Corporation

ACRS BRIEFING

OFFICE OF SPECIAL PROJECTS

MARCH 11, 1988

TVA Projects Division
Office of Special Projects

OVERVIEW

SEQUOYAH UNIT 2

- CURRENT STATUS: MODE 3
- EVOLUTIONS REQUIRED BEFORE CRITICALITY
  - 24 COMPLETED
  - 10 REMAINING
- CRITICALITY NO EARLIER THAN 03/17/88
- MAJOR ISSUES REMAINING:
  - APPENDIX R CONCERNS
  - OPERATIONAL READINESS

EMERGENCY DIESEL GENERATORS

- EMPLOYEE CONCERNS
  - DIESEL GENERATOR CAPACITY INADEQUATE
  - ORIGINAL LOAD SEQUENCE PRE-OP TESTING INADEQUATE
- TVA ACTIONS
  - REQUESTED RELIEF FROM TECHNICAL SPECIFICATIONS LOAD LIMIT
  - REQUESTED CHANGE IN CONTAINMENT SPRAY ACTUATION TIME
  - LOAD SEQUENCE TIMING CHANGE
    - COMPONENT COOLING PUMPS
    - AUXILIARY FEEDWATER PUMPS
  - TIMING RELAY DRIFTS EVALUATION
  - TESTING AND CALCULATIONS
    - TESTING AT REDUCED LOADING
    - CALCULATIONS AT REDUCED LOADING
    - CALCULATIONS AT FULL LOADING
    - ANALYSIS SUPERSEDING CALCULATIONS
    - EVALUATION OF IMPROVEMENT FACTORS

EMERGENCY DIESEL GENERATORS (CONTINUED)

° NRC REVIEW STATUS

- APPROVED TECHNICAL SPECIFICATIONS RELIEF
- APPROVED CHANGE IN CONTAINMENT SPRAY ACTUATION TIME
- APPROVED ANALYSIS
- AWAITING TVA SUBMITTALS
    * CONTACTOR PICK-UP RECALCULATIONS
    * MOTOR OPERATED VALVES OPEN/CLOSE TIME MARGINS
    * IMPROVEMENT FACTORS

ELECTRIC CABLE INTEGRITY

- ° EMPLOYEE CONCERNS
  - CABLE INSTALLATION PRACTICES
  - CABLE PROCEDURAL DEFICIENCIES
- ° NRC/TVA MEETING 03/13/87
  - DEFINITION OF CONCERNS
    * CABLE JAMMING IN CONDUIT DURING INSTALLATION
    * CABLE PULL-BYS IN CONDUIT DURING INSTALLATION
    * LONG VERTICAL DROP OF CABLE IN CONDUIT SUPPORTED BY 90° CONDULETS
  - METHOD FOR RESOLUTION
    * NRC PROPOSED TESTING AT 300 V/mil ON NOMINAL INSULATION THICKNESS
    * TVA PROPOSED TESTING AT 240 V/mil ON NOMINAL INSULATION THICKNESS
  - NRC ACCEPTED TESTING PROGRAM PROPOSED BY TVA
- ° TVA SUBMITTAL OF CABLE TEST PROGRAM PROPOSED AT 03/13/87 MEETING 04/08/87

ELECTRIC CABLE INTEGRITY (CONTINUED)

- TVA CONDUCTED TEST PROGRAM — 04/22/87
  - TEST RESULTS

SAMPLE DESCRIPTION	SAMPLE SIZE	FAILURES
AIW SILICONE RUBBER-INSULATED CABLES	16	3

- TVA SUBMITTAL OF REVISED CABLE TEST PROGRAM — 07/31/87
- NRC/TVA MEETING ON CABLE TESTING STATUS — 09/10/87
  - TEST RESULTS

NON-SILICONE RUBBER-INSULATED CABLES OUTSIDE CONTAINMENT TESTED AT 240 V/mil ON MINIMUM ENVIRONMENTALLY QUALIFIED INSULATION THICKNESS:

SAMPLE DESCRIPTION	SAMPLE SIZE	FAILURES
PULL-BYS	878	0
JAMMING	45	0

SILICONE RUBBER-INSULATED CABLES INSIDE CONTAINMENT TESTED AT 240 V/mil ON MINIMUM ENVIRONMENTALLY QUALIFIED INSULATION THICKNESS:

SAMPLE DESCRIPTION	SAMPLE SIZE	FAILURES
AIW	16	4
ANACONDA	18	0
ROCKBESTOS	16	3

ELECTRIC CABLE INTEGRITY (CONTINUED)

- TVA ACTION
  - ISSUED PRELIMINARY 10 CFR PART 21 REPORT
  - INITIATED WYLE LABORATORY TESTS

- NRC ACTION

  LETTER TO TVA APPROVING ACCEPTABLE CABLE TEST RESULTS FOR NON-SLILCONE RUBBER-INSULATED CABLES AND INFORMING TVA THAT THE INTEGRITY OF SILICONE RUBBER-INSULATED CABLES REMAINS SUSPECT — 11/13/87

- NRC/TVA MEETING ON RESOLUTION OF ON SILICONE RUBBER-INSULATED CABLES — 11/24/87

  - WYLE LABORATORY TEST RESULTS

    * COMPLETE RE-QUALIFICATION TESTS WITH 10 YEARS AGING ON UNINSTALLED CABLES

    * SUCCESSFUL CONDUCTION OF FULL SERVICE VOLTAGE AND CURRENT IN LOCA ENVIRONMENT WITH INSULATION THICKNESSES AS FOLLOWS:

AIW	4 mils
ANACONDA	4 mils
ROCKBESTOS	6 mils

    * SUCCESSFUL CABLE HI-POT TESTS FOLLOWING LOCA EXPOSURE WITH WITHSTAND CAPABILITY AS FOLLOWS:

AIW	18,000 V (4500 V/mil)
ANACONDA	12,000 V (3000 V/mil)
ROCKBESTOS	12,000 V (2000 V/mil)

ELECTRIC CABLE INTEGRITY (CONTINUED)

- TVA REVIEW OF NON-NUCLEAR STANDARDS AND CONCLUSIONS

  * INDUSTRY STANDARDS

    - ASTM D149
    - ASTM D3755

  * DISCREPANCIES AMONG IN-SITU TEST RESULTS AND WYLE LABORATORY TEST RESULTS

- TVA CONCLUSIONS

  * NO FURTHER WORK WARRANTED

  * CABLES WILL PERFORM INTENDED SAFETY FUNCTION

- CABLE INSTALLATION STATUS

  * ALL AIW SILICONE RUBBER-INSULATED CABLES IN CONTAINMENT REPLACED

  * ROCKBESTOS AND ANACONDA CABLES REMAIN IN PLACE

- NRC STAFF POST-RESTART REQUIREMENTS

FIRE PROTECTION - APPENDIX R

- LATE-FILED ALLEGATIONS
- NUMEROUS ISSUES RAISED
- TVA REQUESTED TO RESPOND
- PUBLIC MEETING HELD 03/08/88
- FIRE PROTECTION INSPECTION SCHEDULED FOR WEEK OF 03/14/88
- MAJOR ISSUES INCLUDE:
  - SPURIOUS ACTUATIONS
  - SENSE LINES

REGULATORY GUIDE 1.99, REVISION 2
RADIATION EMBRITTLEMENT OF REACTOR VESSEL MATERIALS

PURPOSE: PUBLISH REVISION 2 IN FINAL FORM

PRESENTATION TO ACRS
MARCH 11, 1988
P. N. RANDALL

REGULATORY GUIDE 1.99, REVISION 2

I. REGULATORY CONTEXT AND SAFETY SIGNIFICANCE

II. TECHNICAL BASIS FOR REVISION 2 - COMPARISON WITH REVISION 1 AND THE PTS RULE

III. RESPONSE TO PUBLIC COMMENTS

IV. IMPACT OF CHANGING FROM REVISION 1 TO REVISION 2 AS THE BASIS FOR P-T LIMITS

V. IMPACT OF AMENDING THE PTS RULE TO BE CONSISTENT WITH REVISION 2.

CHRONOLOGY

APR. 1977 - REVISION 1 OF REGULATORY GUIDE 1.99 ISSUED.

MAR. 1981 - LICENSING STAFF MET WITH INDUSTRY REPRESENTATIVES ON PTS.

NOV. 1982 - SECY 82-465 SENT TO COMMISSION.

JAN. 1984 - PUBLICATIONS BY G.L. GUTHRIE AND G.R. ODETTE THAT PROVIDED THE BASIS FOR REVISION 2.

JULY 23, 1985 - PTS FINAL RULE (10 CFR 50.61) ISSUED.

SEPT. 4, 1985 - PROPOSED REVISION 2 TO REG. GUIDE 1.99 TO ACRS SUBCOMMITTEE ON METAL COMPONENTS.

FEB. 10, 1986 - REVISION 2 TO REG. GUIDE 1.99 ISSUED FOR PUBLIC COMMENT.

JULY 16, 1987 - RES MANAGEMENT AGREED TO MAKE PTS RULE CONSISTENT WITH REVISION 2 TO REG. GUIDE 1.99.

JULY 24, 1987 - PROGRESS REPORT ON REVISION 2 GIVEN TO ACRS SUBCOMMITTEE ON METAL COMPONENTS.

DEC. 9, 1987 - CRGR MEETING ON FINAL REVISION 2 -- APPROVED PUBLICATION.

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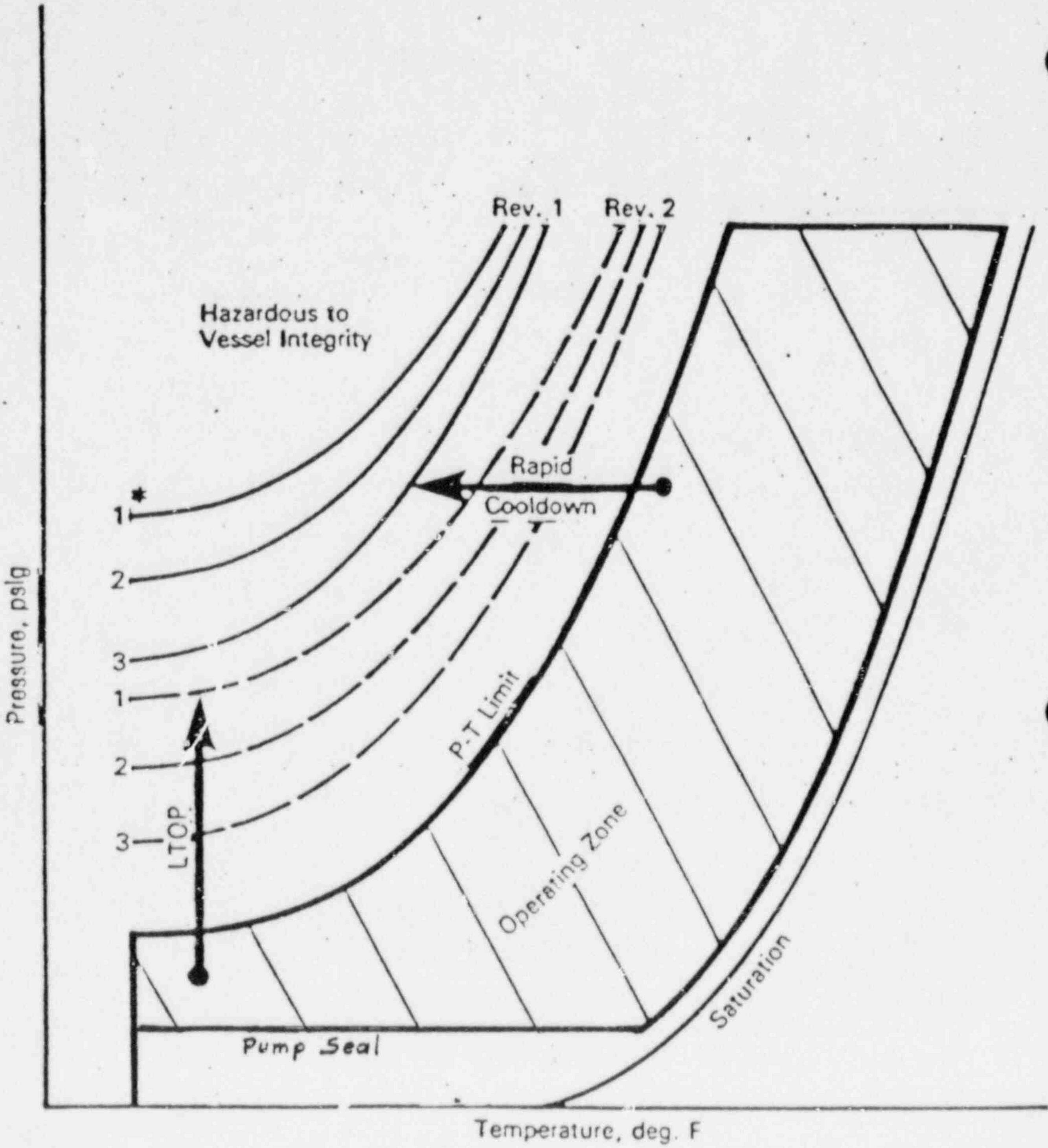


*Note: The three curves represent different cooling rates, Curve 1 being the slowest.

Figure 1 P-T Limit Separates the Operating Zone from Conditions Hazardous to Vessel Integrity

FOUR TYPES OF ANALYSES OF REACTOR VESSEL INTEGRITY
THAT DEPEND ON THE FRACTURE TOUGHNESS OF BELTLINE MATERIAL

1. PRESSURE - TEMPERATURE LIMITS
2. EVALUATION OF FLAWS
3. POST-TRANSIENT EVALUATION OF DAMAGE
4. SCREENING CRITERIA FOR PRESSURIZED THERMAL SHOCK

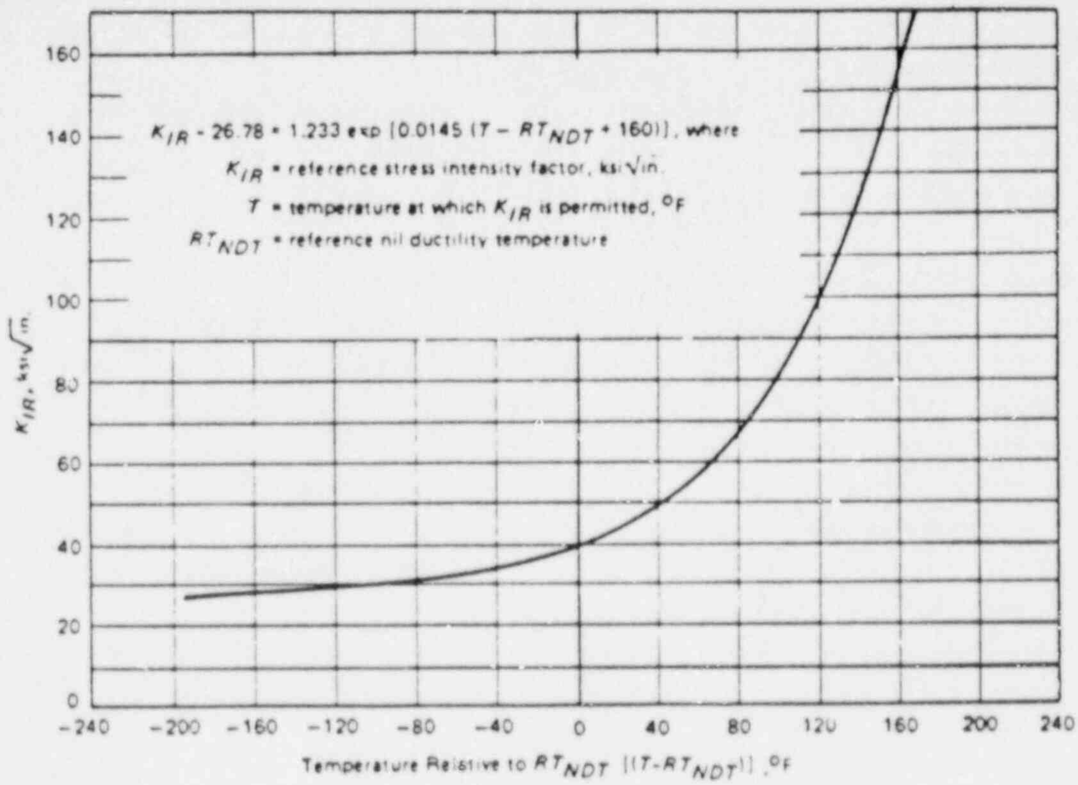

K_{IR} = 26.78 + 1.233 exp [0.0145 ($T - RT_{NDT}$ + 160)], where
K_{IR} = reference stress intensity factor, ksi$\sqrt{in.}$
T = temperature at which K_{IR} is permitted, °F
RT_{NDT} = reference nil ductility temperature
K_{IR}, ksi$\sqrt{in.}$
160
140
120
100
80
60
40
20
0
−240
−200
−160
−120
−80
−40
0
40
80
120
160
200
240
Temperature Relative to RT_{NDT} [$(T - RT_{NDT})$], °F

FIG. G-2210-1

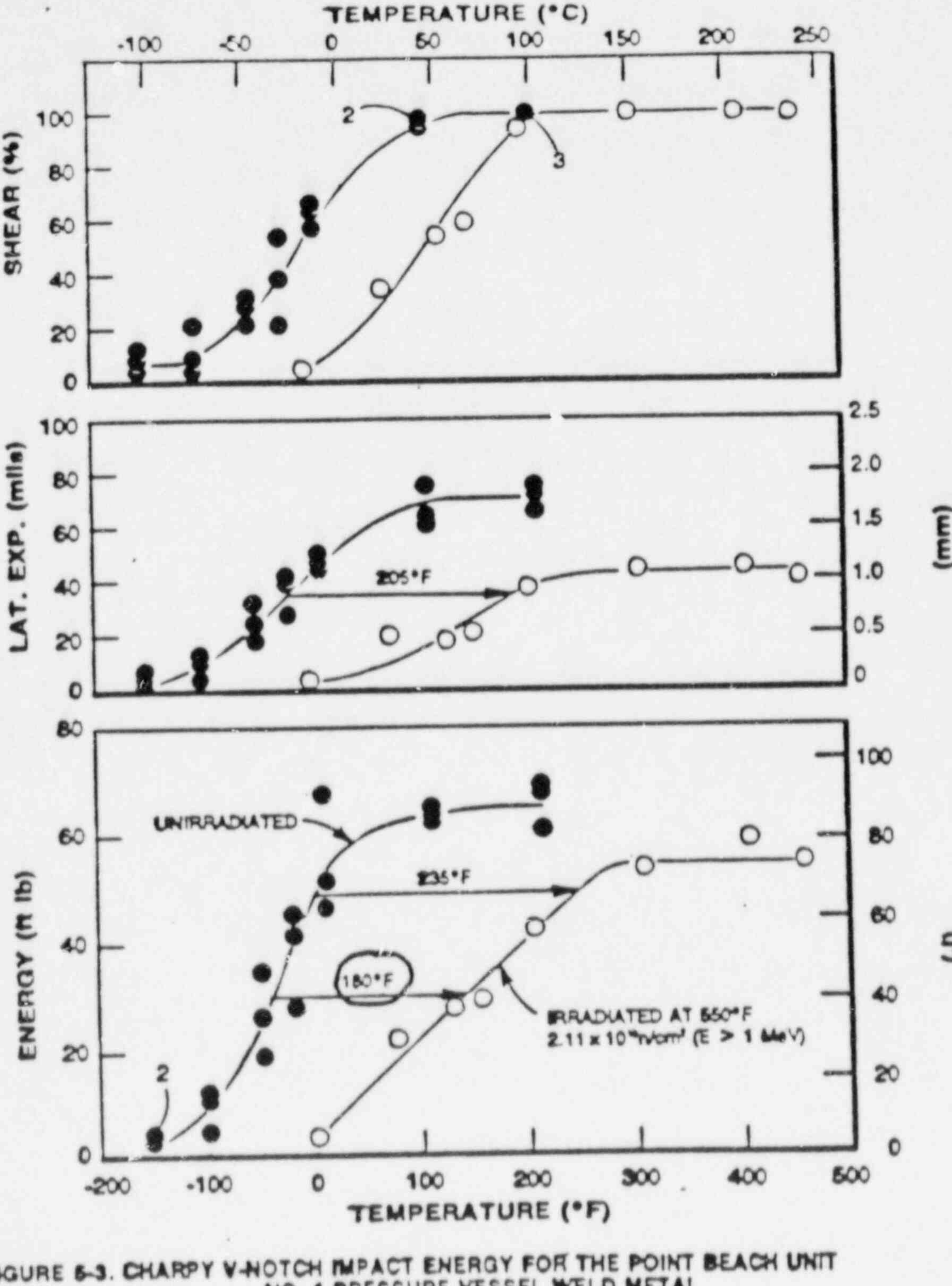


FIGURE 6-3. CHARPY V-NOTCH IMPACT ENERGY FOR THE POINT BEACH UNIT NO. 1 PRESSURE VESSEL WELD METAL

FROM POSITION C 1.1 OF REVISION 2

$$\Delta RT_{NDT} = (CF)(F)^{0.28 - 0.1 \log F}$$

CF = CHEMISTRY FACTOR (COPPER AND NICKEL)

- o TABLE I FOR WELDS
- o TABLE II FOR BASE METAL (PLATES AND FORGINGS)

F = FLUENCE, 10^{19} N/CM^2 (E > 1MeV) AT THE TIP OF THE CRACK

CONCLUSIONS BY GUTHRIE AND ODETTE

(1) SEPARATE CORRELATIONS ARE NEEDED FOR WELDS AND BASE METAL

(2) THE EXPRESSION SHOULD BE THE PRODUCT OF A CHEMISTRY FACTOR AND A FLUENCE FACTOR

(3) THE ELEMENTS IN THE CHEMISTRY FACTOR SHOULD BE COPPER AND NICKEL

(4) THE FLUENCE FACTOR SHOULD PROVIDE A TREND CURVE SLOPE, WHEN PLOTTED ON LOG-LOG PAPER OF ABOUT 0.25 TO 0.30 AT 10^{19} N/CM^2, AND IT SHOULD BE STEEPER AT LOWER FLUENCES AND FLATTER AT HIGHER FLUENCES

10

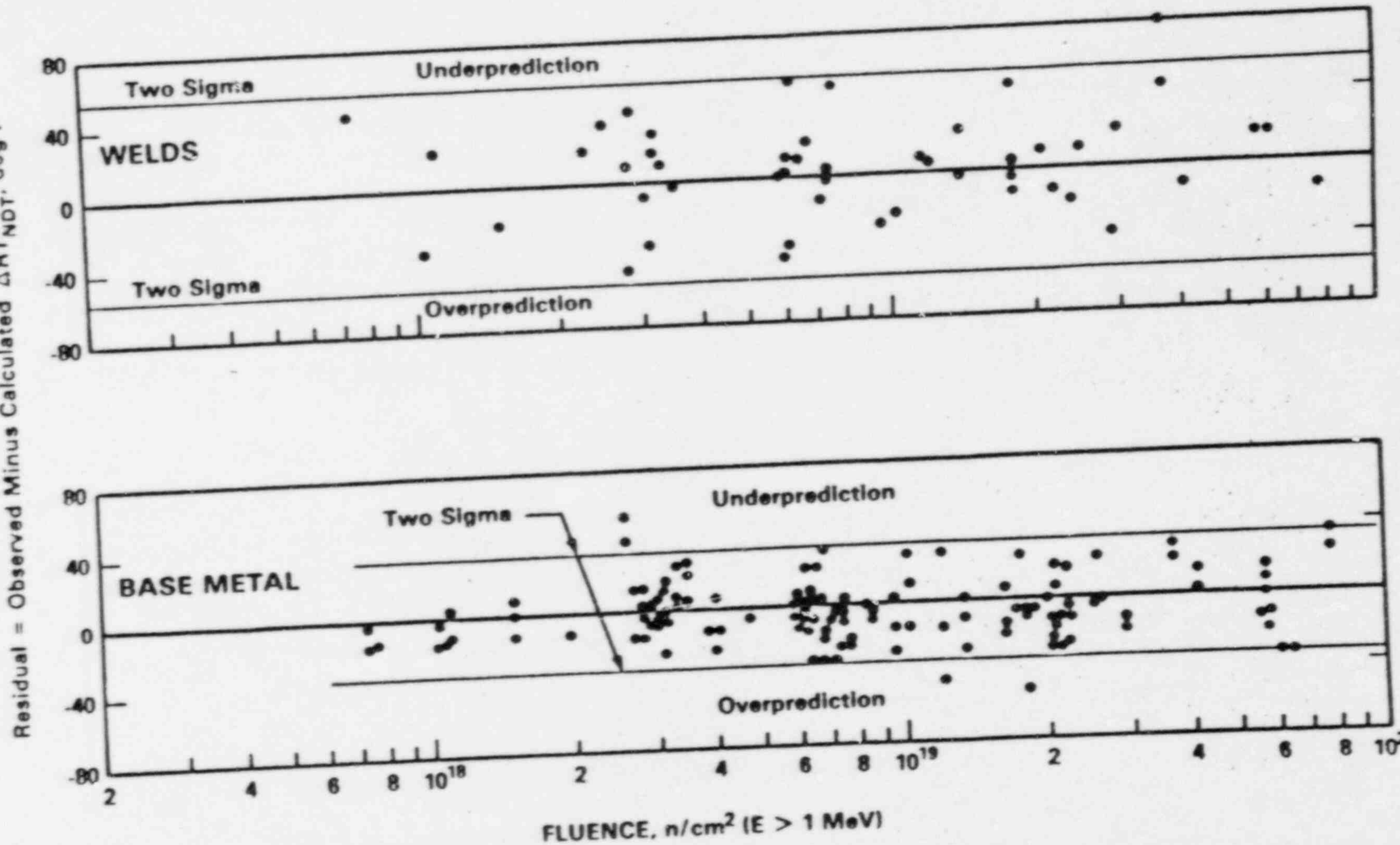


FIG. 11 PLOTS OF RESIDUALS VERSUS FLUENCE FOR 51 WELD AND 126 BASE METAL DATA POINTS

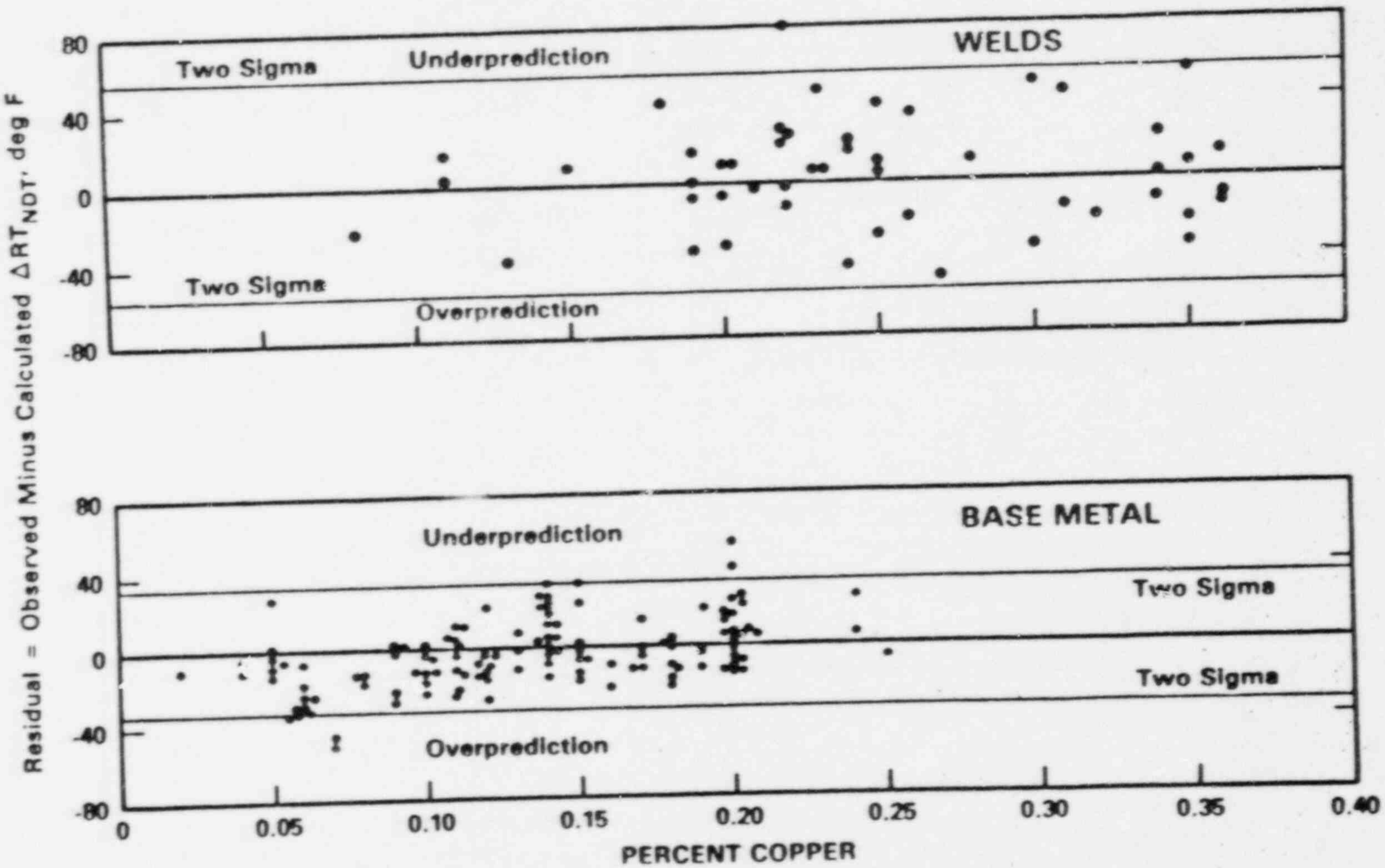


FIG. 12 PLOTS OF RESIDUALS VERSUS COPPER CONTENT FOR 51 WELD AND 126 BASE METAL DATA POINTS

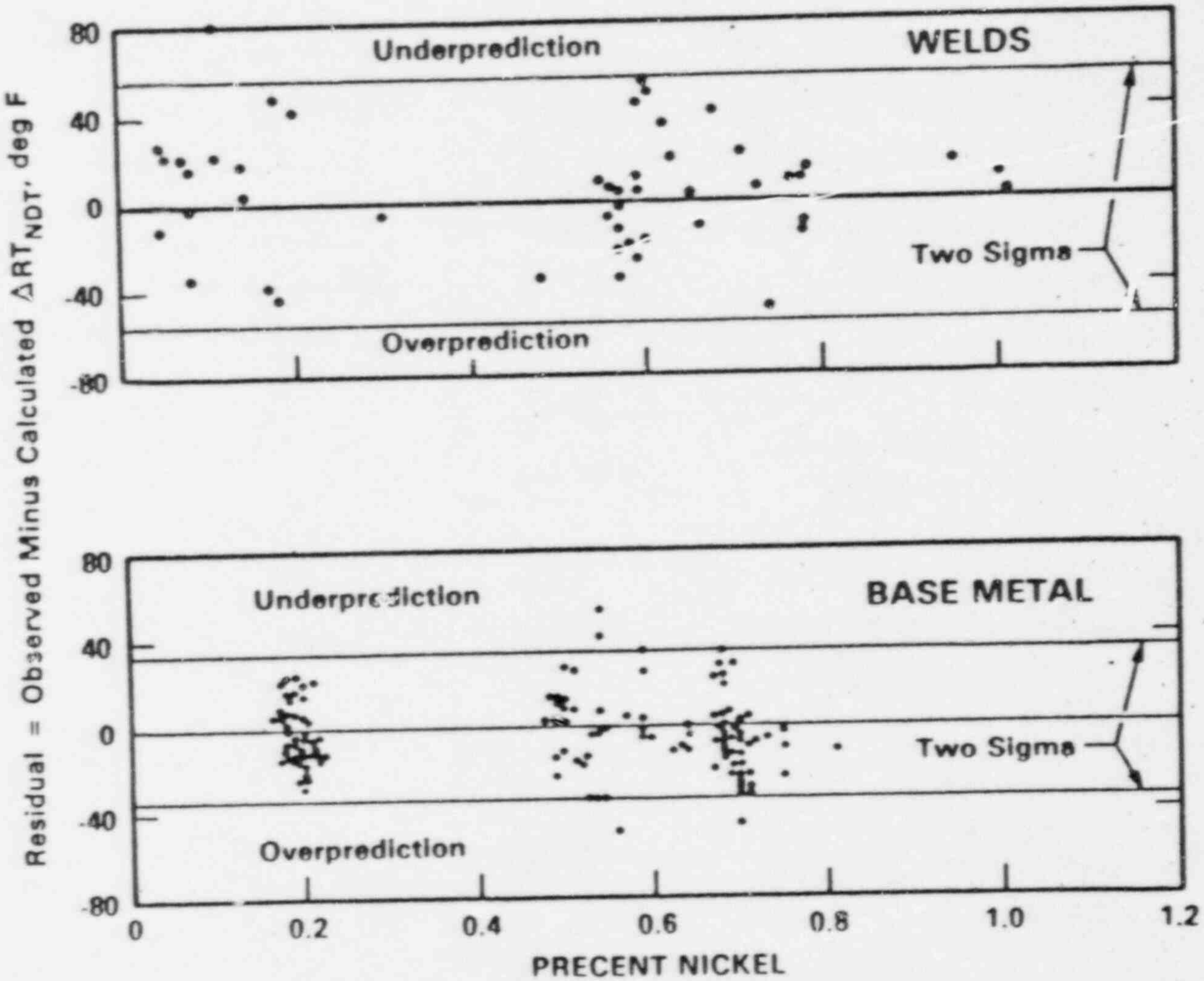


FIG. 13 PLOTS OF RESIDUALS VERSUS NICKEL CONTENT FOR 51 WELD AND 126 BASE METAL DATA POINTS

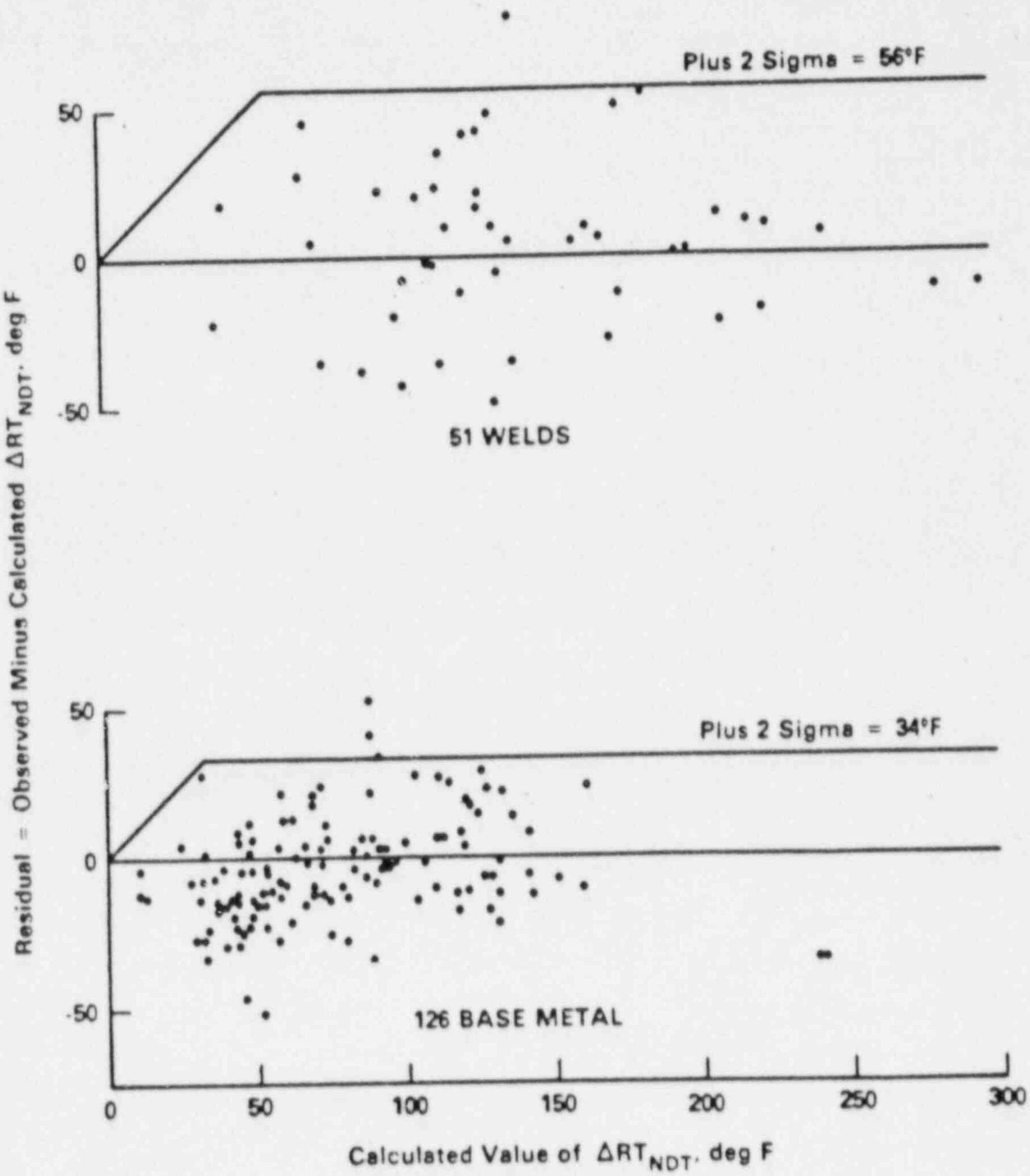


FIG. 14 PLOTS OF RESIDUALS VERSUS CALCULATED VALUE OF ΔRT_{NDT} FOR BOTH WELDS AND BASE METAL

Comparison of Three Radiation Damage Trend Curves

Revision 1	PTS Rule	Revision 2
Upper Bound	Mean Curve	Mean Curve
Copper, Phosphorus	Copper, Nickel	Copper, Nickel (Nickel effect larger)
$(F)^{0.50}$	$(F)^{0.27}$	$(F)^{0.28-0.10\log F}$
One set of curves for weld and base metal.	One set of curves for weld and base metal.	Weld and base metal curves separate.
CF = [40 + 1000(% Cu - 0.08) + 5000(% P - 0.008	CF = [-10 + 470 Cu + 350 CuNi]	CF = From Tables for Weld and Base Meta

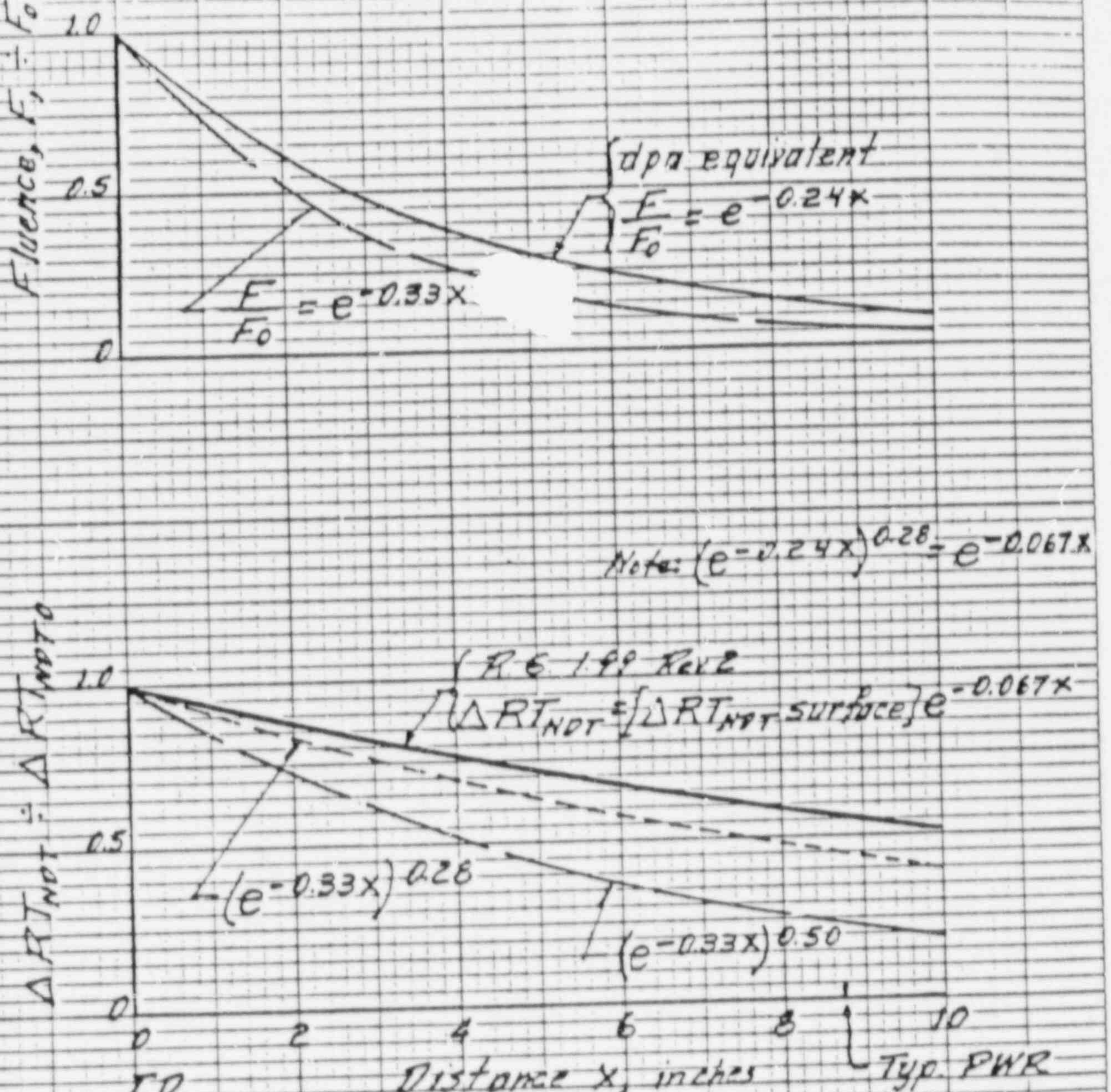
GUTHRIE'S SUMMARY COMPARISON OF SHIFT DATA FROM TEST REACTORS AND POWER REACTORS IN 1985-86 ANALYSIS OF THE MPC/ORNL DATA BASE

- o POWER REACTOR EMBRITTLEMENT (ΔRT_{NDT}) PREDICTIONS BASED ON TEST REACTOR DATA WILL BE NON-CONSERVATIVE.
- o THE BIAS IS MORE APPARENT FOR WELDS THAN FOR PLATE MATERIALS.
- o THE POWER REACTOR DATA SHOWS A MORE OBVIOUS FLUENCE SATURATION EFFECT (FLATTER SLOPE AT HIGH FLUENCES).

Revision 2 to Regulatory Guide 1.99

Comparison to Revision 1

- Updates Revision 1 after 10 years of use
- Based on Regression Analyses by Guthrie and Odette of Power Reactor Surveillance Data
- Gives mean values of ΔRT_{NDT} and states margin separately
- Different chemistry factors for welds and base metal
- Copper and Nickel in Chemistry Factor
- Fluence exponent changes from 0.50 to 0.28 - 0.1 log f
- Gives formula for through-wall attenuation based on DPA
- Tightens requirements for use of plant-specific data.



ATTENUATION OF ΔRT_{NDT} AND FLUENCE THROUGH THE VESSEL WALL

PUBLIC COMMENTS

1. GENERAL SUPPORT FOR THE CALCULATIVE PROCEDURE
   - TOO CONSERVATIVE FOR LOW-COPPER - NOT ACCEPTED
   - NO PHOSPHORUS TERM - NOT ACCEPTED

2. THROUGH-WALL ATTENUATION - CHANGE FROM ATTENUATION OF ΔRT_{NDT} TO ATTENUATION OF FLUENCE-ACCEPTED.

3. REDUCE MARGIN ADDED WHEN ΔRT_{NDT} IS SMALL - ACCEPTED

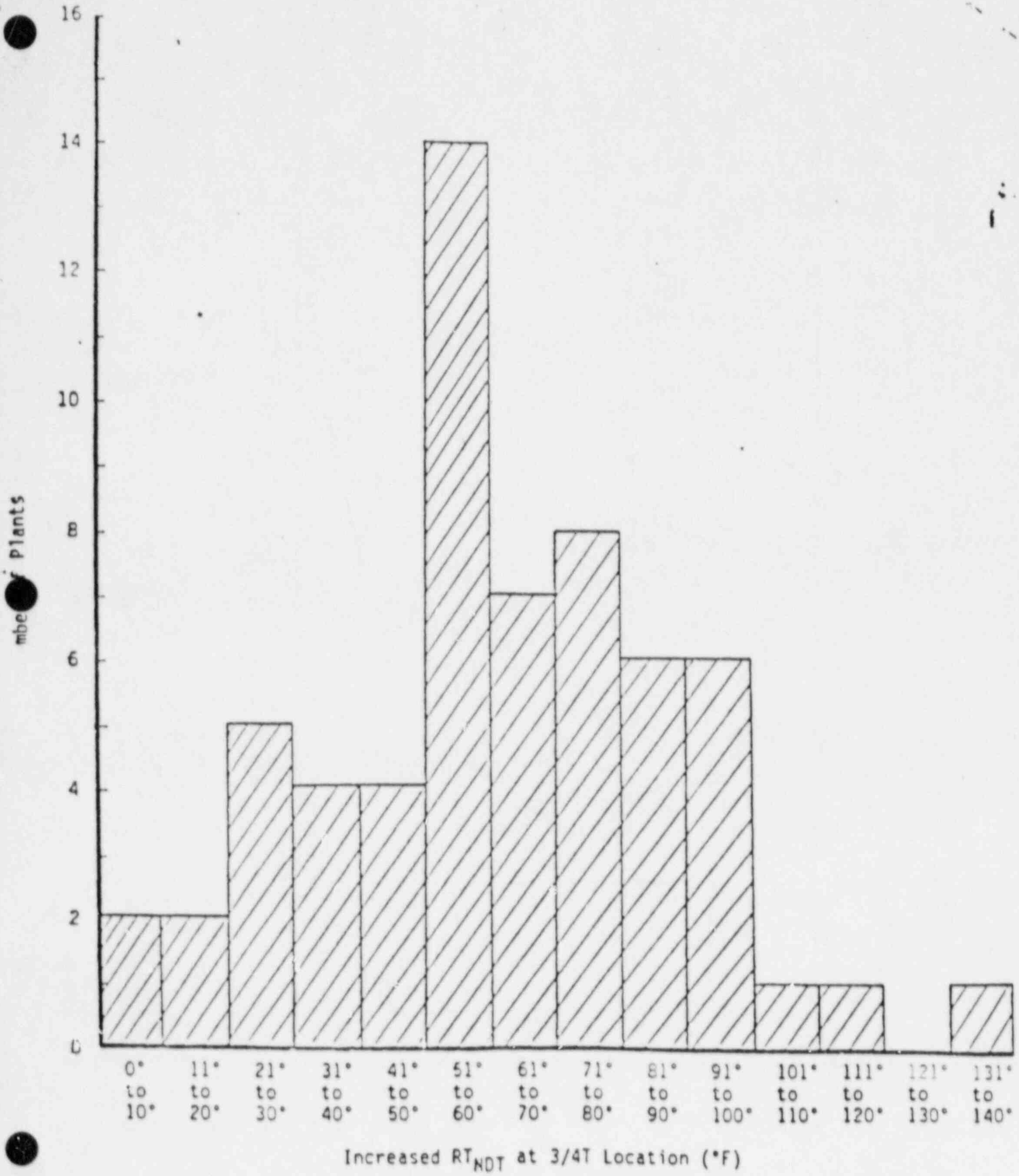
4. MORE CREDIT FOR PLANT-SPECIFIC DATA - SOME FLEXIBILITY ADDED

5. CLARIFICATIONS OF LANGUAGE - ACCEPTED

6. BWR HYDROTEST IMPACT - CHANGES TO OTHER THAN R.G. 1.99

7. PWR LTOP IMPACT - CHANGES TO OTHER THAN R.G. 1.99

8. RELATIONSHIP TO PTS RULE; DON'T CHANGE THE RULE UNLESS THE SCREENING CRITERION IS CHANGED ALSO - NOT ACCEPTED. WE ARE RECOMMENDING TO MANAGEMENT THAT FORMULA FOR RT_{PTS} BE CHANGED.



NUMBER OF PWR PLANTS WITH INCREASED RT_{NDT}
DUE TO REG. GUIDE 1.99 REV. 2

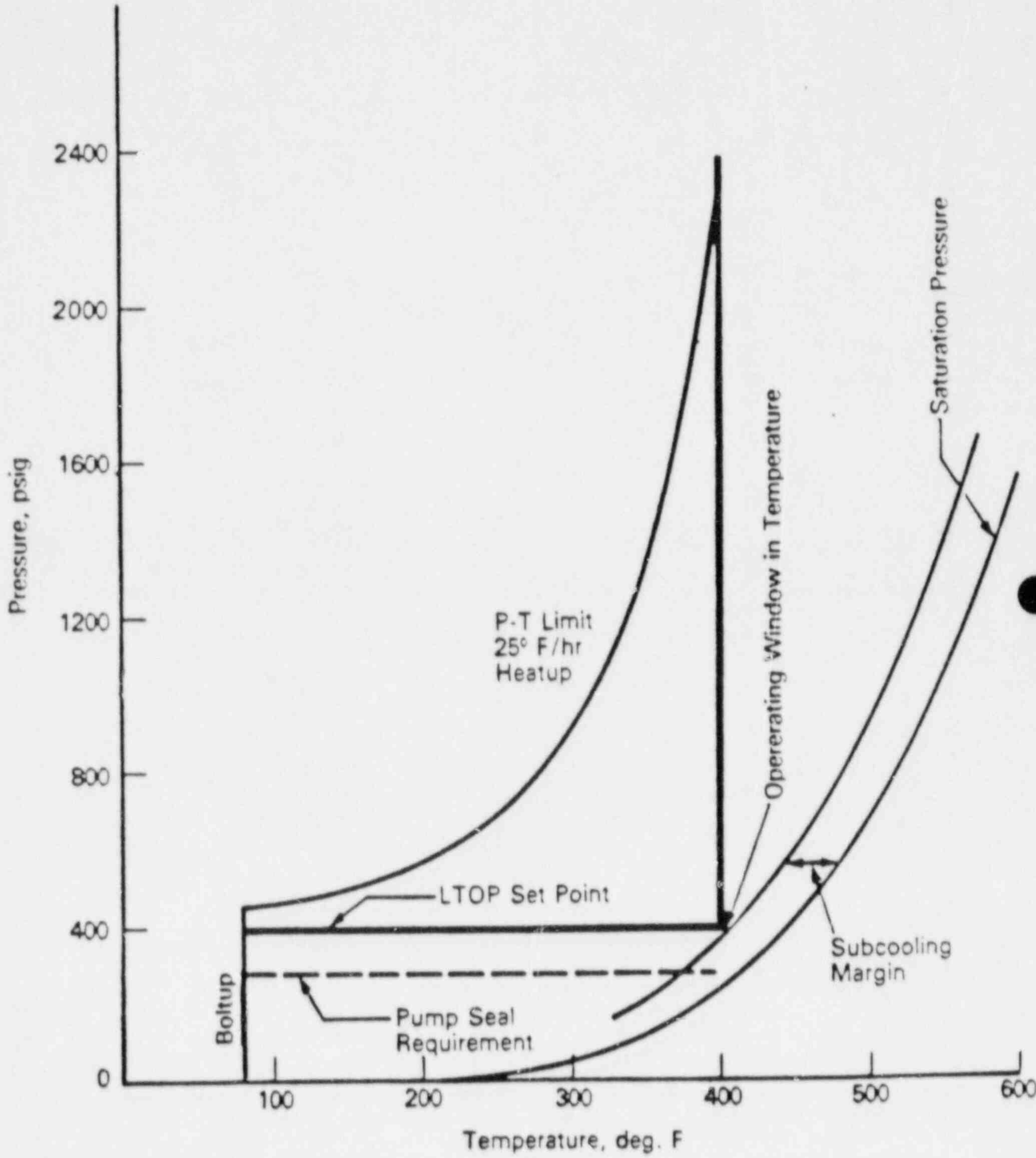


Figure 2 A Fixed LTOP Set Point Accentuates the Impact of Large Adjustments of Reference Temperature on the Operating Window in Temperature

REMEDIES FOR RESTRICTED OPERATING WINDOWS

- DEFINITION OF "AT LOW TEMPERATURE" IN SRP 5.2.2 AND BRANCH POSITION 5-2. PROVIDES ABOUT 60° RELIEF ON TEMPERATURE WINDOW.
- ADJUSTABLE SETPOINT PORVS PROVIDE RELIEF ON TEMPERATURE WINDOW.
- BETTER PRESSURE INSTRUMENTATION OPENS PRESSURE WINDOW.
- TO PUT THE SETPOINT ABOVE THE P-T LIMITS REQUIRES DEMONSTRATION THAT LTOP FREQUENCY IS WELL BELOW ONE PER REACTOR LIFETIME. WILL REQUIRE BUBBLE IN PRESSURIZER AT STARTUP.
- RESOLUTION HAS TO BE CASE BY CASE.

IMPACT ON BWRS - PRESSURE TESTS

- o HIGHER REQUIRED TEMPERATURES INCREASE HEATUP TIME WITH PUMP HEAT.
- o TEMPERATURES OVER 200°F REQUIRE CONTAINMENT CLOSURE - MORE DIFFICULT INSPECTION FOR LEAKS.

REMEDIES

- o "TWO-STEP HYDRO" - REQUIRES CODE CHANGE.
- o AUXILIARY BOILER - TIME SAVED MEANS REPLACEMENT POWER SAVINGS ENOUGH TO PAY FOR BOILER AND PIPING CHANGES.

IMPLEMENTATION OF REVISION 2
PEP GENERIC LETTER

- NRC STAFF WILL USE REVISION 2 AS THE BASIS FOR REVIEW OF P-T LIMIT UPDATES SUBMITTED BY LICENSEES AFTER PUBLICATION OF THE GUIDE.
- LICENSEES TO SUBMIT PLANS AND SCHEDULE FOR UPDATE OF P-T LIMITS, ADJUSTMENT OF LTOP SETPOINTS, ETC., WITHIN 180 DAYS.
- ACTIONS SHOULD BE COMPLETE WITHIN 2 PLANT OUTAGES (3 YEARS).

CABLES SUBMERGED DURING DESIGN BASIS FLOOD

- SPECIFIED FOR WET ENVIRONMENT SERVICE
- NORMALLY DE-ENERGIZED OR LIGHTLY LOADED
- DEGRADATION MECHANISM LACKING
- "AS NEW" WHEN FLOODED
- EQ TESTING ESTABLISHES ADEQUACY

REGULATORY GUIDE 1.99, REVISION 2

RADIATION EMBRITTLEMENT OF REACTOR VESSEL MATERIALS

PURPOSE: PUBLISH REVISION 2 IN FINAL FORM

PRESENTATION TO ACRS

MARCH 11, 1988

P. N. RANDALL

1

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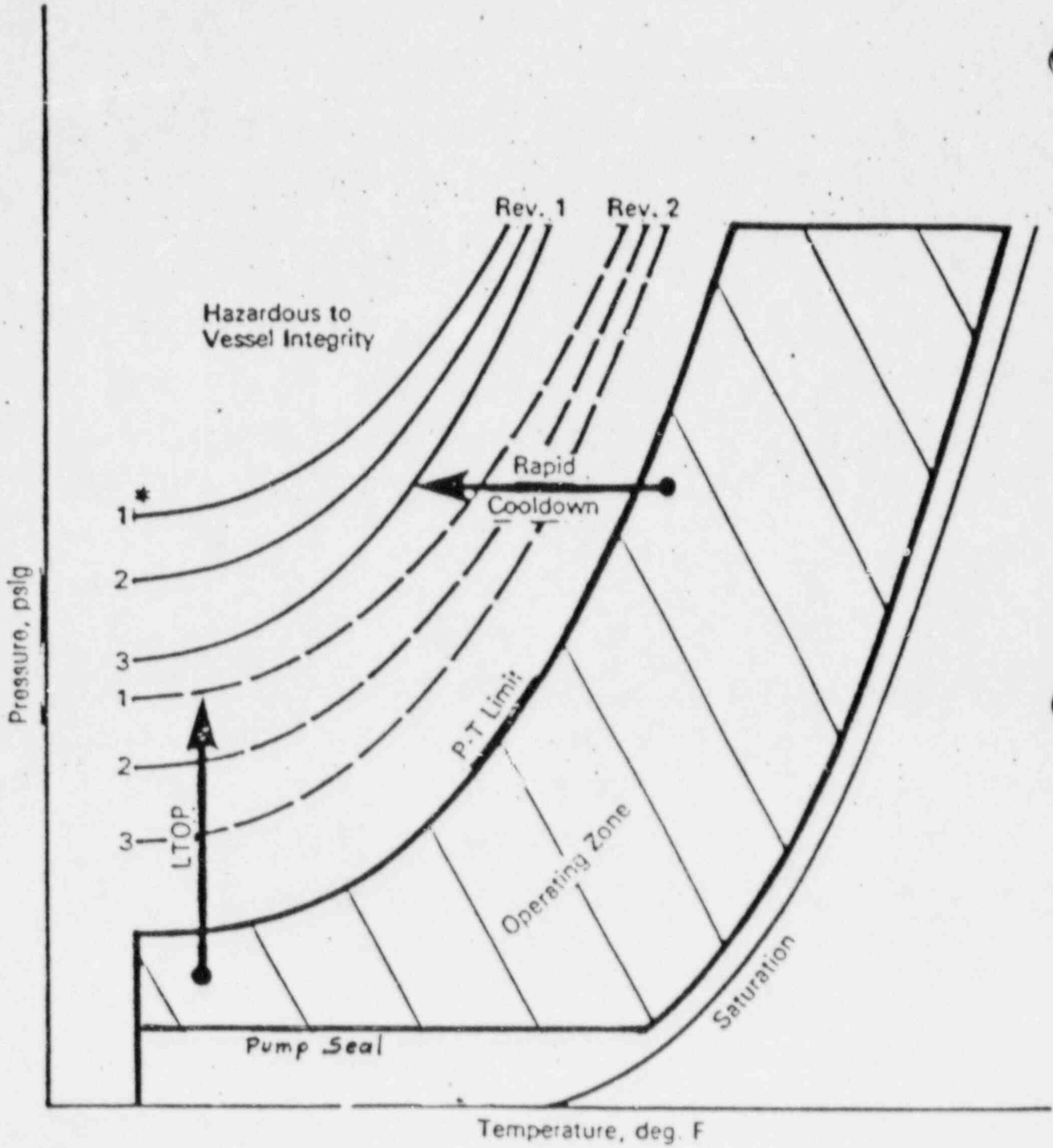

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Figure 1 P-T Limit Separates the Operating Zone from Conditions Hazardous to Vessel Integrity

09/29/87

4

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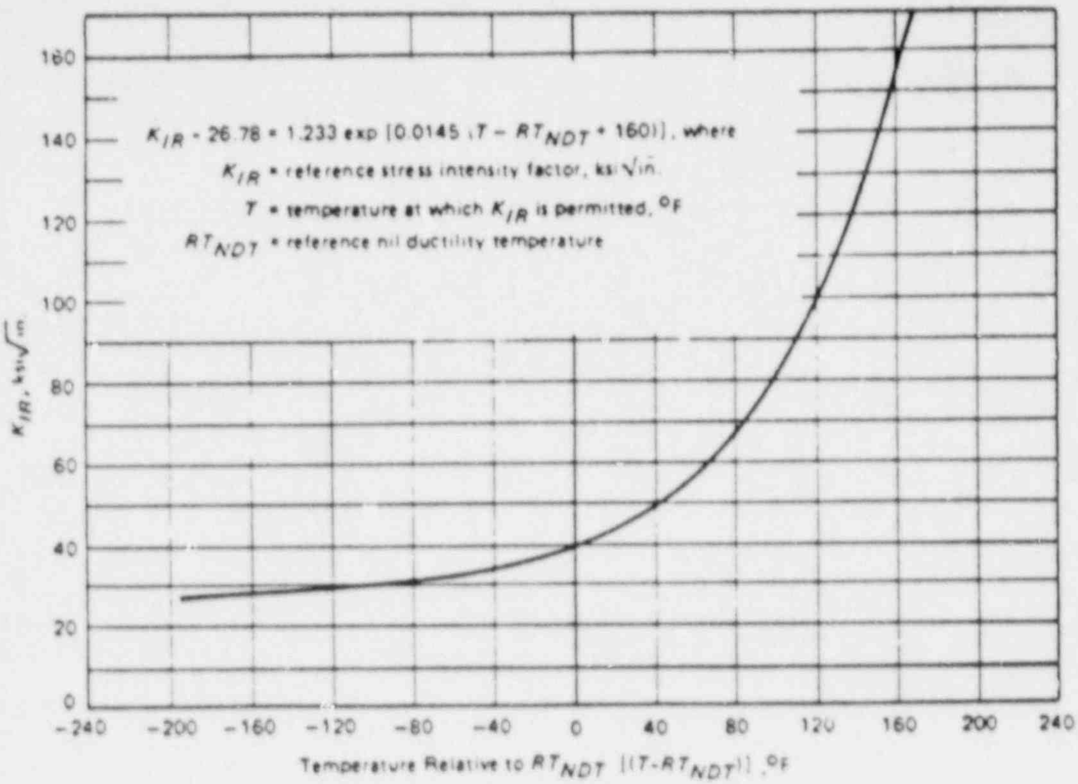
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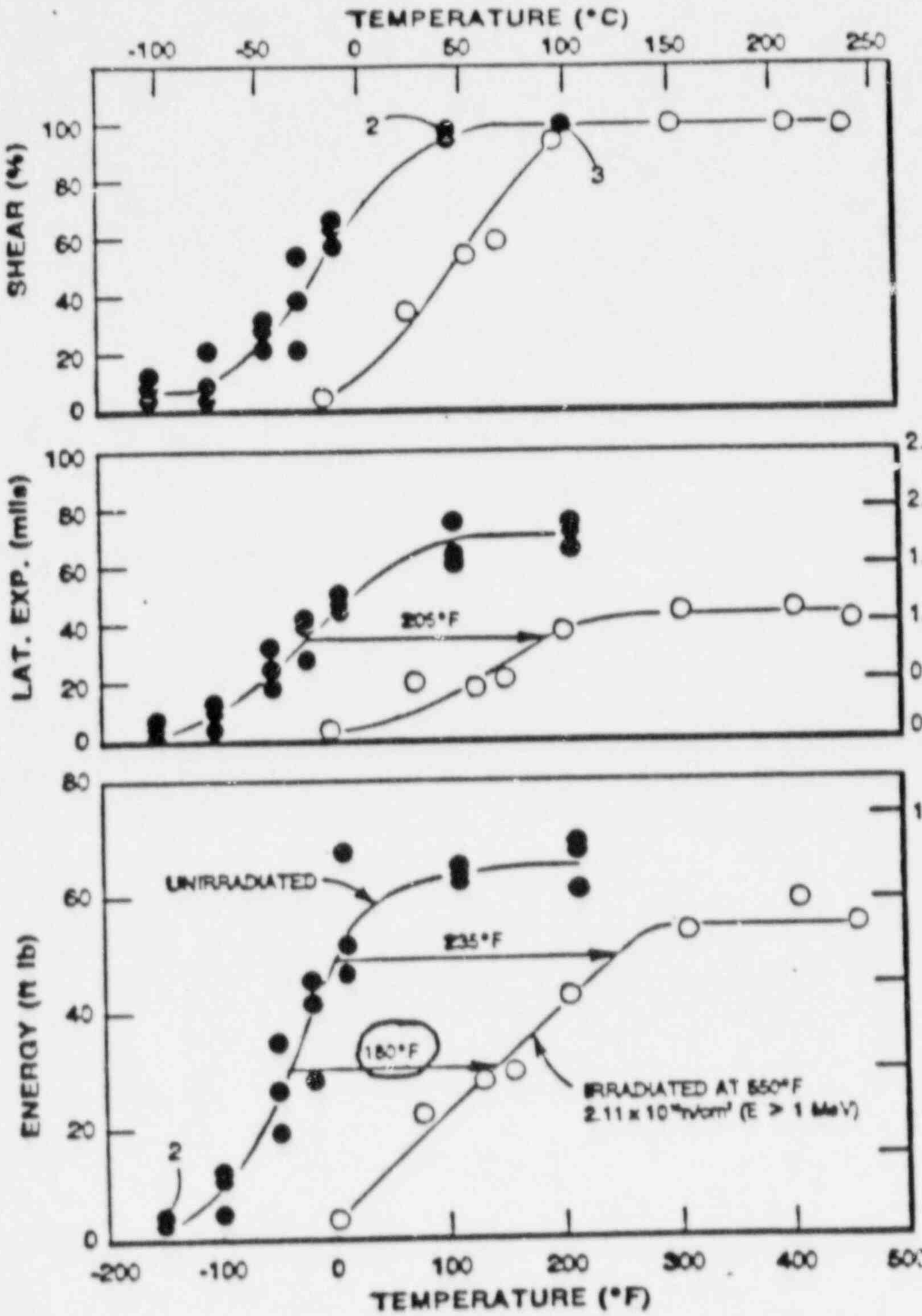
120
140
160
−240
−200
−160
−120
−80
−40
0
40
80
120
160
200
240
Temperature Relative to RT_NDT [(T-RT_NDT)], °F

FIG. G-2210-1



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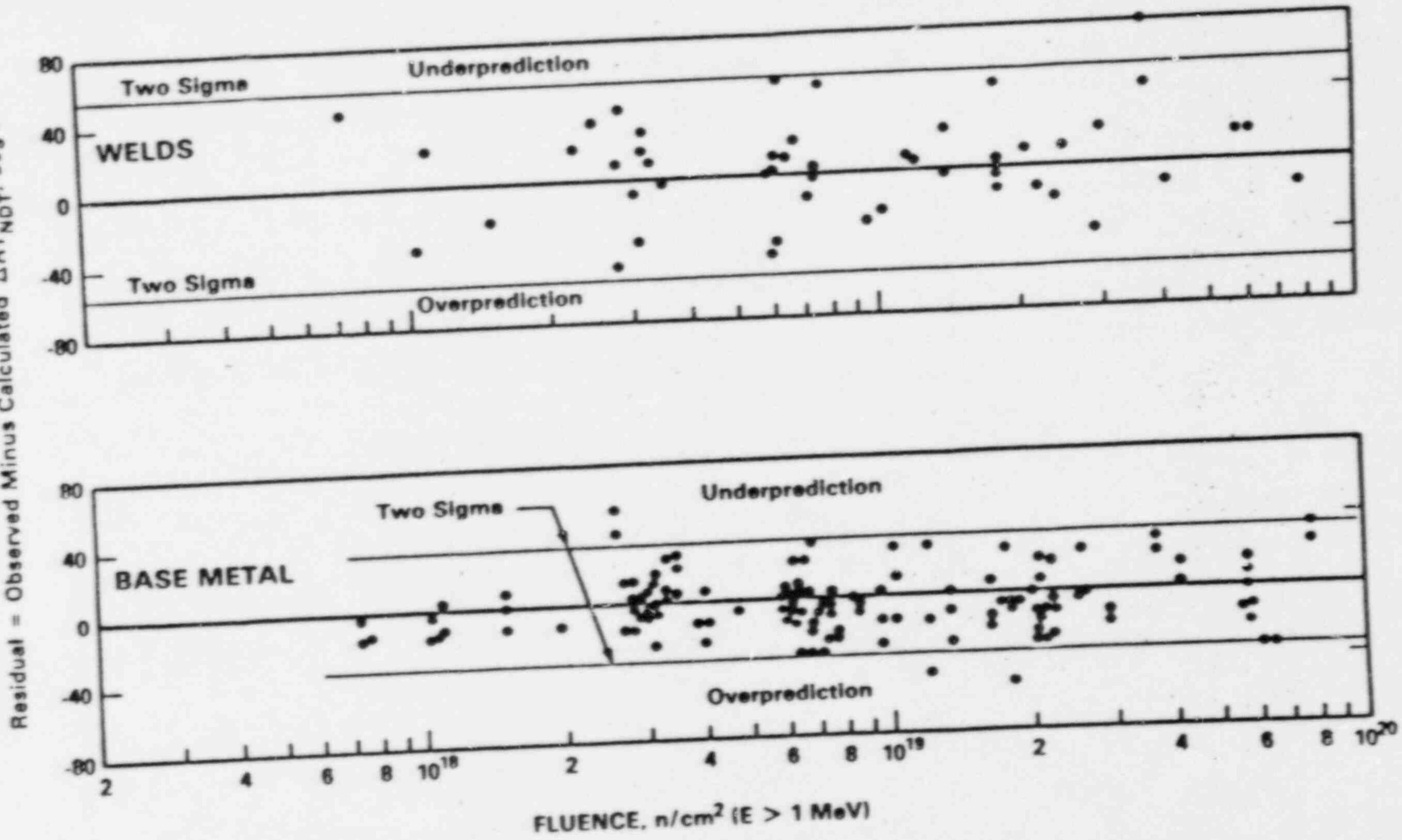

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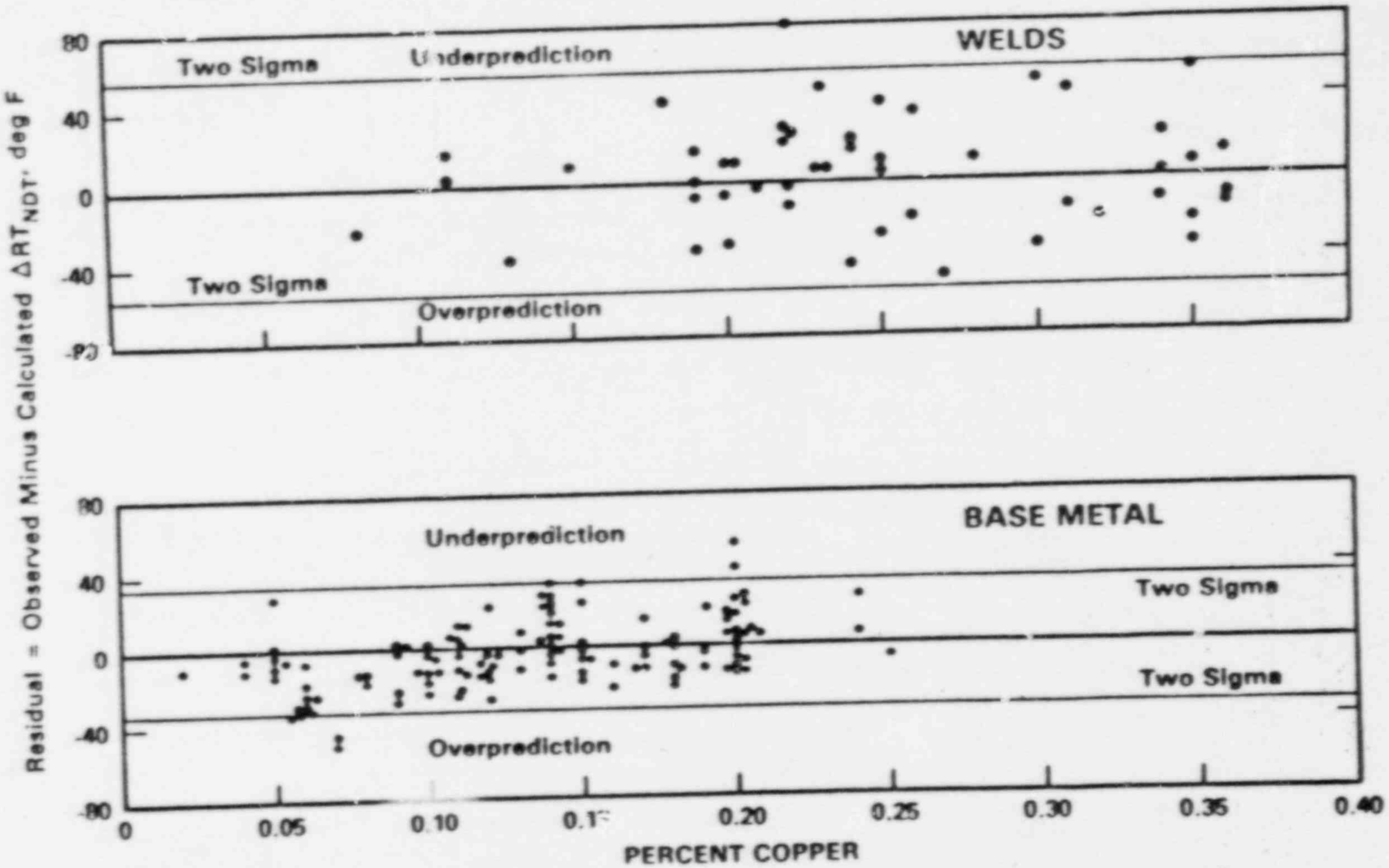

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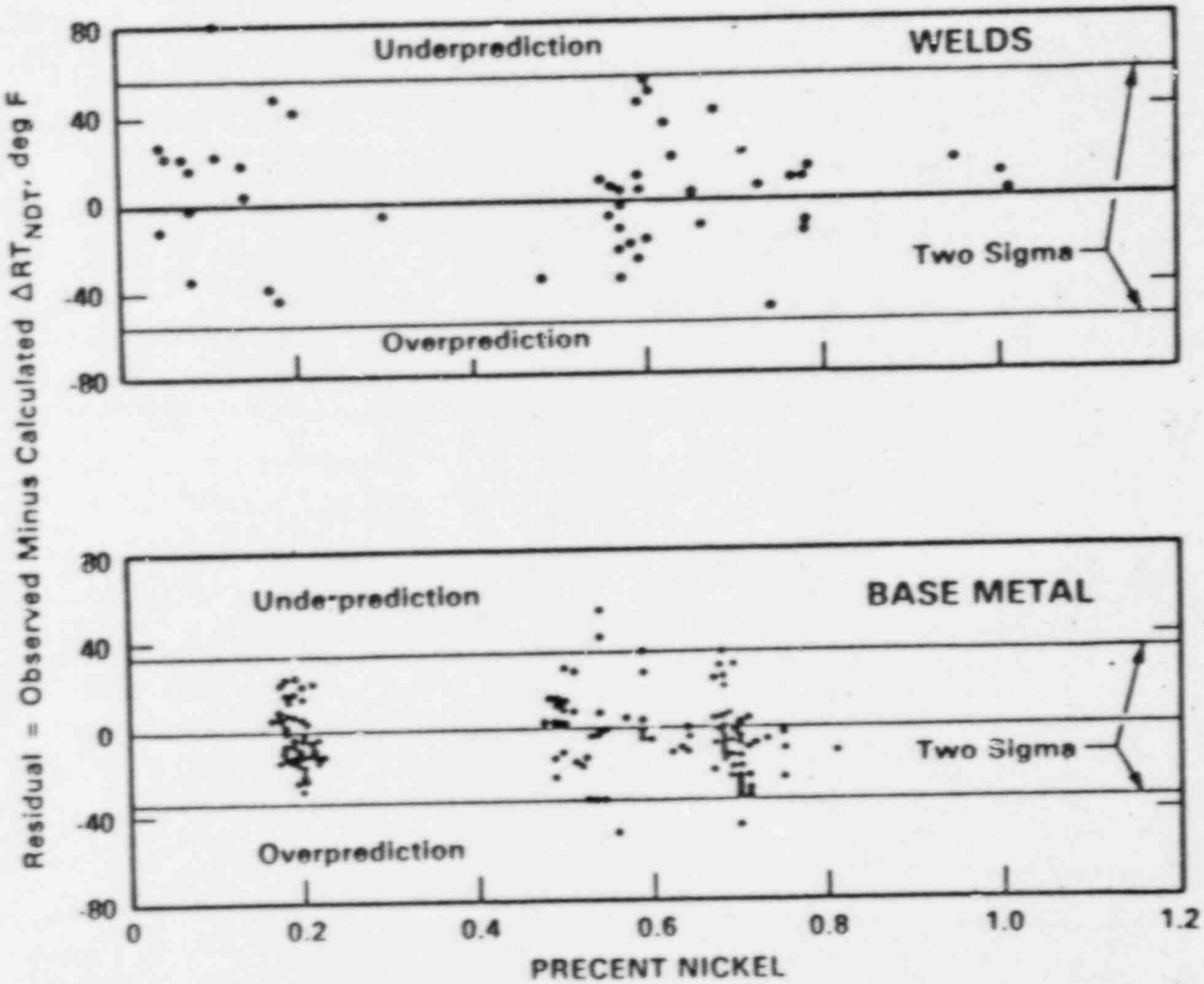

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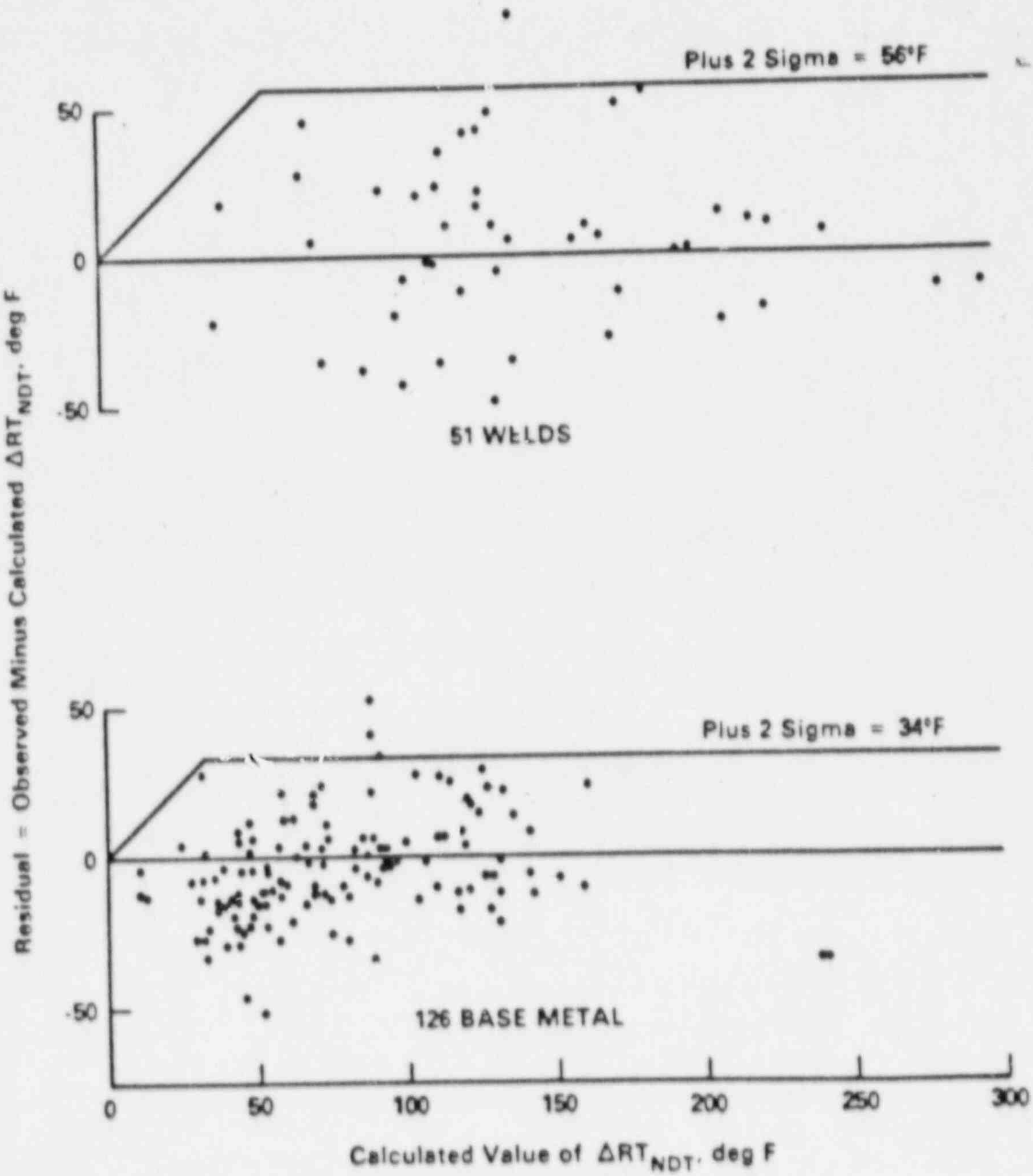

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13

Comparison of Three Radiation Damage Trend Curves

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Copper, Phosphorus	Copper, Nickel	Copper, Nickel (Nickel effect larger)
$(F)^{0.50}$	$(F)^{0.27}$	$(F)^{0.28-0.10\log F}$
One set of curves for weld and base metal.	One set of curves for weld and base metal.	Weld and base metal curves separate.
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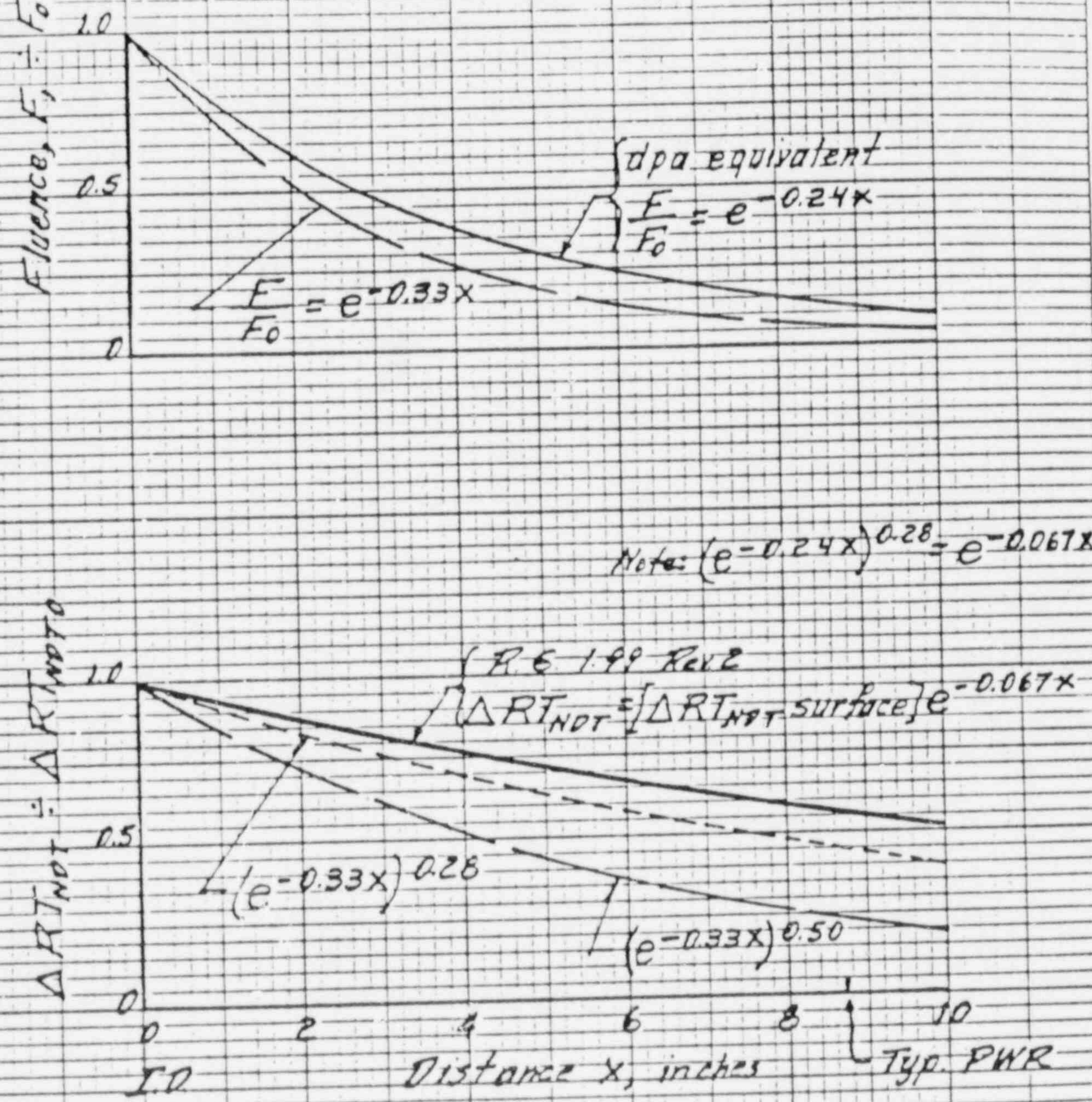
REVISION 2 TO REGULATORY GUIDE 1.99

COMPARISON TO REVISION 1

- UPDATES REVISION 1 AFTER 10 YEARS OF USE
- BASED ON REGRESSION ANALYSES BY GUTHRIE AND ODETTE OF POWER REACTOR SURVEILLANCE DATA
- GIVES MEAN VALUES OF ΔRT_{NDT} AND STATES MARGIN SEPARATELY
- DIFFERENT CHEMISTRY FACTORS FOR WELDS AND BASE METAL
- COPPER AND NICKEL IN CHEMISTRY FACTOR
- FLUENCE EXPONENT CHANGES FROM 0.50 TO 0.28 - 0.1 LOG F
- GIVES FORMULA FOR THROUGH-WALL ATTENUATION BASED ON DPA
- TIGHTENS REQUIREMENTS FOR USE OF PLANT-SPECIFIC DATA.



ATTENUATION OF ΔRT_{NDT} AND FLUENCE THROUGH THE VESSEL WALL

Public Comments

1. General support for the calculative procedure

   - Too conservative for low-copper - not accepted
   - No phosphorus term - not accepted

2. Through-wall attenuation - change from attenuation of ΔRT_{NDT} to attenuation of fluence-accepted.

3. Reduce margin added when ΔRT_{NDT} is small - accepted

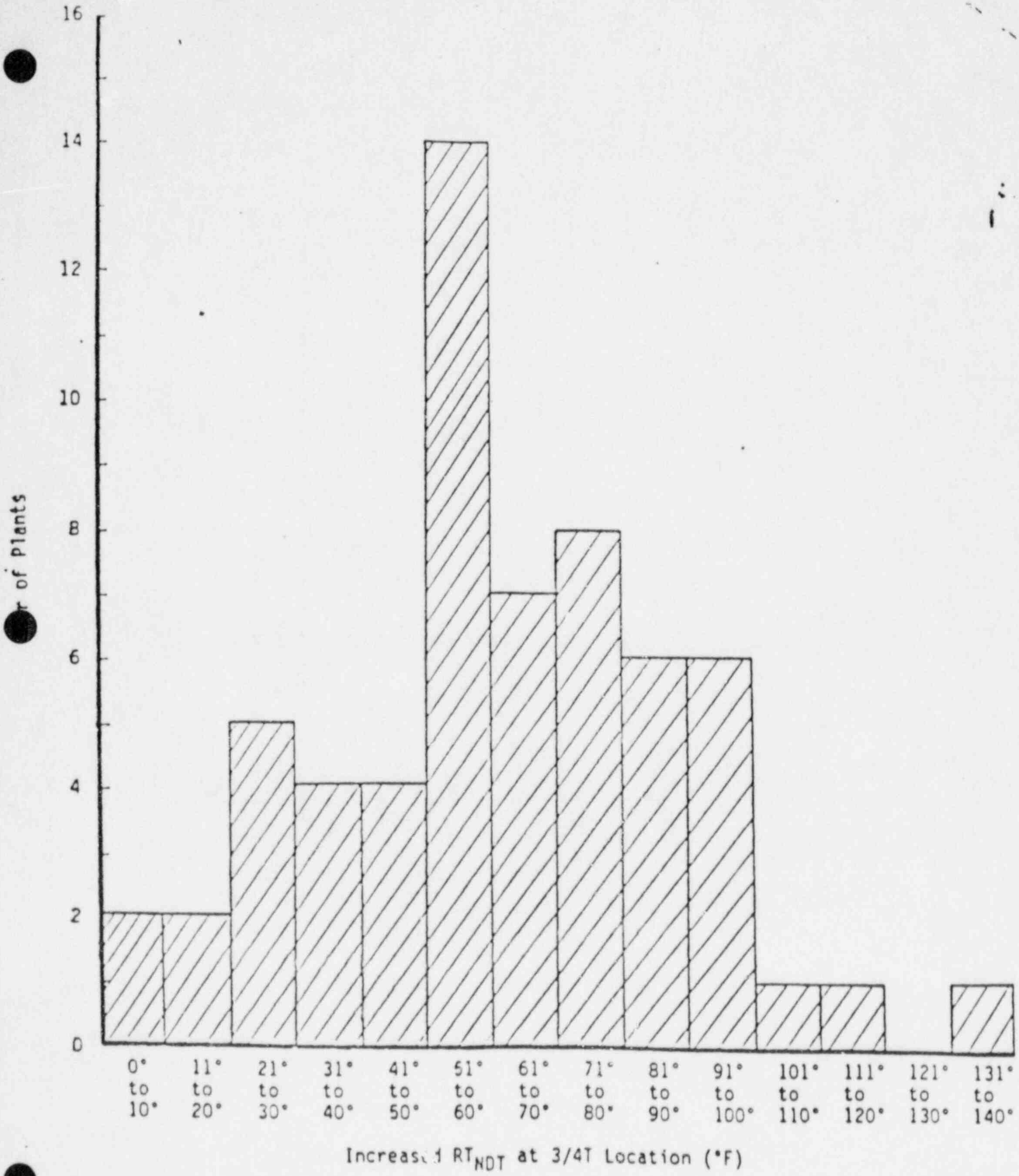
4. More credit for plant-specific data - some flexibility added

5. Clarifications of language - accepted

6. BWR Hydrotest impact - changes to other than R.G. 1.99

7. PWR LTOP impact - changes to other than R.G. 1.99

8. Relationship to PTS Rule; don't change the rule unless the screening criterion is changed also - not accepted. We are recommending to management that formula for RT_{PTS} be changed.



NUMBER OF PWR PLANTS WITH INCREASED RT_{NDT}
DUE TO REG. GUIDE 1.99 REV. 2

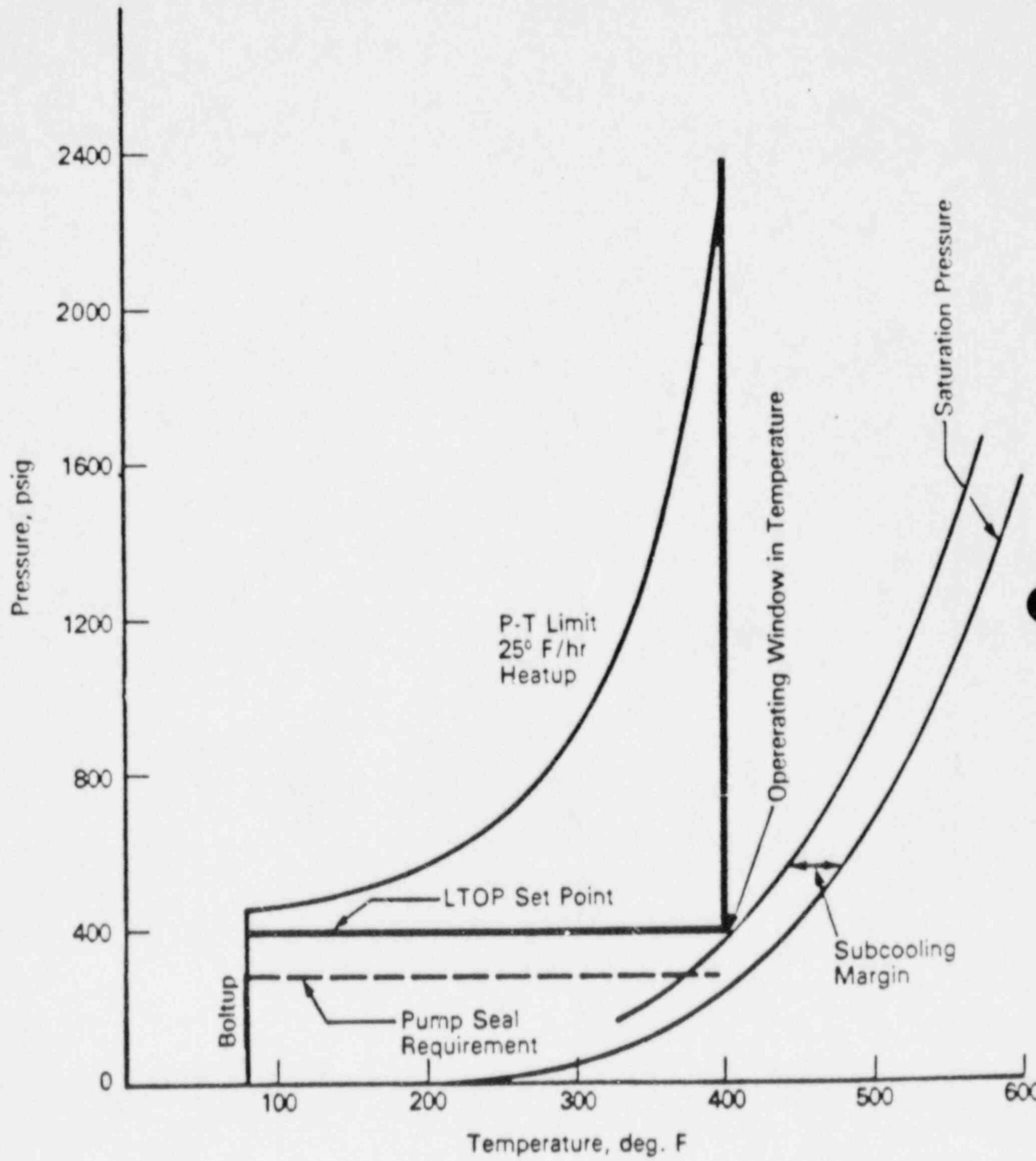


Figure 2 A Fixed LTOP Set Point Accentuates the Impact of Large Adjustments of Reference Temperature on the Operating Window in Temperature

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IMPACT ON BWRS - PRESSURE TESTS

- o HIGHER REQUIRED TEMPERATURES INCREASE HEATUP TIME WITH PUMP HEAT.
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REMEDIES

- o "TWO-STEP HYDRO" - REQUIRES CODE CHANGE.
- o AUXILIARY BOILER - TIME SAVED MEANS REPLACEMENT POWER SAVINGS ENOUGH TO PAY FOR BOILER AND PIPING CHANGES.

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PER GENERIC LETTER

- NRC STAFF WILL USE REVISION 2 AS THE BASIS FOR REVIEW OF P-T LIMIT UPDATES SUBMITTED BY LICENSEES AFTER PUBLICATION OF THE GUIDE.

- LICENSEES TO SUBMIT PLANS AND SCHEDULE FOR UPDATE OF P-T LIMITS, ADJUSTMENT OF LTOP SETPOINTS, ETC., WITHIN 180 DAYS.

- ACTIONS SHOULD BE COMPLETE WITHIN 2 PLANT OUTAGES (3 YEARS).

SAFETY REVIEWS

- o INITIATED BY INDIVIDUALS
  - DISCUSSION WITH SUPERVISOR
  - EMPLOYEE CONCERN PROGRAM
  - QUALITY ASSURANCE PROGRAM
  - DIFFERING STAFF VIEWS
- o INTERNAL REVIEWS
  - INDEPENDENT SAFETY ENGINEERING GROUP
  - NUCLEAR SAFETY REVIEW BOARD
  - PLANT OPERATIONS REVIEW COMMITTEE
  - NUCLEAR MANAGER'S REVIEW GROUP

SYSTEMS INTEGRATION
FOR PAST DESIGN OR MODIFICATIONS

- ENVIRONMENTAL QUALIFICATION
- REVIEW OF AUXILIARY FEEDWATER MODIFICATIONS
- DESIGN BASELINE AND VERIFICATION PROGRAM
  - COMMITMENTS/REQUIREMENTS INDEX
  - NEW DESIGN CRITERIA
  - COMPARISON WITH AS-BUILT
- MODERATE ENERGY LINE BREAK
- CALCULATION PROGRAM
- RESTART TEST PROGRAM
- INTEGRATED DESIGN INSPECTION

LOW TEMPERATURE LOW FLUX

EMBRITTLEMENT OF REACTOR

PRESSURE VESSEL SUPPORT STRUCTURES

Presented to the

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
March 11, 1988

M. E. MAYFIELD

NRC - RES

REACTOR PRESSURE VESSEL SUPPORT EMBRITTLEMENT

- → DESCRIPTION OF THE ISSUE AND CURRENT ASSESSMENT
- DESCRIPTION OF LOW TEMPERATURE LOW FLUX EMBRITTLEMENT PROBLEM AND DAMAGE CHARACTERIZATION
- DESCRIPTION OF THE RESEARCH PROGRAM TO RESOLVE THE ISSUE

RPV SUPPORT EMBRITTLEMENT ISSUE

IS THERE A CURRENT OR FUTURE THREAT TO THE SAFETY OF NUCLEAR POWER PLANTS DUE TO THE MORE RAPID THAN EXPECTED EMBRITTLEMENT OF RPV SUPPORTS RESULTING FROM LOW TEMPERATURE IRRADIATION AT A LOW FLUX LEVEL?

RPV SUPPORT EMBRITTLEMENT

CRITICAL FACTORS IN RPV SUPPORT EMBRITTLEMENT

- o NEUTRON IRRADIATION MUST BE HIGH ENOUGH TO EMBRITTLE THE SUPPORTS
- o A FLAW OR CRACK MUST EXIST AT A CRITICAL LOCATION
- o THE STRESSES IN THE SUPPORTS MUST BE HIGH ENOUGH TO PRODUCE A CRITICAL STRESS INTENSITY

RPV SUPPORT EMBRITTLEMENT

CURRENT ASSESSMENT

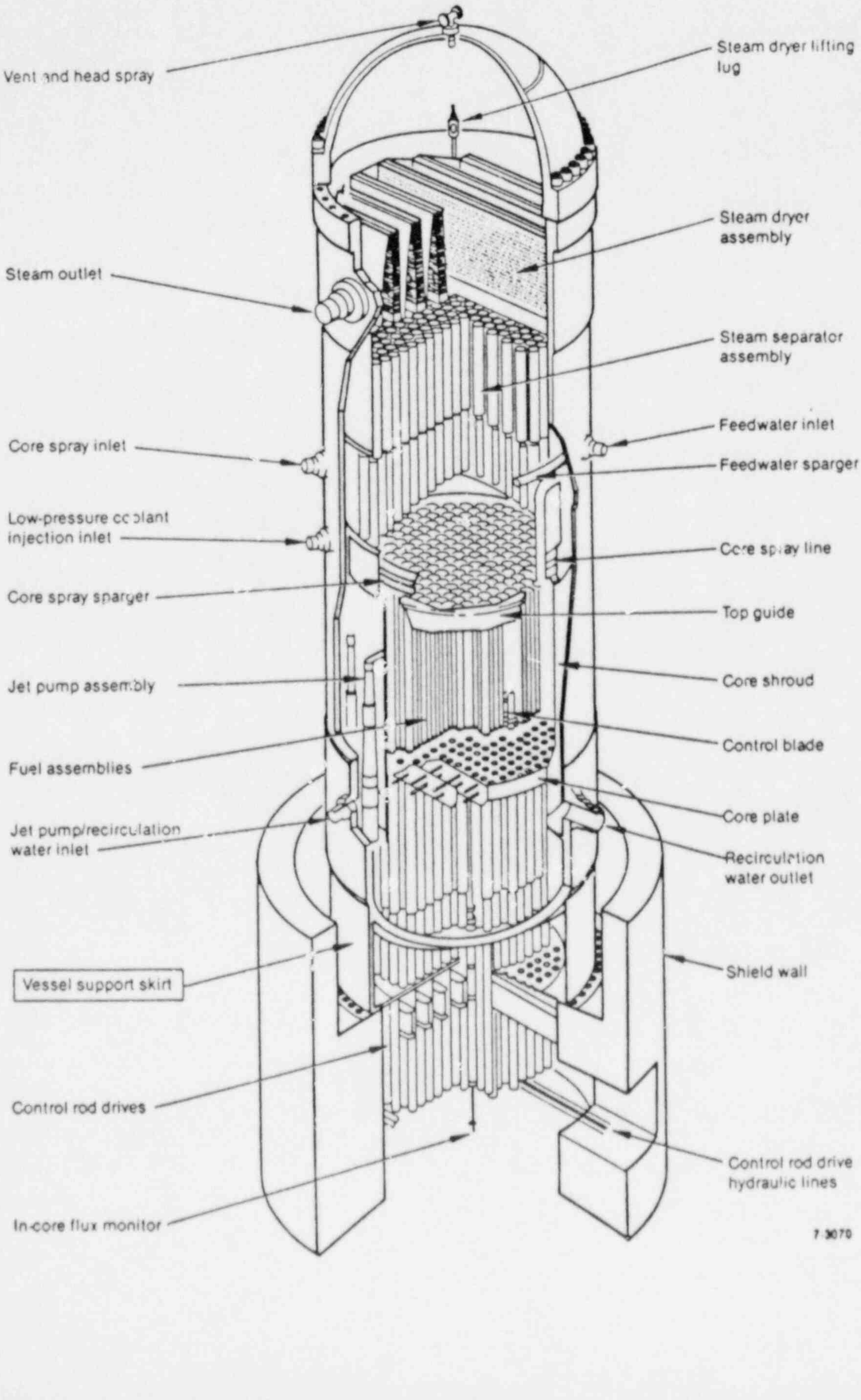
- → o DOCUMENTATION IS BEING SOUGHT TO DETERMINE WHETHER THE NDT TEMPERATURE FOR ANY PLANT EXCEEDS ITS OPERATING TEMPERATURE

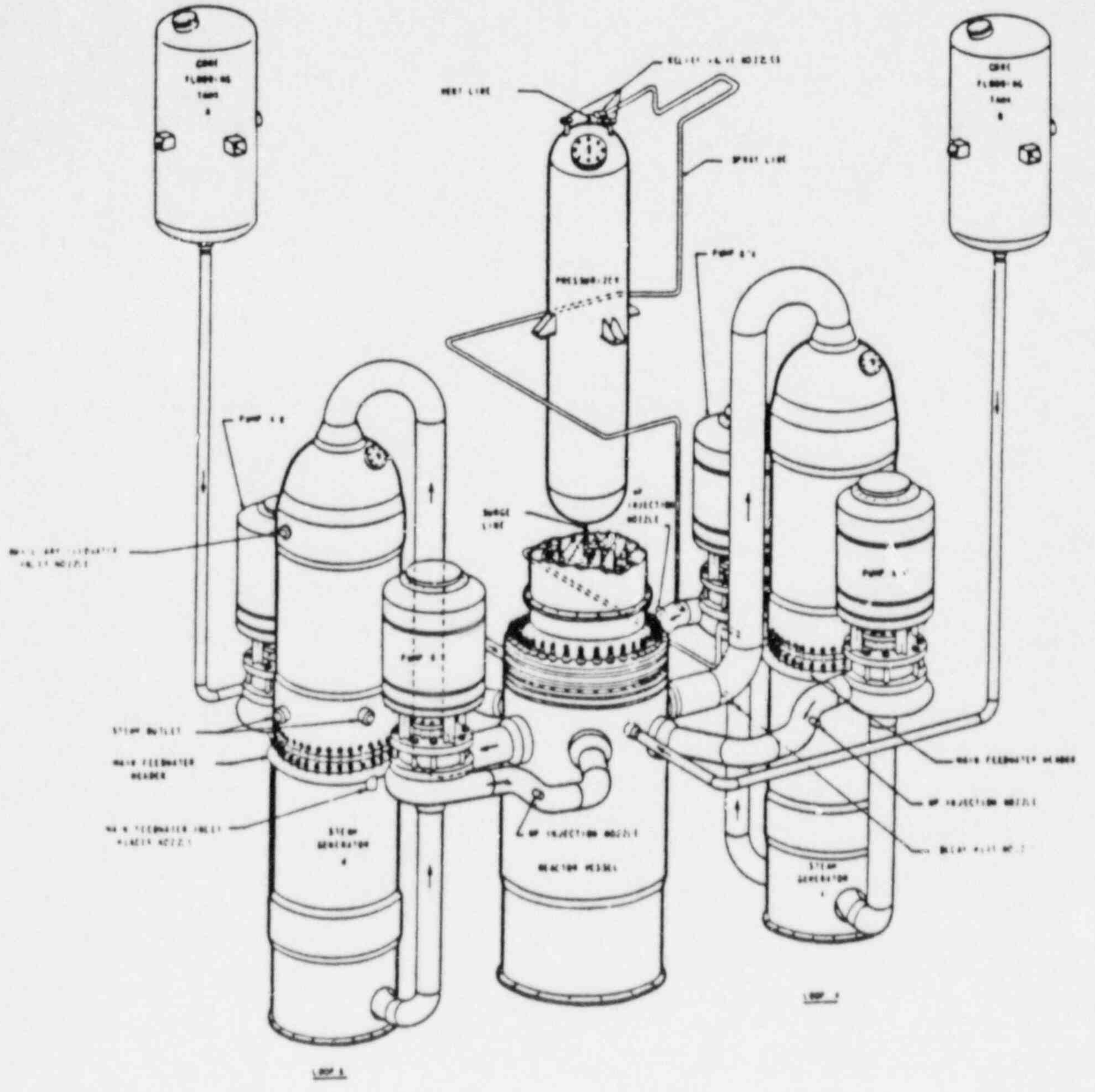
- o SUPPORT RELIABILITY CURRENTLY IS JUDGED TO BE ADEQUATE

- o SUPPORT FAILURE DOES NOT LEAD TO FAILURE OF THE PRIMARY COOLANT LOOP PIPING

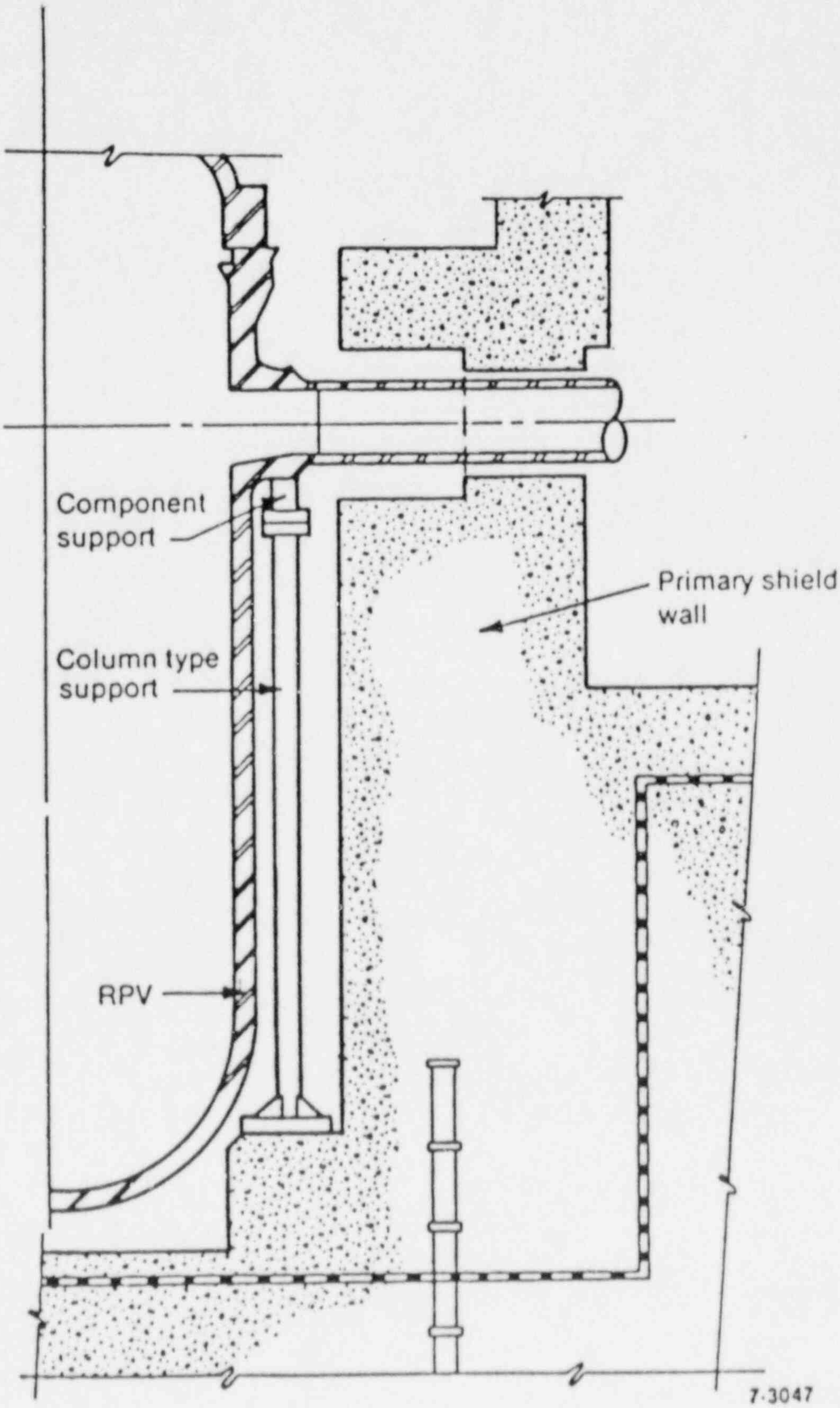
ORNL HAS LISTED TYPES OF VESSEL SUPPORTS FOR "ALL" LWR'S AND CATEGORIZED

CATEGORY NUMBER	CATEGORY NAME	% OF PLANTS
1	SKIRT	ALL BUT ONE OF BWR's ~10% of PWR's
2	LONG COLUMN	~10% OF PWR's
3	SHIELD TANK	~10% OF PWR's
4	SHORT COLUMN	~70% OF PWR's
5	SUSPENSION	BIG ROCK POINT


Vent and head spray
Steam dryer lifting lug
Steam dryer assembly
Steam outlet
Steam separator assembly
Feedwater inlet
Core spray inlet
Feedwater sparger
Low-pressure coolant injection inlet
Core spray line
Core spray sparger
Top guide
Jet pump assembly
Core shroud
Control blade
Fuel assemblies
Core plate
Jet pump/recirculation water inlet
Recirculation water outlet
Vessel support skirt
Shield wall
Control rod drives
Control rod drive hydraulic lines
In-core flux monitor
7-3070

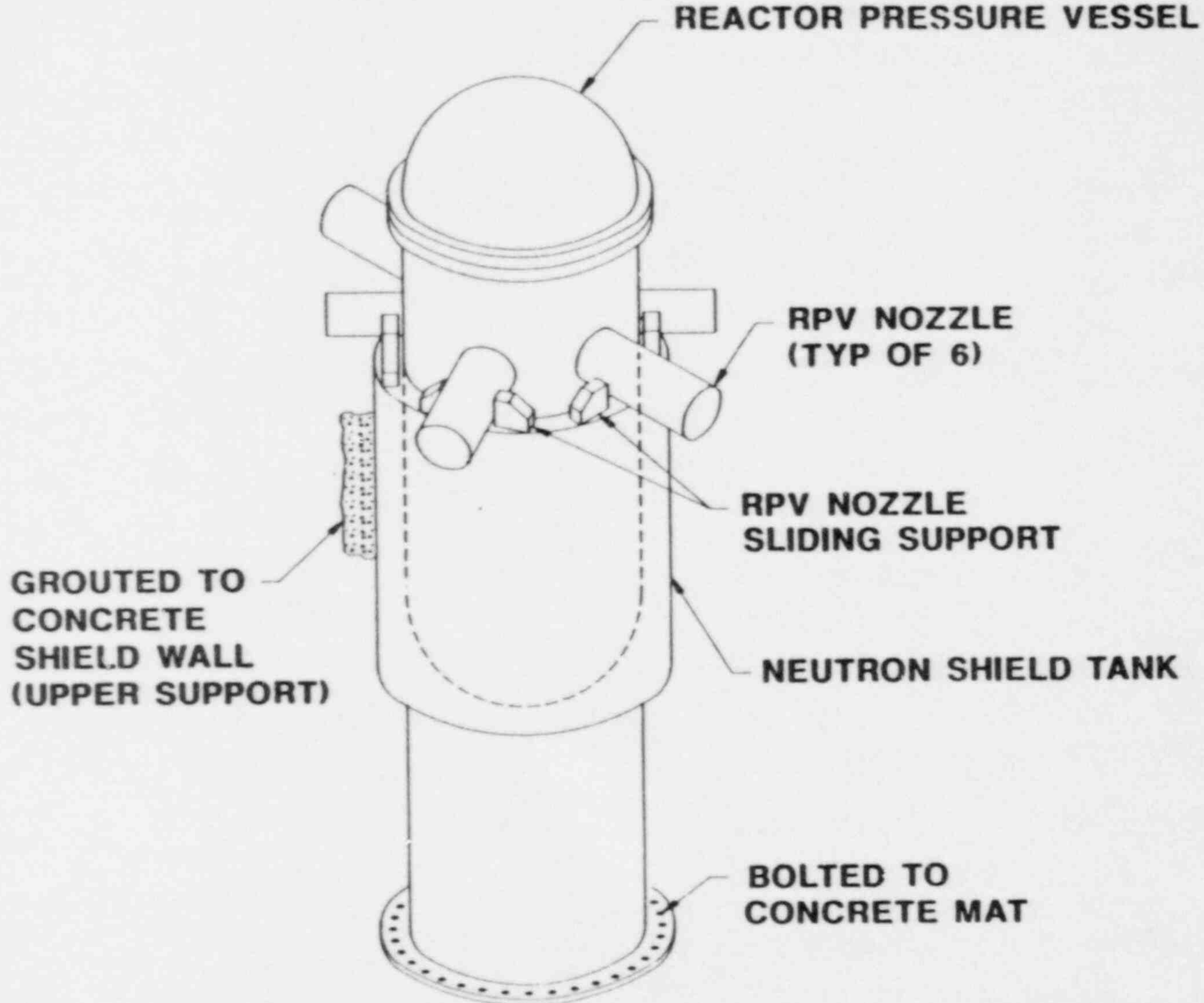


MIDLAND REACTOR COOLANT SYSTEM ISOMETRIC

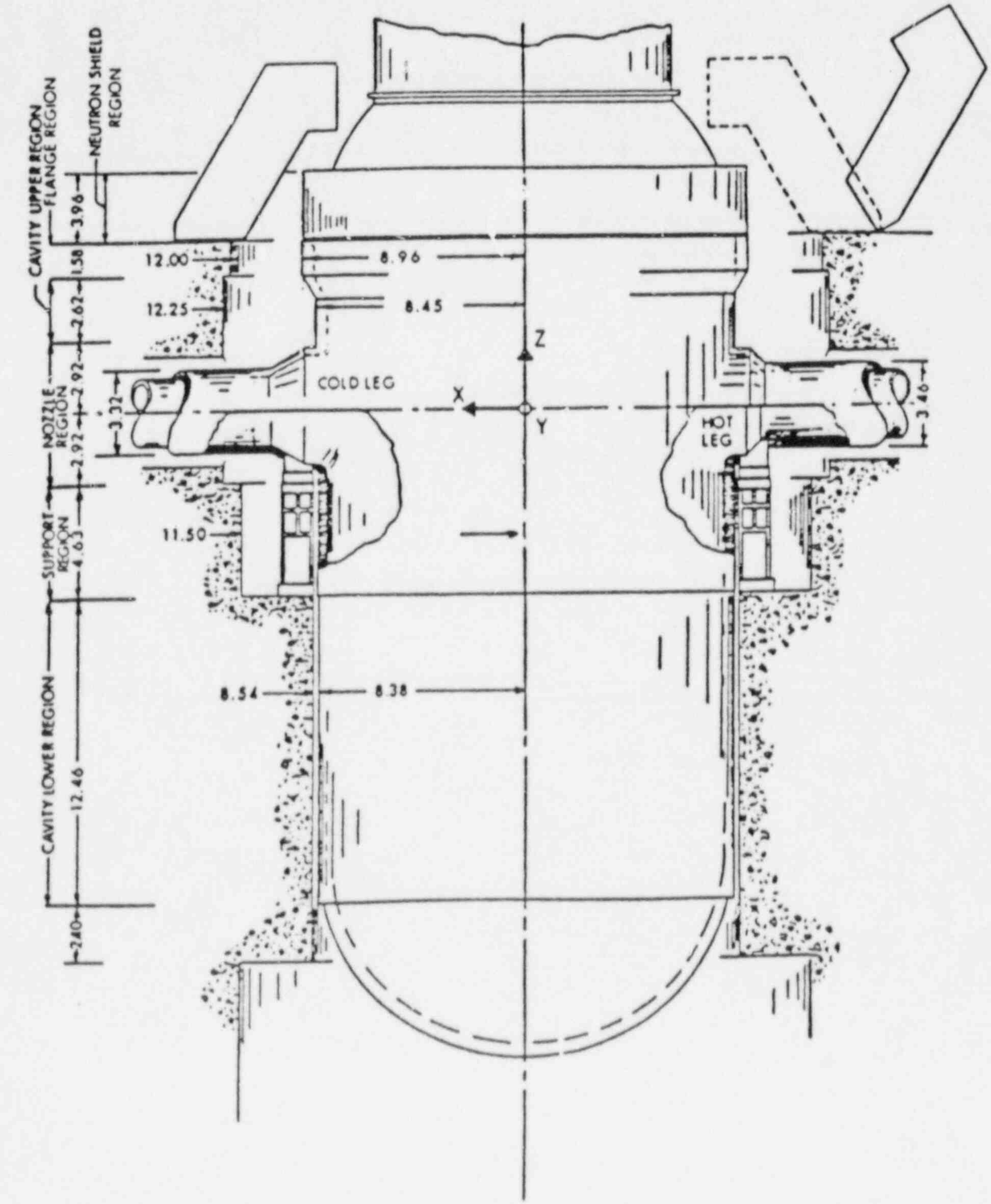


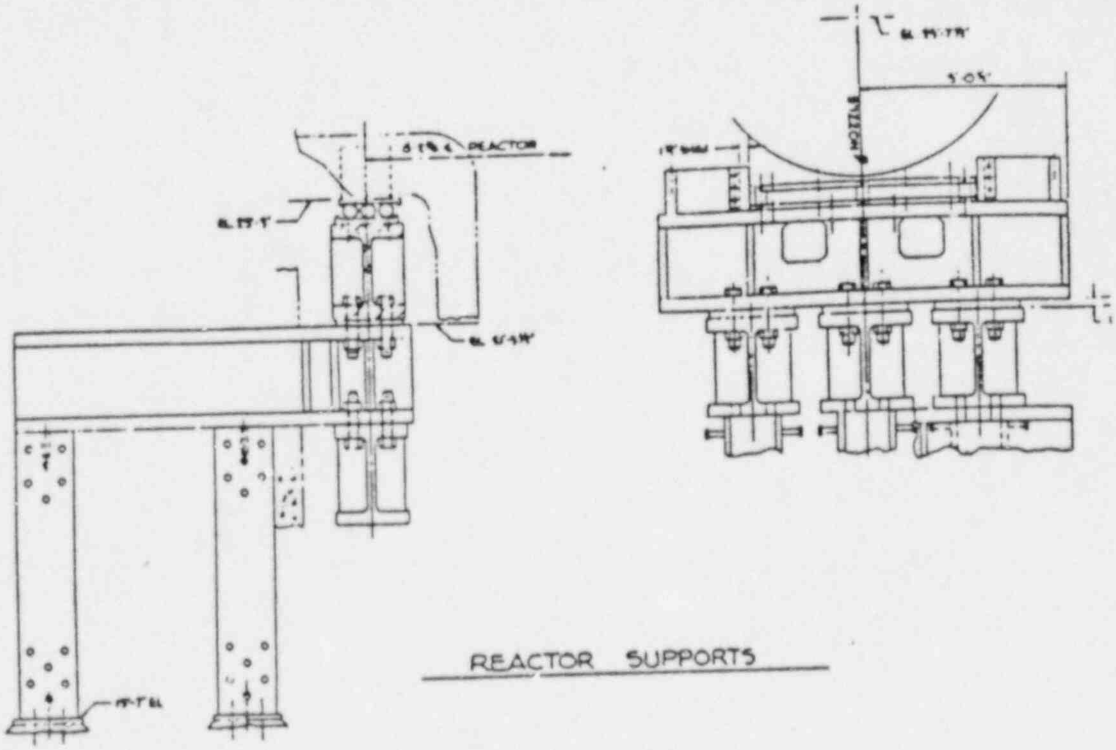
Component
support
Primary shield
wall
Column type
support
RPV
7-3047

REACTOR PRESSURE VESSEL SUPPORT

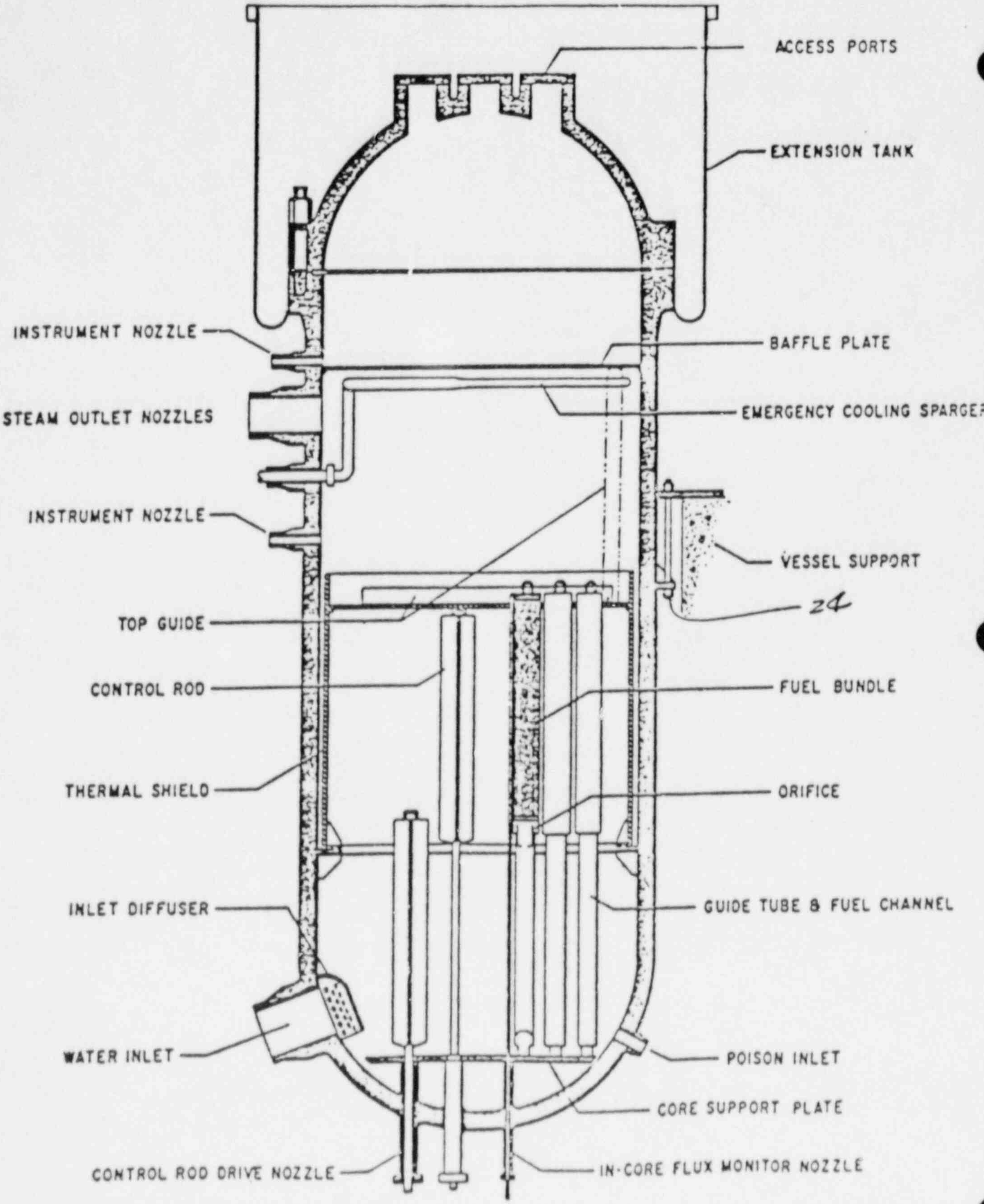


86-49,847


NEUTRON SHIELD REGION
CAVITY UPPER REGION
FLANGE REGION
NOZZLE REGION
SUPPORT REGION
CAVITY LOWER REGION
3.96
1.58
2.62
2.92
2.92
3.32
4.63
12.46
2.40
12.00
12.25
11.50
8.54
8.96
8.45
8.38
COLD LEG
HOT LEG
3.46
Z
X
Y



REACTOR SUPPORTS



ACCESS PORTS
EXTENSION TANK
INSTRUMENT NOZZLE
BAFFLE PLATE
STEAM OUTLET NOZZLES
EMERGENCY COOLING SPARGER
INSTRUMENT NOZZLE
VESSEL SUPPORT
24
TOP GUIDE
CONTROL ROD
FUEL BUNDLE
THERMAL SHIELD
ORIFICE
INLET DIFFUSER
GUIDE TUBE & FUEL CHANNEL
WATER INLET
POISON INLET
CORE SUPPORT PLATE
CONTROL ROD DRIVE NOZZLE
IN-CORE FLUX MONITOR NOZZLE

RPV SUPPORT EMBRITTLEMENT

CURRENT ASSESSMENT

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- →o SUPPORT RELIABILITY CURRENTLY IS JUDGED TO BE ADEQUATE
- o SUPPORT FAILURE DOES NOT LEAD TO FAILURE OF THE PRIMARY COOLANT LOOP PIPING

FACTORS CONTRIBUTING TO SUPPORT RELIABILITY

- STRESSES ARE GENERALLY COMPRESSIVE ALTHOUGH LOCAL AREAS COULD BE IN TENSION
- FOR MODE I LOADING, COMPRESSIVE STRESSES WILL CAUSE CRACK ARREST AND PREVENT CATASTROPHIC FAILURE
- SKIRT SUPPORTS DO NOT RECEIVE SUFFICIENT FLUENCE TO BECOME EMBRITTLED
- FRACTURES IN ONE SECTION OR COMPONENT OF THE STRUCTURE ARE NOT LIKELY TO RESULT IN COMPLETE FAILURE OF THE STRUCTURE BECAUSE THE STRUCTURES INCLUDE REDUNDANT LOAD PATHS AND ARE OVERDESIGNED

SIMPLIFIED PLASTIC ANALYSIS OF COOLANT LOOP PIPING

PLANT TYPE	MIN. TOTAL LOAD RESISTANCE	MAX. TOTAL LOAD (DEADWEIGHT + 0.25g SSE)
WEST. 2-LOOP	3020 KIPS	1950 KIPS
WEST. 3-LOOP C-E, B&W	4530 KIPS	3750 KIPS (2)
WEST. 4-LOOP	6040 KIPS	5500 KIPS (1)

(1) SSE based on 0.75g for Diablo Canyon.

(2) Maximum total load at SONGS 2 & 3 is conservatively estimated as 5830 Kips. However, the load resistance derived from only the two large-diameter, heavy-wall hot legs is estimated to be 7780 Kips -- a significant margin.

RPV SUPPORT EMBRITTLEMENT

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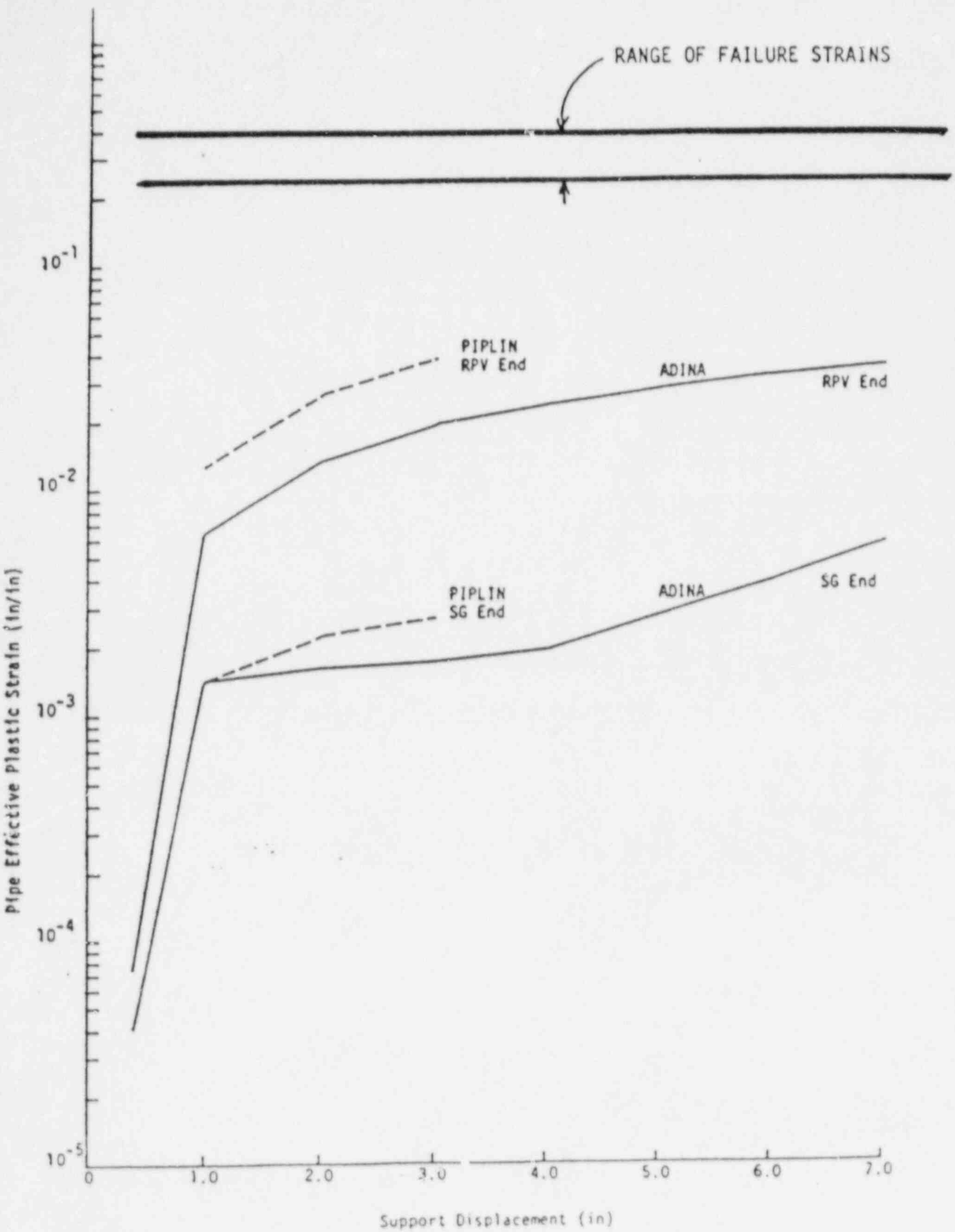


HOT LEG STRAINS FOR SG SUPPORT VERTICAL DISPLACEMENT

<u>SIMPLIFIED PLASTIC ANALYSIS OF COOLANT LOOP PIPING</u>

PLANT TYPE	MIN. TOTAL LOAD RESISTANCE	MAX. TOTAL LOAD (DEADWEIGHT + 0.25g SSE)
WEST. 2-LOOP	3020 KIPS	1950 KIPS
WEST. 3-LOOP C-E, B&W	4530 KIPS	3750 KIPS (2)
WEST. 4-LOOP	6040 KIPS	5500 KIPS (1)

(1) SSE based on 0.75g for Diablo Canyon.

(2) Maximum total load at SONGS 2 & 3 is conservatively estimated as 5830 Kips. However, the load resistance derived from <u>only</u> the two large-diameter, heavy-wall hot legs is estimated to be 7780 Kips -- a significant margin.

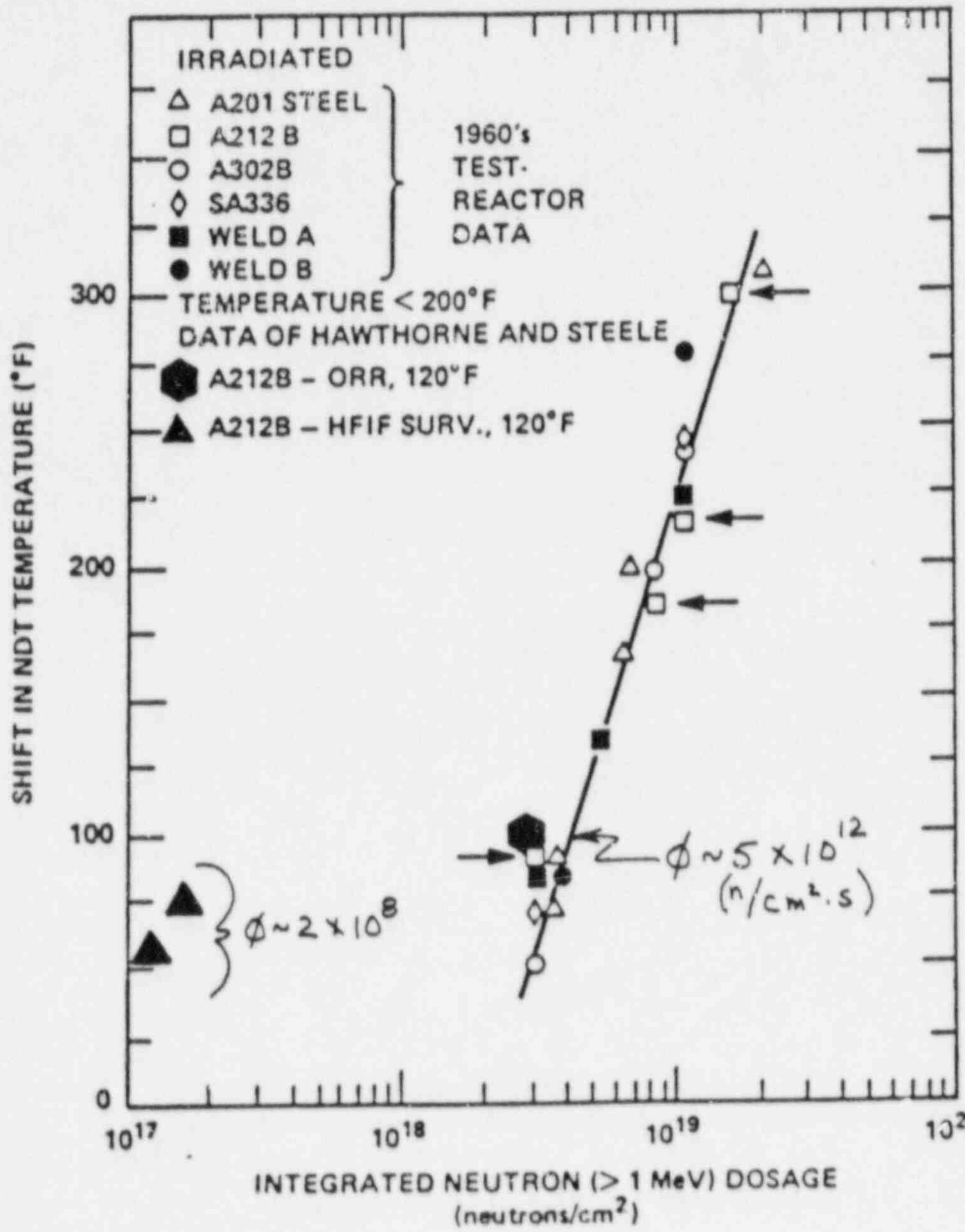
REACTOR PRESSURE VESSEL SUPPORT EMBRITTLEMENT

- o DESCRIPTION OF THE ISSUE AND CURRENT ASSESSMENT
- →o DESCRIPTION OF LOW TEMPERATURE LOW FLUX EMBRITTLEMENT PROBLEM AND DAMAGE CHARACTERIZATION
- o DESCRIPTION OF THE RESEARCH PROGRAM TO RESOLVE THE ISSUE

ORNL-DWG 87-8154

DIFFERENCE IN HFIR VESSEL AND TEST-REACTOR IN-CORE DAMAGE RATES APPARENTLY DUE TO LOWER FLUENCE RATE IN HFIR

● ϕ_F (TEST REACTOR) $\simeq 10^4 \times \phi_F$ (HFIR)



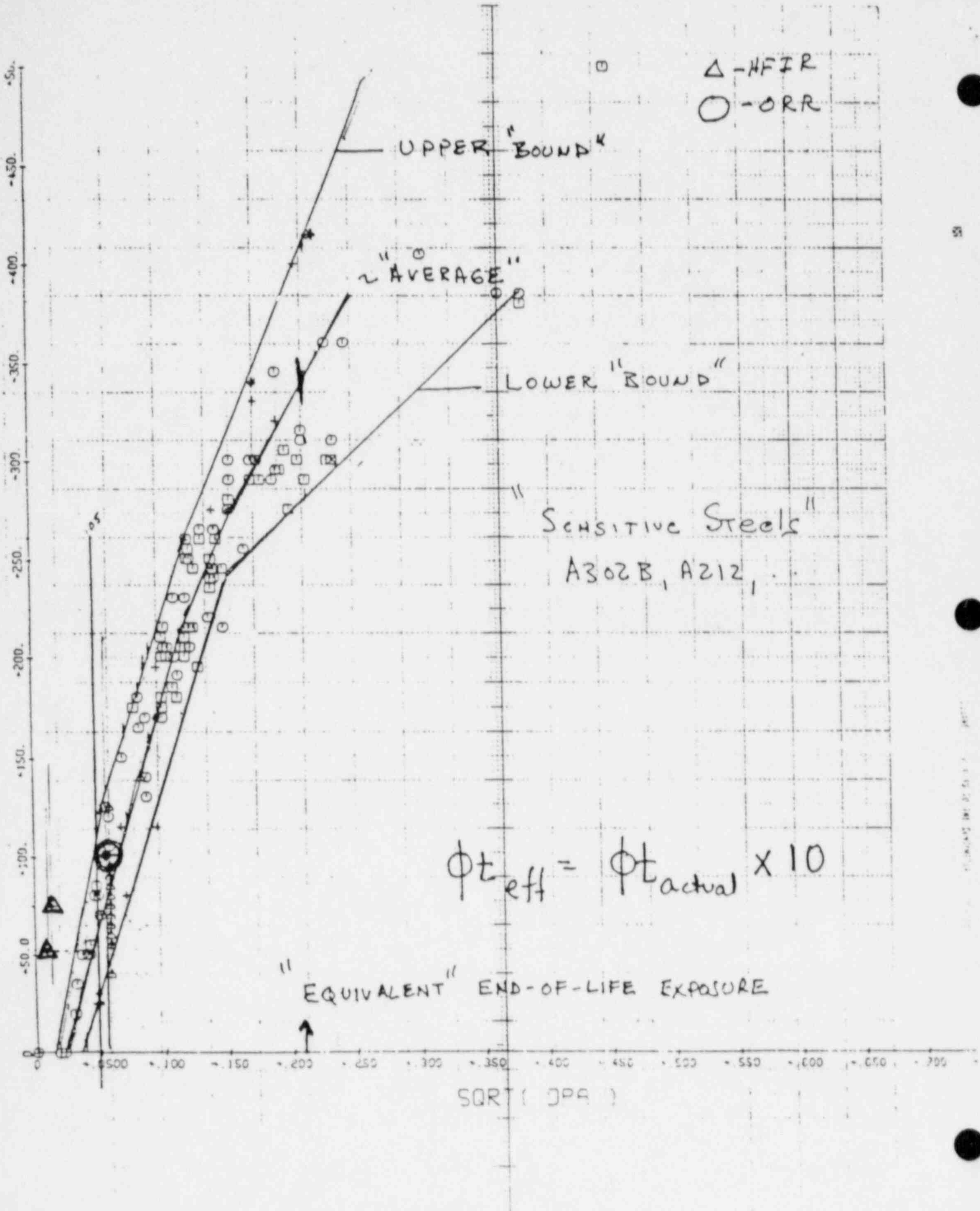
LWR CAVITY ΔNDT (32 EFPY) ESTIMATED BY ODETTE FOR ORNL PRELIMINARY EVALUATION

- PLOT ΔNDT (MTR's, T_R < 200°F) vs DPA

- CALCULATE CAVITY DPA FOR "TYPICAL" B&W, CE, W AND GE PLANTS (32 EFPY)

- MULTIPLY CAVITY DPA BY 10 TO ACCOUNT FOR RATE EFFECT

- DETERMINE ΔNDT (CAVITY, T_R < 200°F) FROM PLOT



Δ - HFIR
O - ORR
UPPER "BOUND"
~ "AVERAGE"
LOWER "BOUND"
"Sensitive Steels"
A302B, A212, . .
$\phi t_{eff} = \phi t_{actual} \times 10$
"EQUIVALENT" END-OF-LIFE EXPOSURE
SQRT(DPA)
0
.100
.150
.200
.250
.300
.350
.400
.450
.500
.550
.600
.650
.700
50.0
100.
150.
200.
250.
300.
350.
400.
450.

RPV SUPPORT EMBRITTLEMENT

TRANSITION TEMPERATURE SHIFT ESTIMATES FOR 32 EFPY (ODETTE)

VENDOR	NOM/MAX	dpc	T1 (C)	T2 (C)
B & W	NOM.	6.9x10(-4)	0	80
	MAX.		9	103
GE	NOM.	6.3x10(-5)	0	0
	MAX.		0	9
W	NOM.	4.7x10(-3)	65	195
	MAX.		90	230
C - E	NOM.	5.0x10(-3)	70	200
	MAX.		95	230

(1) T1 is without flux correction.

(2) T2 is with flux correction.

REACTOR PRESSURE VESSEL SUPPORT EMBRITTLEMENT

- o DESCRIPTION OF THE ISSUE AND CURRENT ASSESSMENT
- o DESCRIPTION OF LOW TEMPERATURE LOW FLUX EMBRITTLEMENT PROBLEM AND DAMAGE CHARACTERIZATION
- → o DESCRIPTION OF THE RESEARCH PROGRAM TO RESOLVE THE ISSUE

RPV SUPPORT EMBRITTLEMENT

APPROACH TO RESOLVE

- o IDENTIFY SUPPORT STRUCTURE TYPES FOR ALL U. S. LWRs
- o IDENTIFY 1 OR 2 PLANTS WITH LIMITING SUPPORT DESIGNS
- o PERFORM DETAILED FRACTURE ANALYSES FOR THESE PLANTS
- o STRENGTHEN BASIS FOR LOW TEMPERATURE, LOW FLUX, SOFT SPECTRUM EMBRITTLEMENT TREND CURVES
  - GET MATERIAL FROM SUPPORTS IN DECOMMISSIONED LWRs SUCH AS SHIPPINGPORT AND THE BELGIAN BR-3 AND EVALUATE TO DETERMINE DEGREE OF EMBRITTLEMENT
  - EVALUATE OTHER ANALYSES OF SUPPORT EMBRITTLEMENT
  - COLLECT AND EVALUATE OTHER LOW TEMPERATURE, LOW FLUX IRRADIATION DATA AND THE APPROPRIATE DAMAGE PARAMETERS
- o DEFINE APPROPRIATE REGULATORY ACTIONS