CORRECTED
6-19-92

ORIGINAL

OFFICIAL TRANSCRIPT OF PROCEEDINGS

Agency: U.S. Nuclear Regulatory Commission
Atomic Safety and Licensing Board

Title: Alabama Power Company
(Joseph M. Farley Nuclear
Plant, Units 1 and 2)

Docket No. 50-348-Civp;
50-364-Civp;
ALSBP No. 91-626-02-Civp

LOCATION: Bethesda, Maryland

DATE: May 21, 1992 PAGES 1996 - 2309

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ATOMIC SAFETY AND LICENSING BOARD

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In the Matter of:	: Docket Nos. 50-348-CivP;
Alabama Power Company	: 50-364-CivP
(Joseph M. Farley Nuclear Plant,	: ASLBP No. 91-626-02-CivP
Units 1 and 2)	:

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Nuclear Regulatory Commission
Fifth Floor Hearing Room
4350 East-West Highway
Bethesda, Maryland

Thursday, May 21, 1992

The above-entitled matter came on for further hearing, pursuant to notice, at 9:00 o'clock a.m., before:

The Honorable G. Paul Bollwerk, Chairman
The Honorable James H. Carpenter, Member
The Honorable Peter A. Morris, Member

Atomic Safety and Licensing Board, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555

APPEARANCES:

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Washington, D.C. 20555

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E X H I B I T S

Exhibit	Description	Identified	Received
APCo 130	States ZWM Terminal Block	2009	2015
APCo 131	States NT Terminal Block	2010	2015
APCo 132	GE CR-151B Terminal Block	2012	2015
APCo 133	GE EB-25 Terminal Block	2013	2015
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PROCEEDINGS

[9:00 a.m.]

JUDGE BOLLWERK: Good morning, everyone.

I think we're here to begin this morning with the rebuttal and surrebuttal testimony relating to terminal blocks.

Any procedural matters the parties wish to take up initially?

MR. REPKA: We have none.

MR. HANCOCK: Yes, we do.

MR. REPKA: Oh, we do?

JUDGE BOLLWERK: Mr. Hancock?

MR. HANCOCK: As we talked about on Monday, your copy -- thu Board's copy of Exhibit 39 was incomplete. We're going to substitute that.

JUDGE BOLLWERK: All right. These are our copies or these are the court reporter's copies?

MR. HANCOCK: These are your copies.

JUDGE BOLLWERK: Okay. The court reporter has them.

MR. HANCOCK: Yes. Our understanding is that theirs was complete.

JUDGE BOLLWERK: Just the Board's copies were not complete.

MR. HANCOCK: Right. You all got the Reader's

Digest version.

JUDGE BOLLWERK: Okay.

Any other procedural matters?

MR. HOLLER: If I may ask a question just for clarification, on APCo 39, if we were to follow the Bates numbers, that's a way to check to make sure the particular copy we're using is a complete one?

MR. HANCOCK: That's correct.

MR. HOLLER: Thank you, sir.

MR. HANCOCK: There was a gap in there. So, we checked it on Monday.

JUDGE BOLLWERK: All right.

So, you're satisfied. I mean, for instance, I can go down and check the copy we have in our file room, but you're satisfied that the copies that were put into evidence are complete, as opposed to what were sent to us earlier as pre-filed exhibits.

MR. HANCOCK: That was our understanding, Judge.

JUDGE BOLLWERK: Okay. I may check that anyway, but at least at this point, we'll go with what you say.

Anything else?

MR. MILLER: We're done.

JUDGE BOLLWERK: All right.

Why don't we go ahead and start with the panels, I guess the staff panel first?

MR. HOLLER: Yes, sir.

I will remind Dr. Jacobus and Mr. Luehman that you are still under oath.

Whereupon,

JAMES G. LUEHMAN

AND

MARK J. JACOBUS,

witnesses, were called for examination by counsel on behalf of the NRC Staff and, having been previously duly sworn, were further examined and continued to testify as follows:

DIRECT EXAMINATION

BY MR. HOLLER:

Q I'll ask each you, in turn, to please identify yourselves by name and current position.

A [Witness Luehman] My name is James G. Luehman, Senior Enforcement Specialist, Office of Enforcement.

A [Witness Jacobus] My name is Mark J. Jacobus. I'm with Sandia National Laboratories, and I'm a senior member of the technical staff.

Q I'll ask each of you if you have before you a document entitled "Rebuttal Testimony of Mark J. Jacobus and James G. Luehman on Behalf of the NRC Staff Concerning Terminal Blocks."

A [Witness Luehman] Yes, I do.

A [Witness Jacobus] Yes, I do.

Q Did each of you participate in the preparation of this document?

A [Witness Luehman] I did.

A [Witness Jacobus] I did.

Q At this time, are there any corrections to this document, beginning with Mr. Luehman?

A [Witness Luehman] Yes. I have one correction.

On the top of page 20, inside the quote -- it's inside the quotation, the very first line. It reads presently, "Terminal blocks in both its evolution . . .," and you should strike "evolution" and insert "evaluation" to make it read -- to make it an accurate quote.

Q Dr. Jacobus, do you have any corrections?

A [Witness Jacobus] I believe I have six corrections. Most of them are fairly minor.

The first one is on page eight, the fourth line from the bottom. It starts with "Requirements based in . . ." It should be "Requirements based on . . .," instead of "in," to make that an accurate quote.

Page 11, the first line of answer to question eight, after it says "Q&A 7," there should be a comma.

The next one is on page 28. This was just a grammatical error. The fourth line, the next-to-the-last word is "was." It should be "were."

On page 39, in the phrasing of question 30, the seventh line of that question references DiBenedetto's testimony at pages 114 to 25. That should be 114 to 15.

The next one is on page 44, the first ne, where Staff Exhibit 73 is referenced, and there is a close parentheses. There should be a second close parentheses there to match the one on the previous page.

And finally, on page 46, the last line of answer 38 begins with "That follow . . ." It should be "That follows . . ." Just add an "s" to "follow."

That's all the corrections that I have.

MR. HOLLER: I would note for the record that those corrections have been indicated on the copy provided to the court reporter.

JUDGE BOLLWERK: Thank you.

BY MR. HOLLER:

Q I would ask you gentlemen at this time, is the document you have before you true and correct to the best of your knowledge and belief?

A [Witness Luehman] Yes, it is.

A [Witness Jacobus] Yes, it is.

MR. HOLLER: At this time, I would move that the rebuttal testimony of Mark J. Jacobus and James G. Luehman on behalf of the NRC staff conc rning terminal blocks be bound into the record as if read.

MR. MILLER: No objection.

JUDGE BOLLWERK: Then the rebuttal testimony of Mark J. Jacobus and James G. Luehman on behalf of the NRC staff concerning terminal blocks will be received and bound into the record.

[The rebuttal testimony of Mark J. Jacobus and James. G. Luehman on behalf of the NRC staff concerning terminal blocks follows.]

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket Nos. 50-348-CivP
ALABAMA POWER COMPANY	)	50-364-CivP
	)	
(Joseph M. Farley Nuclear Plant,	)	
Units 1 and 2)	)	
	)	(ASLBP NO. 91-626-02-CivP)

REBUTTAL TESTIMONY OF MARK J. JACOBUS AND JAMES G. LUEHMAN
ON BEHALF OF THE NRC STAFF CONCERNING TERMINAL BLOCKS

Q1. State your full name and current position with the NRC.

A. Mark J. Jacobus, Senior Member of Technical Staff, Sandia National Laboratories. James G. Luehman, Senior Enforcement Specialist, Office of Enforcement.

Q2. Have you prepared a copy of your Professional Qualifications?

A. (Both) A copy of each of our Professional Qualifications has been admitted previously into evidence as Staff Exh. 1.

Q3. What is the purpose of your testimony?

A. (Both) The purpose of our testimony is to rebut portions of the Alabama Power Company Testimony regarding violations of the environmental qualification (EQ) requirements for the States terminal blocks (Model Nos. NT and ZWM) and the

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General Electric (Model No. CR151) terminal blocks at the Farley nuclear plant which in part led to the civil penalty that is the subject of this hearing. The APCo testimony which is the subject of this rebuttal testimony is contained in Direct testimony of Jesse E. Love, James E. Sundergill and David H. Jones on Behalf of Alabama Power Company (ff. Tr. 978) (hereafter L/S/J) and Direct Testimony of Philip A. DiBenedetto on Behalf of Alabama Power Company (ff. Tr. 1227) (hereafter DiBenedetto).

Q4. Could you please summarize APCo's position as you understand it?[1]

A. APCo is relying on several factors for their position. First, they claim that the terminal blocks were qualified as of November 30, 1985, based on their contention that the terminal blocks did not need to function at peak-LOCA conditions and based on what they consider Staff agreement of their position based on the January, 1984 meeting and the following correspondence. They next claim that even if the terminal blocks are required to function at peak-LOCA conditions, they should not be expected to have known that the blocks were not qualified. This actually presents two opportunities for them to claim that they did not know and they should not have known: first that they did not know the blocks had to be qualified for peak-LOCA conditions, and second, that if the blocks had to be qualified to these conditions, then they did not know and should not have known

[1]Unless indicated otherwise, the response to the questions are by Dr. Jacobus.

that blocks would not perform at the peak-LOCA conditions. Finally, they claim that the number of systems and components affected was minimal, implying that any violation was not significant.

Q5. Let us take things one step at a time. The APCo testimony focuses extensively on their contention that the terminal blocks are not needed at "peak-LOCA" conditions and therefore, their insulation resistance data at 150°F was adequate to qualify the blocks. Could you explain the progression of APCo's information to you that forms the basis for their position on this point?

A. At the time of the inspection, APCo's SCEW sheet formed the original basis for determining to what temperature the blocks must be qualified. The SCEW sheets (Staff Exhs. 69 and 70) for the blocks (or the electrical penetration assemblies of which they were a part) indicated that they had to be qualified to 378°F. The SCEW sheet for the States blocks further indicates that the blocks were only qualified to 307°F. A footnote indicates that the peak surface temperature of the blocks will not exceed the qualification temperature. The SCEW sheet for the General Electric electrical penetrations (which APCo claims also qualifies the terminal blocks) indicates that these blocks were qualified to 340°F. A footnote indicates that the peak surface temperature of the blocks will not exceed the qualification temperature. No additional documentation of their position that the blocks did not have to be qualified for peak LOCA conditions was provided during the inspection, either in the qualification files or in response to written questions to the licensee that questioned the basis for qualification (Staff Exhs. 71 and 72). In response to EQ Question Number 26 (Staff Exh. 71), APCo indicated that the basis for selection of an acceptance criterion of $1 x 10^7$ Ω was contained in the response to EQ Action Items 018 and 067 (APCo Exh. 52). This document discusses the Conax test report, including the environments that the tested (Connectron) blocks were exposed to and the minimum insulation resistance measured for the blocks. Interestingly, there is no mention in that document of the temperatures when the insulation resistances were measured, nor is there any argument that the blocks are not required at peak LOCA conditions. The temperatures at which IR measures were performed is clearly not obvious from the plot that is cited from the Conax report.

At the meeting in Atlanta on November 25, 1987, APCo indicated that they still had faith in the Conax report for qualifying the blocks. At that meeting, they presented an enhanced version of the graph from the Conax report (APCo Exh. 56). This enhanced graph included several data points that were not included on the Conax graph. It also included the temperatures at which the insulation resistance measurements were performed, which also were not part of the Conax graph. Interestingly, this data was presented to the Staff at this meeting with no qualifications.

Following their presentation of the data, I pointed out that the data in the Conax report was invalid as stated by the test report. This point was discussed in my previous Direct Testimony. This was the first time that APCo acknowledged to the Staff that some of the data in their figure was invalid. APCo's Direct Testimony addresses this point for the first time, where in Mr. Love's response to Q107 (L/S/J p. 117), he states that with regard to the this plot (APCo Exh. 56),

> This curve, which was developed specifically for the meeting, did not contain any explanatory notes indicating that the peak-LOCA portions of the IR data from the Conax testing were indicated in the test report to be defe ve. This fact had no bearing on the substantive nature of the elevant issues because these IR data points, which were all equal o or greater than 5E9 ohms, were not used in our selection of the value of 1E7 ohms.

It is extremely unclear to me why APCo would take a valid data figure, add invalid data to the figure (data that could have most definitely misled the NRC Staff because of the appearance of favorable IR data at 300°F), and then now claim that the data they had specifically added to the figure was irrelevant to their argument.

At the same meeting in Atlanta, APCo presented the data from the Sandia report (Staff Exh. 73) as part of the JCO (APCo Exh. 59). Although they still stood behind the Conax data for qualification, they provided an analysis of the Sandia data "to further exemplify the amount conservatism built into the setpoint analysis" (APCo Exh. 59). This is the first time that APCo provided any documentation that claimed that the blocks did not need to function at peak-LOCA conditions. They assessed the Sandia data and concluded that the blocks would function acceptably at 296°F and that the blocks were not needed at higher temperatures. This was based on an IR versus temperature plot that assumed the IR on a log scale to be linearly related to temperature.

When it was demonstrated that IR was in fact not related to temperature in this way, the meeting adjourned with APCo planning to replace the terminal blocks.

Aside from oral responses during the 1991 depositions of APCo witnesses, the APCo Direct Testimony is the first documentation provided to the NRC Staff that claims that the terminal blocks are not needed above some still lower temperature. I am aware of Mr. DiBenedetto's assertion that his January 8, 1988 report (Staff Exh. 47)

> . . . demonstrates that terminal blocks used in the APCo applications, that is pre-accident exposure and post-accident long term cooling, were capable of performing their intended functions. (DiBenedetto Q&A 143, p. 113).

However, his report addresses the issue of when the instrumentation circuit terminal blocks are required at Farley with reference to the Farley terminal block JCO (APCo Exh. 59). The JCO claimed that the terminal blocks were not required above 296°F. Mr. DiBenedetto does not assert, in his 1988 report, the temperature above which the terminal blocks are not required to function. APCo still has not defined what temperature they feel the blocks need to be qualified to, based on the circuit-by-circuit analysis that they claim to have used as a basis for qualification all along.

Q6. You referred to APCo's response to EQ Action Items 018 and 067 (APCo Exh. 52). What was in APCo's response?

A. The APCo Response to EQ Action Items 018 and 067 (APCo Exh. 52) states with regard to IPS-107 that

> The test operations (Sect. 6.0) describes the phases of the test sequence during which insulation resistance (IR) measurements were made. Readings of IR were taken during the Phase I and II LOCA environment testing. Sect. 6.6 describes the LOCA environment test operation. Peak chamber pressure during Phase I testing reached 57.5 PSIG (290°F) at 120 seconds, and Phase I peak chamber temperature reached 300°F (56 PSIG) at 10 minutes from introduction of steam (Time 0). At 60 seconds from Time 0, chamber chemical sprays were initiated. Phase II LOCA testing began at 30 minutes, 45 PSIG (294°F), and at 30 minutes, 35 seconds, the pressure was reduced to 0 and temperature was ramped down to 144°F and was maintained between 140°F and 150°F for 240 hours. During this time, chemical sprays were continuously introduced into the chamber. IR measurements were taken on each test item during the Phase I and II LOCA tests (Sect. 6.6.12), IR Test Nos. 6 thru 16 of Appendix B (IPS-107).
>
> Appendix E of IPS-107 provides a compilation of the IR Test Data. Graph No. 1 of Appendix E provides a plot of the minimum IR data points for the #16 AWG test conductor and terminal blocks which were recorded during the DBA and Post DBA testing for aged and unaged specimens. From this graph, it can be seen that the minimum IR point recorded for a #16 AWG conductor and block was 3E7 ohms for aged specimens, and 1.5E8 ohms for the unaged specimens.

The conclusion of that document states:

> As the FNP terminal blocks used in E.Q. instrumentation and control circuits located inside containment have superior significant characteristics to the Connectron NSS3 block tested in IPS-107, and as the FNP E.Q. enclosure configurations do not subject the FNP terminal blocks to submergence and provide equal or superior protection to that provided to the NSS3 block in the tested configuration, the use of minimum IR #16 AWG NSS3 values from IPS-107 test report for calculation of DBE leakage currents on instrumentation terminations inside containment is acceptable.

Although the above does not explicitly state it, the impression I get when reading the above is that the insulation resistance was greater than 10^7 Ω at all temperatures up to 300°F. This, of course was not actually the case.

Q7. What are the regulations that govern whether the blocks had to be qualified for peak-LOCA conditions?

A. 10 C.F.R. § 50.49 is the requirement for qualification and is what must be followed. Section (k) does not require requalification for equipment that was previously qualified to NUREG-0588 (Staff Exh. 23) or to the DOR Guidelines (APCo Exh. 8). The DOR Guidelines applied to the terminal blocks in Farley Unit 1 and the requirements of NUREG-0588, Category II applied to the terminal blocks in Farley Unit 2.

Section 5.2.5 of the DOR Guidelines states that:

> Failure criteria should include instrument accuracy requirements based ~~in~~ on the maximum error assumed in the plant safety analyses. If a component fails at any time during the test, even in a so called "fail-safe" mode, the test should be considered inconclusive with regard to

> demonstrating the ability of the component to function for the entire period prior to the failure.

Section 5.2(1) of the DOR Guidelines states that:

> The environment in the test chamber should be established and maintained so that it envelops the service conditions defined in accordance with Section 4.0 above. The time duration of the test should be at least as long as the period from the initiation of the accident until the temperature and pressure service conditions return to essentially the same levels that existed before the postulated accident.

Section 2.2(7) of NUREG-0588, Category II requirements states that:

> Performance characteristics of equipment should be verified, before, after, and periodically during testing throughout its range of required operability.

Section 2.2(9) of NUREG-0588, Category II requirements states that:

> The operability status of equipment should be monitored continuously during testing. For long-term testing, however, monitoring at discrete intervals should be justified if used.

Section 3(4) of NUREG-0588, Category II requirements states that:

> Some equipment may be required by the design to only perform its safety function within a short time period into the event (i.e., within seconds or minutes), and, once its function is complete, subsequent failures are shown not to be detrimental to plant safety. ... Equipment in these categories is required to remain functional in the accident environment for a period of at least one hour in excess of the time assumed in the accident analysis.

It is evident that, based on the above sections of the relevant guidelines, that the Commission expected equipment to be qualified for the entire accident, with only NUREG-0588 providing an exception. The exception still requires a minimum 1-hour qualification, and therefore does not support APCo's arguments. The intent of the regulations is made somewhat more clear in Section (i) of 10 C.F.R. § 50.49, which discusses the JCO process. Five factors were outlined that should be considered, as appropriate, to demonstrate that "the plant can be safely operated pending completion of equipment qualification required by this section." Factor 4 is "Completion of the safety function prior to exposure to the accident environment resulting from a design basis event and ensuring that the subsequent failure of the equipment does not degrade any safety function or mislead the operator." Thus, an analysis, such as the one APCo is relying on for the qualification of terminal blocks, was only to be permitted for a JCO, not for qualification of the equipment.

At this point, I should discuss what Mr. Love states in his testimony in response to Q120 (L/S/J pp. 130-32):

> It must also be recognized that the instrument loops at issue here were covered by Reg. Guide 1.97. (APCo Exh. 32). Reg. Guide 1.97 recognized explicitly, prior to the deadline for EQ, that the function of instrument circuits was time-dependent. Reg. Guide 1.97, Revision 2, stated at page 2 (emphasis added), that "[i]t is essential that the required instrument be capable of surviving the accident environment in which it is located for the length of time its function is required."

I think he is making a serious misinterpretation of Reg. Guide 1.97. The Reg. Guide does not state that equipment must be capable of functioning only when the instrument is believed to be required to function. It also does not state that the function of instrument circuits is time dependent. A correct restatement of the words in Reg. Guide 1.97 is that equipment must continue to function properly until it is no longer needed. This would include functioning through the peak LOCA conditions for the terminal blocks that are required after that time.

Q8. Why should APCo have clearly known that the blocks had to be qualified to peak-LOCA temperatures?

A. In addition to the regulatory basis provided in Q&A 7, from a pure technical standpoint, the blocks have to be qualified to peak-LOCA conditions unless the utility can provide clear and convincing evidence to the contrary. I have previously outlined what such analyses would have needed to consider. The relevant information is also included in Q&A 26 below. As I stated in response to Q5 above, prior to the APCo Direct Testimony being submitted, APCo had not ever provided any documentation, other than the JCO and the SCEW sheets, indicating that the blocks did not have to function at peak-LOCA conditions. The SCEW sheets claimed the blocks were qualified to 307°F (States) or 340°F (General Electric), while the JCO claimed that the blocks did not have to function above 296°F.

Clearly, the regulations and IN 84-47 should have been well known to APCo and they form the basis for why APCo "clearly should have known." Further, Sandia report NUREG/CR-3691 (Staff Exh. 74), which both APCo and Bechtel agree was reviewed by Bechtel (Tr. 1130, ll.12-25), provide a very strong basis as to why APCo "clearly should have known." This report's Conclusion 3 clearly indicated that "Most industry qualification tests do not monitor for low level leakage currents during LOCA simulation tests of terminal blocks. Without quantitative knowledge of these leakage currents, adequate analyses of their effects on instrumentation and control circuits cannot be performed." (Staff Exh. 74, page 117, Conclusion 3) However, in answering the question involving the Sandia reports, "did those documents, in any way, alter your view technically, of what needed to be done to address the instrument accuracy issues?" Mr. Love testifies "No." (Tr. 1130, l.22). This follows his recognition that the data APCo was relying on at the time was based on data taken after the completion of accident testing (L/S/J Q&A 94; pp. 104-05), not during the accident testing. I am not certain what Bechtel considers to be an adequate review of a document, but I would think that at the very least, the conclusions of the document would have to be read.

Q9. Given that blocks have to be qualified to peak-LOCA conditions for the Farley applications, why is it that APCo "clearly should have known" that they were not qualified as of November 30, 1985?

A. Information Notice 84-47 was the initial notification that insulation resistance data during the accident test was necessary. The subsequent issuance of the Sandia reports, which Bechtel has testified to having reviewed (Tr. 1130, ll. 12-25), further clearly outlined the concerns with operation at elevated temperature LOCA conditions. Conclusion 3 of NUREG/CR-3691 (Staff Exh. 74) was discussed in response to Q8 above. Conclusion 6 provided further information that "Terminal block leakage currents in a steam environment may degrade performance of instrumentation and control circuits to an extent sufficient to cause erroneous indications and/or actions." Figure 8-3 on page 85 of the same report (same as Figure 40 in NUREG/CR-3418) demonstrated vividly the effects of terminal block leakage currents on an actual pressure transmitter circuit. For these figures, only one terminal block was used in the circuit. Many Farley circuits contained two terminal blocks inside containment, effectively doubling the leakage currents that would be expected. The data from these figures is based on a General Electric EB-25 terminal block in the transmitter circuit and is intended as an illustration of the real effects of terminal blocks on such circuits. It clearly does not represent the Farley transmitter circuits exactly.

Mr. DiBenedetto states in testimony in response to Q145 (DiBenedetto p. 113-14) that "As I stated previously, if the APCo terminal blocks were to be used during the peak conditions of the accident, the Staff's assessment would be correct and justified." Thus, he agrees that if the blocks had to be qualified to peak-LOCA conditions, then the blocks were not qualified as of November 30, 1985 and the Staff's position would be correct.

Although Information Notice 84-47 was the major alert to licensees on the issue of degraded insulation resistance, the NRC also issued Information Notice 85-39, Auditability of Electrical Equipment Qualification Records at Licensees' Facilities, on May 22, 1985. (Staff Exh. 77). This information notice states, in part, on page 3:

> An EQ test report, in and of itself, does not completely support a determination that equipment is qualified. In order to ensure that plant-specific requirements are adequately considered, the following types of additional information may be needed: . . . (4) effects of decreases in insulation resistance on equipment performance; . . . (6) applicability of EQ problems reported in IE information notices and bulletins and their resolution.

Q10. APCo has claimed that the number of systems and components affected was minimal, implying that any violation was not safety significant. How do you respond to their assertion? (L/S/J Q&A 121 pp. 132-34).

A. Of the 13 Type A, Category 1 variables that were identified in Table of the Farley Regulatory Guide 1.97 submittal (Staff Exh. 75), multiple channels of 5 variables would be affected. As stated in the APCo response to EQ Action Items 018 and 067 (APCo Exh. 52), both units relied on terminal blocks in transmitter circuits for 2 channels of wide range reactor coolant system (RCS) pressure for 3 channels of pressurizer pressure, for 3 channels of pressurizer level, for 3 channels of narrow range level in each of 3 steam generators, for 1 channel of wide range level in each of 3 steam generators (only in Unit 2), for 2 channels of containment post-accident sump level, and for 2 channels of flow in each of 3 steam generators. Of these, RCS pressure, wide range steam generator level, narrow range steam generator level, pressurizer level, and containment sump level are the Type A, Category 1 variables. Type A variables are "those variables to be monitored that provide the primary information required to permit the control room operators to take the specified manually controlled actions for which no automatic control is provided and that are required for safety systems to accomplish their safety function for design basis accident events." According to RG 1.97, "Category 1 provides the most stringent [qualification] requirements and is intended for key variables."

Q11. What effects will the terminal blocks have on instrumentation circuits?

A. Referring to Figure 8-1 in NUREG/CR-3691 (Staff Exh. 74), which is a simplified schematic of a pressure transmitter circuit, the terminal blocks provide a leakage path R_{TB} between the supply conductor to the transmitter and the return conductor from the transmitter. Because of the voltage difference between the two conductors, leakage currents I_{TB} flow between them. The magnitude of the leakage currents varies with changes in the external environment, but the effect is always that the power supply has to supply more current I_L through the measuring resistor (I to V isolation amplifier) than if no leakage currents were present (I_{TB} =0). Thus, the measuring resistor reads not only the current supplied from the end device (I_T), but also the current that is leaking between the terminals of the terminal block (I_{TB}). Because the leakage current (I_{TB}) is always in the same direction, the readout device will always read a higher value of current (I_L) than that coming from the end device (I_T), resulting in the pressure (or level or flow) appearing higher than it actually is.

EVOLVING REQUIREMENTS

Q12. Let us move to other areas of the APCo testimony. They testify extensively regarding "evolving requirements" for loop accuracy calculations. Let us begin with the Sandia seminar. How do you respond to their testimony regarding the seminar?

A. In his Direct Testimony (L/S/J Q&A 100 pp. 109-10), Mr. Love indicates that, based on my deposition, he presumes that with regard to the instrument accuracy issue that the Sandia EQ seminar "contributed to the latest interpretation of this issue, and that the post-deadline EQ NRC inspections findings and violations were the method of communicating the latest thinking." (L/S/J p. 110). I think it is appropriate for me to restate the purpose and content of the seminar held at Sandia in 1987. The seminar had two primary purposes. The first was to provide training of new inspectors that had recently been assigned to EQ, particularly at the NRC Regional offices. The second was to make all inspectors aware of those areas where significant problems had been found during the first year or so of first round inspections. This was simply to help inspectors make the best use of their time when performing inspections, rather than trying to start from the beginning at every inspection. The purpose of the seminar was not to define new interpretations of requirements, nor to require enhanced documentation from licensees at future inspections.

The information that was presented regarding the accuracy contribution of terminal blocks on instrument circuits was based virtually 100% on the Sandia terminal block test results in NUREG/CR 3418 (Staff Exh. 73) and NUREG/CR-3691 (Staff Exh. 74) and other industry tests that occurred prior to November 30, 1985. A copy of the material discussed at the seminar was provided to APCo during discovery (Staff Exh. 59). Based on the above, their assumptions as to what went on at the seminar regarding instrument accuracy are not correct.

Q13. In Q&A 34 of their Direct Testimony (L/S/J p. 43), Mr. Love and Mr. Sundergill testify as follows:

> Q34. Were there any other aspects of EQ that were "evolving" subsequent to the EQ deadline and prior to the 1987 Farley inspections?
>
> A34. (Love, Sundergill) Yes. One example is terminal blocks, which we will discuss further below. This was a topic where Sandia National Laboratories (Sandia) had conducted some tests and was developing data. Sandia became involved in the inspection process after the deadline and it was only natural that they brought to the inspection the

> most-recent, post-deadline perspectives. However, their 1987 views do not properly reflect what APCo "knew or clearly should have known" as of the November 30, 1985 deadline.

How do you respond to their testimony?

A. (Jacobus) The only thing that they state correctly is that Sandia "had conducted some tests." I believe the other statements to be incorrect. Sandia was not, in fact, developing data on terminal blocks after the EQ deadline. The final reports on terminal blocks were published in August and September of 1984, completing the Sandia terminal block testing program more than a year before the EQ deadline. Mr. Craft, the author of the terminal block reports, changed jobs in late 1984, leaving EQ entirely. No additional terminal block testing or data development was performed at Sandia from late 1984 up until the time of the inspections at Farley.

Sandia was involved in the inspection process for EQ beginning in about 1981, with very significant activity in late 1982 and into 1983. The earlier inspections were at vendors, A/Es, and test labs. In FY82, Sandia supported 11 inspections. In FY83, Sandia supported 40 inspections. Sandia was also involved with the first round EQ inspections at virtually every plant in the country.

(Luehman) Clearly, this assertion is not supported by the facts. Information Notice 84-47 which dealt with this subject was sent to APCo well before the deadline. Further, NRC inspectors had questioned the use of terminal blocks in instrumentation circuits in a number of pre-deadline inspections.

Finally, as supported by a number of APCo witnesses, numerous licensees had responded to the Information Notices 82-03 and 84-47, prior to November 30, 1985, by removing terminal blocks from these circuits and the NRC integrated their concern into 10 C.F.R. § 50.49 audits.

Specifically, with respect to pre-deadline inspections, the inspection report dated January 29, 1985 documenting an October 15-19, 1984 inspection at Calvert Cliffs (Staff Exh. 63), on page 12, states "The inspectors also reviewed an internal BG&E letter dated October 3, 1984, that states an FCR is being prepared to replace terminal blocks in instrumentation circuits by qualified splices."

As part of a joint affidavit on behalf of the Nuclear Utility Group on Environmental Qualification (NUGEQ) submitted to the NRC as an enclosure to an October 3, 1988 letter from the NUGEQ, Messrs. Noonan and DiBenedetto, APCo witnesses, and Mr. LaGrange, APCo affiant, commented on this subject. With respect to Information Notice 84-47, they state on page 15 of the affidavit (which also was submitted as part of APCo's response to the Notice of Violation (Staff Exh. 15)) "...virtually all licensees simply replaced instrumentation terminal blocks..." and more importantly, "The intent of the Notice was to call attention to this problem such that utilities would replace terminal blocks in instrumentation circuits with qualified splices. This specific problem was discussed during meetings held with each licensee but the broader issue of total instrument loop accuracy was not. ... The NRC integrated this concern for instrumentation circuit terminal blocks into both its ~~evolution~~ evaluation of NTOL equipment qualification [illegible] and 50.49 compliance audits." (emphasis added).

Q14. In Direct Testimony (L/S/J Q&A 80, pp. 93-94), Mr. Love and Mr. Jones testify that

> At Farley, we addressed terminal blocks in instrument circuits as did the rest of the industry in accordance with NRC dictates -- by including their portion of the instrument loop error in the instrument setpoint calculations for emergency procedures, as discussed further below.

Similarly, in his Direct Testimony (DiBenedetto p. 100), Mr. DiBenedetto states that

> Subsequently, instrument accuracy became an "evolving"' technical issue that needed to be addressed by industry as a generic matter. By 1984, industry had initiated efforts to address the instrument accuracy issue through Emergency Operating Procedure (EOP) setpoints and error margins. This effort did involve some consideration of accuracies of terminal blocks. APCo -- through Bechtel and Westinghouse -- proceeded on the same path as did others in the industry...

Based on Sandia's experiences with the inspection process, as well as other contact with industry, how would you characterize how the rest of the industry addressed terminal blocks in response to Information Notice 84-47?

A. Without going into detailed results of inspections, I would simply note that I do not know of any plant that uses terminal blocks in 4-20 mA transmitter circuits that require harsh environment qualification and are located inside containment. I recall being told during many inspections that all inside containment terminal blocks in 4-20 mA circuits had been replaced in response to IN 84-47. In many cases, plants went beyond replacing only the terminal blocks in 4-20 mA circuits. Some replaced all terminal blocks in all instrumentation circuits inside containment and some even replaced terminal blocks in control circuits. Still others replaced selected terminal blocks outside containment in instrument circuits. This is very different than the Farley approach.

In terms of performing loop accuracy calculations involving contributions of calibration equipment and other secondary effects, I would agree that APCo probably began such calculations in the same time frame as the rest of the industry. However, that is not the issue in these proceedings. The issue is specifically for not properly considering the effects of terminal blocks on the accuracy of instrument circuits. The NRC Staff expected to see acceptance criteria established for the terminal blocks (based on their required function) and then a demonstration that the terminal blocks meet those specified functional performance requirements during accident conditions as is required by regulations. If the only way APCo felt they could establish the functional performance requirements of the terminal blocks was to perform a detailed analysis of the entire circuit and if they did not have the capability to do that analysis prior to November 30, 1985, they could have chosen to remove the terminal blocks, as many other utilities chose to do. Information Notice 84-47 and their review of the Sandia reports clearly should have given them ample reason to doubt the capability of their installed terminal blocks. These documents indicated that the terminal blocks likely formed a "weak link" in the instrument loop. All utilities that I know of, with the exception of APCo, took appropriate action to respond to IN 84-47.

Q15. In his Direct Testimony (L/S/J Q&A 89, p. 100), Mr. Love testifies that total loop effects, which include terminal block IR data, were not yet being considered when finalizing the qualification of terminal blocks. What did Information Notice 84-47 suggest with regard to total loop effects?

A. IN 84-47 specifically suggested that licensees "review terminal block qualification documents to ensure that the functional requirements and associated loop accuracy of circuits utilizing terminal blocks will not degrade to an unacceptable level due to the flow of leakage currents that might occur during design basis events" (emphasis added). Note that the suggested activities were very specific.

Q16. In Q&A 102 (L/S/J pp. 110-12), Mr. Love testifies that

> In essence, consistent with the latest thinking, we needed to find IR data for terminal blocks in low voltage instrument circuits, taken during LOCA testing, to include in the loop accuracy calculations. The Wyle data used in 1984 was not taken during LOCA testing. To do this, based on the 1986-1987 interpretation of this issue, we consulted the corrective actions contained in IN 84-47...

How do you respond to this testimony?

A. It seems ridiculous to me that only in 1986-1987 would a utility finally consider performing the corrective actions that had been clearly identified in an information notice issued 2-3 years earlier. It would seem that it took them 2-3 years to finally figure out that the corrective actions listed in IN 84-47 applied to them. Even when they did finally recognize the need for the insulation resistance data during LOCA testing, they took the data from a report on terminal blocks in which insulation resistance was measured only at temperatures below 150°F.

Q17. At the end of his response to Q112 (L/S/J p. 124), Mr. Love testifies that

> The violation at issue here appears to be based only on a failure to reach agreement in the instrument loop accuracy paperwork as to which value of IR should have appeared in the Westinghouse calculations in 1987. The selection of the IR data point for the 1987 loop accuracy calculations was entirely a 1987 issue and should not be the subject of enforcement for pre-deadline compliance.

Do you agree?

A. IN 84-47 was issued more than a year before the deadline and specifically stated that licensees should "review terminal block qualification documents to ensure that the functional requirements and associated loop accuracy of circuits utilizing terminal blocks will not degrade to an unacceptable level due to the flow of leakage currents that might occur during design basis events." What this said to licensees is that terminal blocks can be a large contributor to loop inaccuracy and that terminal blocks should be considered in that light as a part of the ongoing

10 C.F.R. § 50.49 reviews being performed by licensees at that time (prior to the EQ deadline). If APCo was incapable of performing this action prior to the EQ deadline, they could have chosen to replace the terminal blocks (as many other licensees chose to do).

The fact that the NRC did not further cite APCo in the violation for not having "performance specifications under conditions existing during and following design basis accidents" for terminal blocks as required by 10 C.F.R. § 50.49(d)(1) was consistent with the Modified Enforcement Policy of generally considering all information that the licensee had available at the time of the audit. At the meeting in Atlanta shortly after the audit, APCo had established a performance specification of $5x10^5$ Ω for the terminal blocks. If APCo would not have come up with an appropriate performance specification, then they might also have been cited for that deficiency.

Q18. In response to Board examination, Mr. Love discussed his use of the word "consensus" with regard to "how the calculation of leakage currents from the complete instrument loop (including terminal block contributions) would be made." He testifies that

> Previous to the 1986-87 timeframe, there were assumptions made in the calculations that the cables and other components that may be in the harsh environment in the instrument loop, such as connectors or terminal blocks or cable splices, were -- their contribution to the error was insignificant as compared with the

sensor itself due to the adverse environment effects. (Tr. 1139, ll.14-21).

He again testifies in response to Judge Carpenter's question

> JUDGE CARPENTER; Would you say that the errors associated with these terminal blocks that were at issue and are now at issue before us pre-November, 1985, EQ-deadline were thought to be small but in fact were unknown?
>
> WITNESS LOVE: The exact contribution from the terminal block was thought to be small in the previous terminal. (Tr. 1141, ll.2-8).

Following Mr. Love's response, Mr. Jones testifies

> WITNESS JONES; I agree. I think you're correct. (Tr. 1141, l.9).

How do you respond to their testimony?

A. I think they clearly have the facts wrong. IN 84-47 clearly informed utilities that "the NRC staff recognizes that leakage currents do exist during LOCA/MSLB simulations and that the leakage currents may be of significance in some applications." It went on to suggest what utilities should do as I have previously discussed. A methodology for calculating the effects of degraded insulation resistance on various circuits was presented in NUREG/CR-3691 (Staff Exh. 74).

The testimony of Mr. Jones bears this out when he testifies that "I don't think that it's the calculation that has evolved. It's the amount of contributions of which components that has evolved over a period of time." (Tr. 1140, ll.3-6). His statement is exactly correct in this case. In response to IN 84-47, terminal blocks were either replaced or appropriately considered as part of the loop accuracy calculations by other utilities. At that point, most utilities began considering the effects of cables, electrical penetrations, and splices also. In the evolution of loop accuracy calculations after the EQ deadline, items such as process measurement accuracy, sensor calibration accuracy, sensor temperature effects, sensor pressure effects, sensor drift, rack calibration accuracy, rack comparator setting accuracy, rack temperature effects, and rack drift began to be considered in the loop calculations (Staff Exh. 76). APCo has not been cited for failure to consider these type of effects. They have only been cited for failing to consider the effects of terminal blocks, the issue identified in IN 84-47.

In addition to Mr. Jones' testimony, Mr. DiBenedetto's testimony at Q&A 118 (DiBenedetto p. 98) states that with regard to moisture films and IN 84-47 that "This notice, which came out in June 1984, was the first generic notice of the issue." He then goes on in Q&A 119 to respond to the question "Was this the first time instrument accuracy, or at least the contribution of terminal blocks to instrument accuracy, was ever considered to be a significant problem?" with "Generally, that is correct." Thus, he confirms that Mr. Love's testimony at Tr. 1139 and Mr. Jones' agreement with that testimony are indeed incorrect.

Q19. In response to Q147 (DiBenedetto pp. 115-17), Mr. DiBenedetto testifies that "the Staff withdrew a violation associated with instrument loop accuracy in apparent recognition of the fact that the licensee could not have known of the issue prior to the EQ deadline." Did the violation at Robinson have anything to do with the use of terminal blocks in instrument circuits?

A. No. The issue at Robinson was very different. Robinson had performed adequate loop calculations (except for a problem with how they treated penetrations). What they had failed to do was to provide documented plant requirements for comparison with the calculated loop accuracy. At Farley, terminal blocks were being used inside containment in instrument circuits without properly considering the effects of the terminal block leakage currents, an issue clearly and unmistakably identified in IN 84-47.

SIMILARITY ARGUMENTS

Q20. Let us now consider the APCo testimony regarding the Conax test of Connectron terminal blocks. In Q&A 103 (L/S/J pp. 112-14), Mr. Love tries to justify that the APCo similarity analysis was correct because it considered the physical characteristics of the Connectron vs. the States and GE blocks. He goes on to indicate that their "approach to qualification by analysis is not unusual and is acceptable under 10 CFR 50.49." How do you respond to his testimony?

A. I completely agree that a complete and correct analysis may be used to establish similarity. The issue is whether their analysis was complete and correct. It was not because it did not consider the fact that the Connectron blocks have every other terminal at a different elevation, while the GE and States blocks both have terminals that are all at the same height. The "compact step-type configuration" is a feature that is clearly delineated in the Connectron literature. Further, differences in how moisture collects on different terminal blocks ~~was~~ were not addressed. Presumably, "engineering judgement" was used to discount these factors. I do agree that every element of engineering judgement need not be documented in great detail, but I do firmly believe that they should be able to provide a sound engineering basis that demonstrates that their engineering judgement was reasonable.

Q21. In Q&A 104 (L/S/J pp.114-15), Mr. Love testifies that

> We had considered the differences identified by the Staff and concluded that they were not germane.
>
> First, let me address the alleged material differences.... The Sandia report indicated that insulation resistance of the terminal block <u>material</u> was not the important factor. Based on this conclusion it is clear to me that a materials similarity analysis between the NSS3, NT/ZWM and CR151 terminal blocks is immaterial to the issue.

How do you respond to his testimony?

A. I have no idea how he came to the conclusion that there were "alleged material differences." He refers to my Direct Testimony on page 4, in which I can find no mention of the word "material." Similarly, in my deposition, pages 112-116, similarity was discussed, with no mention of material differences. Mr. Love then goes on to discuss the Sandia report and what it states about material differences, which is completely irrelevant in light of the fact that I have never brought up material differences.

Q22. Mr. Love goes on to discuss that he feels that the differences in height between the adjacent terminals would not have "any impact on the existence or non-existence of a conductive moisture film... or on the relative performance in instrumentation circuits." (L/S/J p. 115). How do you respond to this part of his testimony?

A. I agree with the first part of his statement regarding whether a film will exist. However, the second part of his statement is not correct. In APCo's original similarity analysis they recognized that the distance between terminals was an important parameter. What APCo did not consider is that the step design effectively increases the distance between adjacent terminals. Taken to a ridiculous extreme, let us assume that there was a 1 foot height difference between adjacent terminals. Then the effective distance between terminals would be about 1 foot even if the center-to-center spacing were only 1/4 inch. Using the APCo logic would then imply that a single level terminal block with 1/2 inch between terminals would be better than the step design with effectively 1 foot between terminals.

Q23. Mr. Love then goes on

> Finally, the allegation of differences in construction is groundless. In my view, this issue as raised by the Staff inspectors in effect challenges the efficacy of qualification by analysis. It seemed during the inspection, as it does now, that the staff would only be satisfied by prototype LOCA testing for this IR parameter. (L/S/J p. 115).

How do you respond to this part of his testimony?

A. In fact, APCo had such test results in their procurement file at the time of the inspection. Which would one prefer to believe, data on the actual terminal blocks at appropriate LOCA conditions, or data taken on significantly different terminal blocks at conditions much less severe than would actually exist during a design basis accident? I do not believe that it takes too much "engineering judgement" to answer that question.

As an example of the differences in construction, the GE and Connectron blocks are molded as a single piece of insulating material, barriers and all. In contrast, the terminal bases and barrier materials are formed separately for the States blocks and then these are attached with screws to a base metal plate. This results in what NUREG/CR-3418 (Staff Exh. 73) and NUREG/CR-3691 (Staff Exh. 74) term a sectional terminal block, as defined on page 12 of NUREG/CR-3691. Differences such as these were not addressed in the similarity analyses.

Q24. Under cross examination you were asked about the conditions under which a similarity analysis might be possible. (Tr. 737). Could you explain the distinction between your answer "If the terminal blocks are exposed to fairly mild conditions, from a technical standpoint, there's very little that you have to do to show similarity," (Tr. 373, 1.22), and your statement "If the blocks are exposed to fairly severe conditions, you have to do much more." (Tr. 738, 1.2)?

A. The distinction is drawn in that under more severe conditions, the terminal blocks are near their performance limits. Thus, even subtle differences between blocks can make a difference as to whether the circuits will maintain acceptable accuracy. We must recall that in going from an IR of $10^5\ \Omega$ to an IR of $10^4\ \Omega$, Westinghouse has indicated that the error goes from roughly 5% to 50%. Thus, fairly small changes in terminal block IR in this range have much more significant effects on the loop accuracy than do changes in IR from say $10^7\ \Omega$ to $10^6\ \Omega$. This latter change would have essentially no effect on the overall accuracy of the circuit, because other factors would be dominant. Thus, when the terminal blocks (or any other equipment items) are near their performance limits, the judgement to use similarity arguments must be made much more carefully than when the equipment is well within its performance limits. The similarity analysis must also be much more rigorous.

This also explains why I agree that if the terminal blocks only had to function at 150°F, then the similarity analysis, while not adequate for similarity at higher temperatures, would have been considered adequate at the lower temperatures. This is not meant to imply that the blocks would behave exactly the same, but rather that the differences between the IRs at this temperature would not have any significant effect on the circuits they were a part of.

Q25. How important is the similarity analysis in terms of the violation?

A. The similarity analysis is not important to the violation. Even if the similarity analysis were completely acceptable, the fact that the Connectron blocks only had insulation resistance data up to 150°F renders the test useless from the point of view of qualifying the APCo terminal blocks for temperatures near 300°F.

REQUIRED QUALIFICATION TEMPERATURE/
ARGUMENTS THAT BLOCKS WERE QUALIFIED/JCO

Q26. In reviewing the APCo Direct Testimony, what conclusion do you come to about when APCo claims the terminal blocks have to be qualified?

A. APCo's Direct Testimony still does not give the temperature that they contend the blocks have to be qualified to for instrument accuracy considerations. It does appear to claim, in Mr. Love's response to Q110 (L/S/J pp. 120-21), that some of the terminal blocks are not needed until the "temperature is below 200°F for worst case LOCA" and that "post accident monitoring instrumentation will not be relied upon for operator action at the 313°F containment temperature peak; it is relied upon during the post-peak periods when the temperature is significantly reducing or tailing off." His response, even at this late date, does not consider the following factors:

a. the qualification regulations, as explained above in Q&A 7

b. the possibility of operators taking inappropriate actions in response to incorrect readings

c. the effects of different accident sequences and whether the terminal blocks might have to function at higher temperatures in these alternative accident sequences (a design basis LOCA can only be used as a bounding accident if it is demonstrated that the equipment performs throughout the accident test)

d. warnings to the operators that the instruments could be inaccurate at the high containment temperatures

e. whether any of the instrument circuits containing terminal blocks are connected to alarms and/or any type of recorder and how these factors might contribute to misleading of the operators, either in diagnosing or responding to various accident conditions

Q27. Focusing on items b. and d. of your previous response, is there any APCo documentation that you can cite that supports that warnings in the EOPs (or as they are generically referred to by Westinghouse, Emergency Response Procedures (ERPs)) would have been necessary and that there was potential for incorrect operator action?

A. Attachment 2 to the JCO (APCo Exh. 59) is a letter from Westinghouse to APCo. This letter states in part that:

> For RCS Subcooling, Steam Generator Narrow Range Level and Wide Range Pressure, it is recommended that for Farley Unit 1 that a containment temperature criterion be defined that is indicative of current leakage resistance of less than $5 \times 10^5\ \Omega$. A value of greater than $5 \times 10^5\ \Omega$ results in an instrument inaccuracy that will allow the current ERP values to be used by the operator to take action as specified in the ERPs. **The temperature or a corresponding containment pressure criterion should be used as guidance to the operator using the ERPs on when to consider that additional error above that already accounted for in the ERPs may exist.** Under conditions exceeding these criteria, no action which could reduce the margin of safety, specifically termination of safety injection based on RCS Subcooling or stopping of all auxiliary feedwater based on Steam Generator Narrow Range Level or stopping of RHR pumps based on Wide Range Pressure, should be performed since the errors may exceed those accounted for in the ERPs....(emphasis added)

APCo has not provided any evidence that from November 30, 1985 until the time of the inspection that such warnings were a part of the ERPs. In fact, it is apparent that they were not. Further, it should be again noted that such an argument, consistent with 10 C.F.R. § 50.49(i)4, is a JCO argument, not a qualification argument.

Q28. With regard to the figure presented in the JCO and discussed in the meeting in Atlanta (APCo Exh. 59), Mr. Love was questioned by the board regarding this plot. Is there any reason to believe that a graph of insulation resistance versus temperature is linear on a semi-log plot? (Tr. 1144-56).

A. I have not seen any data that would suggest that it is over the range of temperature from 203-347°F. The experimental data that I have examined suggests that it can be quite non-linear. For example, extensive data is presented of IR versus temperature in NUREG/CR-3418 (Staff Exh. 73) (which is also SAND83-1617), from pages 88-93. This data is reasonably consistent in indicating that IRs above a temperature of about 120°C (248°F) were not highly dependent on temperature.

In addition to the data from the Sandia tests, the General Electric test report dated November 6, 1973, that was in the Farley files, indicates that the IR of the blocks at temperatures from 260-340°F would be in the range of 2×10^4 Ω, with very little dependence on temperature over this range. The ambient temperature IRs in the GE test were on the order of 10^8 Ω, clearly indicating that the plot must become quite non-linear at some lower temperatures.

I believe that the two test reports cited above demonstrate that IR cannot be assumed to be linear, and I do not believe Bechtel had any valid basis for assuming that it was. It should also be noted that the data on the figure they presented was not for either of the two types of blocks that were used in the

Farley plant. I have to continue to wonder why, with two test reports available that gave data for both of the exact blocks that were used in the Farley station, that Bechtel would attempt to use similarity analyses to qualify the blocks. They initially attempted to use similarity to the Connectron blocks tested by Conax, and then they tried to use similarity to the General Electric blocks tested by Sandia. Both Sandia and General Electric had performed tests of both the GE CR151 blocks and the States ZWM blocks. At a temperature of 300°F, both of these test reports indicate that the IRs of both types of blocks would be too low to meet the APCo acceptance criterion for terminal block IR. It should also be emphasized that the GE test exposed the blocks to only one DBA cycle, a factor that APCo claims they considered important in assessing the Sandia test results, which they claimed had subjected the blocks to three DBA cycles.

Attachment 3 to the JCO (APCo Exh. 59) is a memo from Mr. Love that provides his explanation for not using the data on GE CR151B terminal blocks and States ZWM terminal blocks tested in the Sandia Phase 1 tests. He states that the data "was not used due to the inaccuracies associated with the SNL electrical test circuitry that measured leakage current values during Phase I testing." In actual fact, there were no abnormal inaccuracies associated with the circuitry. I think what he meant to state is that the Phase I testing used a serpentine connection of the terminal blocks (see Figure 10 on page 21 of NUREG/CR-3418, Staff Exh. 73), resulting in five parallel conducting paths for leakage currents, rather than only one, resulting in overly conservative data if the data is uncorrected. However, Conclusion 6 in the report (Staff Exh. 73) on page 126 states in part that "The comparison between the serpentine circuit connection and the once-through connection is consistent with expected results based on parallel conducting path arguments..." Thus, the data from the Phase I testing can be reasonably multiplied by 5 to account for the parallel conducting paths, resulting in realistic average values of IR for the GE CR151B and the States ZWM terminal blocks.

It is interesting to note that in the JCO (APCo Exh. 59), APCo states on page 3 that "Figure 1 represents a correlation between temperature and IR conservatively assuming a logarithmic relationship between temperature and IR." Clearly, they have no basis whatsoever to claim that assuming the relation to be logarithmic is in any sense conservative.

In response to a question from Judge Carpenter, Mr. Love states that "there may be some curvilinear aspect of it, however, I do not believe the profile would be anywhere near as radical as that which is predicted by using the numbers across all of the DBA profiles that were consecutively applied to these terminal blocks." (Tr. 1219-20). This is quite in contrast to their statement in the JCO (APCo Exh. 59) that "Figure 1 represents a correlation between temperature and **IR conservatively assuming a logarithmic relationship between temperature and IR.**" (emphasis added).

Mr. Jones (the transcript that I currently have incorrectly attributes it to Judge Carpenter) states that "I would just like to add that at the time Sandia put this report together, I would think if they thought it was important and it wasn't linear, they would have recorded more than two datapoints." (Tr. 1221-22). His statement is ridiculous. Sandia literally measured thousands of datapoints in these tests. Data at multiple temperatures was measured during the test profile, which essentially followed IEEE Std. 323-1974--APCo simply chose to ignore this data at multiple temperatures, claiming it was too conservative for their use. It was not Sandia's requirement at the time the tests were performed to provide qualification data for APCo or any other utility. However, if APCo, or any other utility, chose to use the data, it was their responsibility to take all of the available data into account.

Q29. Mr. Love, in his clarification testimony, claims that they did not consider the detailed IR data as a function of temperature because

> ...there is obviously something that's happened to the recovery capability of the terminal block by the time it's gotten to the Phase III DBA. The significance of this is, that is essentially subjecting this same terminal block to three very severe design basis accidents and then using insulation resistance data across that complete timeframe and saying that is representative of the cooldown period of the terminal block, which I believe not to be valid. (Tr. 1222).

How do you respond to this?

A. The fact of the matter is that they had no basis whatever to conclude that the plot should have been linear. The data in the test report that the data was extracted from and the data in the General Electric report that was in the Farley files both indicate that the plot is not linear over the range that they assumed it to be linear. They have provided neither a technical basis nor any data to support their assumption that it was linear, much less any justification that such an assumption was conservative.

Q30. In response to Q113 (L/S/J pp. 124-25), Mr. Love claims that with regard to your statement that "if the utility could clearly demonstrate that the equipment was not required to function during peak LOCA conditions and any inaccurate readings during peak LOCA conditions would not mislead the operators nor cause any undesired automatic operations," that "We showed exactly this to Mr. Jacobus during the November 1987 inspection and at the subsequent November meeting at Region II." Also, in response to Q146 (DiBenedetto pp. 114-25), Mr. DiBenedetto claims that "APCo has maintained from the inception of its EQ program ... that the terminal blocks installed at Farley would be required at the onset of the accident and not again until post-accident long-term cooling." Mr. DiBenedetto also claims to have discussed this point with you (DiBenedetto Q&A 128; p. 106). Did they show you any such evidence either during the inspection or at the subsequent meeting?

A We did not receive any such analyses during the inspection. It is interesting that they claim to have shown me this analysis, but they have not provided any exhibit to back up their statement. I can only conclude that they did not have such an analysis. As noted previously, APCo, at the Region II meeting, did appear to claim that the blocks would only be needed at 296°F and below, but they could not demonstrate acceptable IRs at 296°F. In addition, they did not provide detailed technical justification as to why the blocks did not have to be qualified to peak LOCA conditions as detailed in Q&A 26 above.

Q31. In response to Q130 (DiBenedetto p. 107), Mr. DiBenedetto testifies that with regard to the NRC's position of when instruments need to function "They apparently did not believe APCo's position on when the instruments would be relied on by operators. I cannot explain what, if anything, was the technical basis for their position." Could you clarify?

A. Please see Q&A 26 above. In addition, at the meeting in Atlanta, APCo was claiming that they did not need the blocks except at temperatures below 296°F but they could not demonstrate qualification at 296°F. Thus, acceptance or rejection of their argument regarding when the blocks had to function was irrelevant at that point.

Q32. In his response to Q139 (DiBenedetto p. 111), Mr. DiBenedetto states that "APCo used the same conservative peak LOCA insulation resistance data for these blocks..." Is his statement correct?

A. Here he makes a strong implication that there was data at peak LOCA conditions, which is absolutely wrong, as he acknowledged in response to Q133 (DiBenedetto p. 108).

Also, in response to Q147 (DiBenedetto pp. 115-17), Mr. DiBenedetto testifies that "prior to the inspection APCo had a reasonable basis to conclude that instrument accuracy data for these terminal blocks at peak LOCA conditions was not necessary. And if such data was deemed necessary, it had provided conservative estimates based on similarity to tested terminal blocks." His statement that "if such data was deemed necessary, it had provided conservative estimates based on similarity to tested terminal blocks" almost directly states that the Conax test data was taken at peak LOCA conditions, rather than only at temperatures up to 150°F. It should be extremely clear by now that what he is referring to is not peak LOCA insulation resistance data.

Q33. In response to Q103 (L/S/J pp. 112-14), Mr. Love testifies that

> Graph No. 1 from CONAX test report IPS-107 provided a plot of the minimum IR data points for the 16 AWG test conductor and terminal blocks which were recorded during the DBA and post-DBA testing. (APCo Exh. 53). From this graph (test numbers 9 through 16), it can be seen that the lowest value of the IR data points recorded were 2E7 to 3E7 ohms. During this portion of the DBA testing, the chamber pressure and

temperature were reduced from 45 psig and 294°F to 0 psig and 140-150°F and maintained for 240 hours....

Do you have any comments on his description of the test?

A. If I did not know better, I would interpret his testimony as implying that valid IR measurements were performed at temperatures above 150°F. It should be made very clear that that was not the case.

Q34. Does Mr. DiBenedetto's final statement in response to Q129 (DiBenedetto pp. 106-07) follow from the information presented?

A. No. The fact that they presented documentation that the end devices will perform "within their specified accuracy requirements during accident testing" in no way implies that "peak LOCA insulation resistance data was unnecessary." In fact, if they are assuming that the instruments need to function during all accident conditions, then clearly peak LOCA IR data is necessary. On the contrary, they are effectively claiming throughout their testimony that the end devices do not have to be qualified for peak LOCA conditions, for if they did have to be qualified, then the terminal blocks would also have to be qualified.

Q35. In response to Q110 (L/S/J pp. 120-21), Mr. Love testifies that "Due to the inherent thermal lag time... terminal blocks will have completed their performance function (automatic) before reaching significant temperatures which could affect these functions." Will terminal blocks have this thermal lag effect?

A. The temperature of the block will, of course, lag the temperature of the environment. However, moisture films will form on the terminal block very rapidly when steam is introduced in the vicinity of the terminal blocks. This is exactly the same phenomenon that occurs when one breathes moist breath onto a cold window and causes the window to fog. I believe that everyone knows how rapidly the fog forms in such a case. The fog is nothing more than a moisture film on the window. The thermal lag of the material in either case has little bearing on the film formation. Thus, Mr. Love's testimony has no valid technical basis.

Attachment 2 to the JCO (APCo Exh. 59), a letter from Westinghouse, also stated that:

> A review of the Reactor Protection System and Emergency Safeguards Features functions has determined that the significant functions required for harsh environment events (pressurizer pressure - Low SI and steam generator water level - Low-Low) are required only before 5 minutes after the event occurrence for pressurizer pressure - Low SI and 60 seconds for steam generator water level - Low-Low. This early time of use in the event should ensure that the function necessary will be performed before a significant error from leakage current develops.

Obviously, Westinghouse had no basis for the last statement above. (Presumably, both Westinghouse and APCo are making the statements regarding thermal lag based on the fact that most components experience such effects. The thermal lag effects have never been demonstrated to be applicable to terminal blocks and both theoretical considerations and experimental data demonstrate that they will not be applicable. For an example of experimental data, see Figure 25 on page 47 of NUREG/CR-3418, SAND83-1617 (Staff Exh. 73). It should also be noted that by 5 minutes into the event, the LOCA conditions have already passed the peak temperature. But APCo claims the terminal blocks are not needed at peak LOCA conditions, contrary to the Westinghouse analysis, which effectively states that they are.

Q36. During cross-examination, (Tr. 726-27), you were questioned as to whether you had performed correlations between the terminal blocks at issue and particular circuits and when these circuits had to function. You stated that you had not. Why had you not done this prior to the enforcement action?

A. APCo had never provided any analysis to us that indicated that they claimed the blocks did not have to be qualified to at least 296°F (the value APCo claimed at the November 1987 Atlanta meeting) for instrument accuracy effects. Thus, when we determined that the blocks were not qualified to even that temperature (whether we agreed that they only had to be qualified to that temperature or not), we do not have any reason to perform additional analysis to attempt to come up with a qualification argument on behalf of APCo by considering individual circuits and the effect of instrument inaccuracy on those circuits. That is simply not our job. In addition, the regulations and applicable standards do not provide allowance for such qualification arguments.

Responses to Q&A 5, 7, 10, 26, 27 and 35 above provide more information on the circuits affected, when they need to function, and why the APCo analyses were not acceptable.

Q37. In response to Q34 (DiBenedetto pp. 34-35), Mr. DiBenedetto testifies that with regard to his report or summary (APCo Exh. 64) that "The lowest recorded insulation resistance was on the order of 1E5 ohms. This is a value Westinghouse supported during the audit and during the enforcement conference." How do you respond to this?

A. It is interesting that he claims that this value was supported by Westinghouse at the audit in light of Mr. Love's testimony during examination by the board, where he testifies with regard to Figure 1 of the JCO (APCo Exh. 59), that "When we prepared this basic graph, we were not aware that the result of the Westinghouse calculation was going to be 5 times 10 to the 5th ohms, in which case they came backwards to the graph and came up with 296, and they did not have the test report." He further testifies "That is correct" in response to Judge Carpenter's question "To be sure that I understand, you're saying that your group prepared **this graph in the absence of any notion about what values of resistance might be critical with respect to loop accuracy?**" (emphasis added). (Tr. 1149-50).

The 5E5 value used by Mr. Love is the value Westinghouse actually supported. The 1E5 value comes from a Westinghouse letter, which is

Attachment 2 to the JCO (APCo Exh. 59). The attachment to that letter at the end of the third paragraph states that "If the ERP values for RCS subcooling are **changed** for Safety Injection termination, then a leakage current resistance of $1 \times 10^5\ \Omega$ or greater would be acceptable for use." (emphasis added). Thus, with the ERPs as they were, the value of $1 \times 10^5\ \Omega$ would not have been acceptable.

Q38. In Q112 (L/S/J pp. 123-24), Mr. Love is asked "Have others concurred with your conclusion?" Do you agree with his response?

A. Presumably, his "conclusion" was that data at 150°F was adequate. He responds "Yes...." to the question. He then seems to imply that "Westinghouse specialists" agreed with his conclusion, but he never states that. In fact, he never explicitly states anybody that agreed with his conclusion. I do not believe that the testimony that followshis yes response supports that response in any way.

Q39. During examination by the Board, Mr. DiBenedetto testifies that "If the equipment such as the terminal blocks we're talking about, performs its intended function well before it sees the adverse environment, then the documentation that that's when it performs its function, that's all that's necessary." (Tr. 1289, ll.8-12). Did APCo in fact provide you any documentation that the terminal blocks perform their intended function well before they see the adverse environment?

A. No. I believe that I covered that point in some detail in my response to Q5. However, I should further note that APCo is not even claiming that the blocks perform their function prior to seeing the adverse environments. Most, if not all, of the terminal blocks are needed for post-accident monitoring also.

MISCELLANEOUS

Q40. In Mr. Love's testimony to Q113 (L/S/J pp. 124-25), he testifies that

> ...the Staff is basing their findings on the Sandia terminal block IR and leakage current data observed only during the peak of the LOCA temperature profile, which was 341°F to 347°F. However, in doing so they ignored all other seemingly relevant observations, such as the dependence of the IR on temperature and the recovery of the IR values during the post-LOCA periods of cooldown as well as the functional requirements of the instrument loops....

Do you agree with his statements?

A. Absolutely not. The NRC Staff is not basing its findings at all on the IR data observed during the peak LOCA conditions of the Sandia terminal block tests. In fact, as noted previously, the Farley plant files had documentation that the IR of the blocks at temperatures from 260-340°F would be in the range of $2x10^4$ Ω. The Staff is actually basing its findings on the information in IN 84-47, the information contained in the GE test report and summarized in the GE Penetration report, the lack of demonstrated similarity to the Connectron terminal blocks, and the fact that no IR data was even available for the Connectron blocks at temperatures above 150°F. When APCo appeared to claim at the Atlanta meeting that they needed terminal block data at only 296°F or below and they then proceeded to use Sandia data to claim that the terminal blocks would have acceptable IRs at 296°F, they were in fact the ones who used the Sandia data at the peak temperature to make their case. All I did was to fill in the data at the lower temperatures, which they had incorrectly interpolated.

Q41. In his response to Q136 (DiBenedetto p. 110), Mr. DiBenedetto states that "To a reasonable engineer versed in EQ, there was sufficient auditable documentation." Do you have any comments on his statement?

A. (Jacobus) I am a reasonable engineer versed in environmental qualification and it is my opinion that there was not "sufficient auditable documentation" at Farley for reasons that I have already discussed.

(Luehman) Dr. Jacobus' findings were reviewed and approved by NRC Staff technical management prior to issuing the inspection report of the November 1987 inspection (Staff Exh. 12), the Notice of Violation (Staff Exh. 2), and the Order Imposing Civil Monetary Penalty (Staff Exh. 3).

Q42. In response to Q115 (L/S/J pp. 126-27), Mr. Love and Mr. Jones testify that:

> For the GE CR151B terminal blocks, APCo did not have a separate EQ package. These blocks are part of the GE electrical penetration assemblies... The blocks were prototype tested by GE as part of the penetration assembly qualification testing program. (APCo Exh. 58). The qualification test reports were intended to cover the complete assembly.

> Mr. Jacobus, on page 4 of his testimony on this issue, points out that he found the GE penetration test report in the Farley procurement files. There was some confusion in locating this report encompassing the GE terminal blocks at the time of the inspection because the blocks were addressed as part of the penetration assembly. However, it strikes us as odd that the staff complains about this, yet acknowledges that the report existed (well prior to the inspection) and that is was physically in APCo's possession at Farley.

Similarly, in response to Q140 (DiBenedetto pp. 111-12), Mr. DiBenedetto testifies that

> As I recall, at the time of the audit APCo was not readily able to locate the file [for GE terminal blocks]. However, this administrative matter in my opinion should not be treated as an EQ deficiency. The terminal block information was located in the qualification file for the penetrations. Moreover, at the time of the audit I was personally aware of the existence of the test report qualifying GE CR151B terminal blocks from my general EQ experience. (APCo Exh. 58).

How do you respond to their testimony?

A. I do not agree with several things they state. First, I found the GE terminal block qualification report in the procurement files, not the penetration report. The penetration report, I believe, was included in the file for the penetrations all along. The penetration report is dated March 27, 1975.

I do not know if the terminal block testing was part of the penetration assembly qualification testing program, but the detailed results of the terminal block testing were not included in the penetration test report that they have cited as qualifying the terminal blocks (APCo Exh. 58). Therefore, not enough information is presented to conclude that the blocks are qualified. However, it is a fact that the results (in terms of minimum recorded insulation resistance) of the terminal block tests were reported in the penetration test report. It is also a fact that the penetration test report quotes minimum insulation resistance values for the terminal blocks of 2×10^4 ohms at 500 Vdc. This value is well below the required APCo acceptance criterion of 5×10^5 ohms.

Other than the above stated results, the only other information regarding the terminal block tests that was included in the penetration report (APCo Exh. 58) was a statement of the type of blocks that were tested and an indication that the environmental profile was the same as that used in the penetration test. Thus, the terminal blocks were not qualified by the penetration file. In fact, the single item of test data that was included in the penetration report relating to the terminal block performance was not used in any way by APCo.

Regarding their testimony that "the staff complains about this, yet acknowledges that the report existed...," (L/S/J p. 127) we never disagreed that it is perfectly allowable to include terminal block qualification information in the penetration file. The fact of the matter is that the information in the penetration file did not demonstrate qualification of the terminal blocks. Further, the only data point it contained demonstrated that the blocks were not qualified. The terminal block report that I found in the procurement file did provide more detail of the terminal block test, but the conclusion that the blocks were not qualified remained unchanged. In fact, had the terminal block report that I found demonstrated the adequacy of the terminal blocks for the application, I would have agreed that the problem was merely a documentation and auditability issue and treated it as such.

I do not understand the basis for Mr. DiBenedetto's statement that "at the time of the audit I was personally aware of the existence of the test report qualifying GE CR151B terminal blocks from my general EQ experience. (APCo Exh. 58)." (DiBenedetto p. 112). As described above, there is only one performance data point in the GE penetration test report that relates to terminal blocks, and this single data point was not even used by APCo in their evaluation. Further, if APCo had used this point, they would have only been able to come to the conclusion that the blocks were not qualified for their application.

Q43. During cross examination, Mr. Love responds to the question "Is it not correct, also, that test that was referred to for the G.E. blocks had a minimum insulation resistance of 2 times 10 to the fourth ohms?" with "No. That is not correct." (Tr. 1123). Is his response accurate?

A. Referring to the test report directly (APCo Exh. 58), it clearly states on page 11 of 14 with regard to the terminal block tests that "Autoclave qualification tests simulating LOCA defined in para. 4.4 events 1 thru 4 were conducted on General Electric CR151 and States Co. type N.T. and recorded a minimum insulation resistance 2×10^4 Ω @ 500 VDC." Therefore, I do not understand his response of "No. That is not correct."

Q44. During cross examination, Mr. Love responds to the question "...if you relied on this report, are you not saying then that the 2 times 10 to the 4th, at least in 1985, was sufficient to qualify the G.E. blocks?" with "I'll say it was sufficient, yes." (Tr. 1126) What is your response to this?

A. Clearly, the IR of 2 times 10 to the 4th ohms was not adequate to qualify the blocks in 1985. This is a value that would cause significant instrument error as confirmed by Westinghouse. A proper evaluation of that data in response to IN 84-47 would have come to that conclusion.

Q45. During redirect, Mr. Love testified that

> And I might add, that that[sic] doesn't mean that we feel that -- all of the data contained in the Sandia report should be used as absolute values. Because, in my opinion, there are difficulties with that report, which one should not rely on the absolute values of data that are contained in that report for drawing conclusions. (Tr. 1135)

What is your response?

A. Presumably, this constitutes at least part of his basis for only selecting two data point out of a report that has literally hundreds of data points. He also does not specify what the "difficulties with that report were" and whether he really means "difficulties with the application of that report to the Farley plant." These are two very different statements. In one case, he is essentially accusing Sandia of publishing invalid data. In the alternative, he is merely stating that the valid data that is published is not applicable. In stating that one should not rely on the absolute values of the data in the Sandia reports, he apparently does not consider how the data might be properly interpreted. Q&A 28 above provides a perfectly reasonable approach to interpreting the Sandia data.

Q46. Does this complete your testimony regarding this matter?

A. (Both) Yes.

JUDGE BOLLWERK: Mr. Repka.

Whereupon,

JESSE E. LOVE,

DAVID H. JONES,

PHILIP A. DiBENEDETTO,

AND

JAMES E. SUNDERGILL,

witnesses, were called for examination by counsel on behalf of Alabama Power Company and having been previously duly sworn, were further examined and continued to testify as follows:

DIRECT EXAMINATION

BY MR. REPKA:

Q Gentlemen, would you please identify yourselves for the record, starting on my left with Mr. DiBenedetto?

A [Witness DiBenedetto] Philip A. DiBenedetto.

A [Witness Sundergill] James E. Sundergill.

A [Witness Love] Jesse E. Love.

A [Witness Jones] David Hubert Jones.

Q Gentlemen, do you have in front of you a copy of Alabama Power Company's surrebuttal testimony in this proceeding, the surrebuttal testimony of Mr. Love, Sundergill, Jones, and DiBenedetto on terminal blocks?

A [Witness DiBenedetto] Yes, I do.

A [Witness Sundergill] Yes, I do.

A [Witness Love] Yes, I do.

A [Witness Jones] Yes.

MR. REPKA: Judge Bollwerk, at this point, I think I need to point out that we are offering Mr. Sundergill as part of this panel.

When we divided up the testimony, I believe he, in this phase of the testimony, did not sponsor any of the specific answer in the surrebuttal testimony but has been a part of the panel, and we are offering him in that capacity.

JUDGE BOLLWERK: All right.

Any objection from the staff?

MR. HOLLER: No objection, sir.

JUDGE BOLLWERK: All right.

BY MR. REPKA:

Q With that, I'll ask you, Mr. DiBenedetto, Mr. Love, and Mr. Jones, did you assist in the preparation of the answers to -- the questions and answers in the surrebuttal testimony?

A [Witness DiBenedetto] Yes, I did.

A [Witness Love] Yes, I did.

A [Witness Jones] Yes.

Q And is this your testimony in this proceeding?

A [Witness DiBenedetto] Yes, it is.

A [Witness Love] Yes, it is.

A [Witness Jones] Yes.

Q Gentlemen, are you familiar with -- on April 29, 1992, I filed with the Board in this proceeding errata related to the pre-filed testimony on this topic. Are you familiar with that information?

A [Witness DiBenedetto] Yes, I am.

A [Witness Love] Yes, I am.

A [Witness Jones] Yes.

Q Mr. Love, can you tell me, are those your errata?

A [Witness Love] Yes, they are.

MR. REPKA: Judge Bollwerk, unless you feel otherwise, I do not feel it necessary to read all those errata. They have been marked. They have been actually physically corrected in the copies that have been submitted to the reporter today.

JUDGE BOLLWERK: That's acceptable with the Board.

BY MR. REPKA:

Q Mr. Love, do you have any additional corrections you need to make to your pre-filed testimony?

A [Witness Love] Only two additional minor corrections.

On page 115, the second full paragraph, it would be the next-to-the-last sentence, where it says, "Nevertheless, the similarity analysis is now beside . . .," I would just like to strike the word "now" and have it read ". . . is beside the point."

And the other correction is on page 150. It would be the first complete sentence at the top of page 150. The sentence starts, "After reaching 95 degrees C (203 degrees F) and maintaining this temperature for approximately 30 minutes . . .."

". . . approximately 30 . . ." should read "approximately 40."

Those are the onl, other changes.

Q Gentlemen, with those corrections, is this surrebuttal testimony true and correct to the best of your knowledge and belief?

A [Witness DiBenedetto] Yes.

A [Witness Love] Yes, it is.

A [Witness Jones] Yes.

MR. REPKA: With that, Alabama Power Company moves the admission of this surrebuttal testimony, that it be bound into the record in this proceeding.

JUDGE BOLLWERK: Any objection?

MR. HOLLER: No objection from the staff.

JUDGE BOLLWERK: Then the APCo surrebuttal testimony regarding terminal blocks will be received and bound into the record.

[The surrebuttal testimony of Jesse E. Love, David H. Jones, and Philip A. DiBenedetto on behalf of Alabama Power Company concerning terminal blocks follows.]

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket Nos. 50-348-CivP
ALABAMA POWER COMPANY	)	50-364-CivP
	)	
(Joseph M. Farley Nuclear	)	
Plant, Units 1 and 2)	)	ASLBP No. 91-626-02-CivP

SURREBUTTAL TESTIMONY OF JESSE E. LOVE, DAVID H. JONES, AND PHILIP A. DIBENEDETTO ON BEHALF OF ALABAMA POWER COMPANY CONCERNING TERMINAL BLOCKS

Q. State your full name.

A. (Love) My name is Jesse E. Love. I am employed by Bechtel Corporation as a Project Engineer for the Farley Project.

(Jones) My name is David Huber Jones. I am currently Manager of Engineering Support, Farley Nuclear Plant, for Southern Nuclear Operating Company, Inc.

(DiBenedetto) My name is Philip A. DiBenedetto. I am president of DiBenedetto Associates, Inc., which is an engineering and management services company that provides services to utility clients related to equipment qualification, quality assurance, and nuclear regulatory licensing. I am responsible for the technical and administrative management of the company, including participation in, and supervision of, the extensive environmental qualification (EQ) services that DiBenedetto Associates offers.

Q. Have you previously testified in this proceeding?

A. (Love, Jones, DiBenedetto) Yes. We have previously testified on various technical issues raised by this enforcement proceeding.

Q. What is the purpose of your present testimony?

A. (Love, Jones, DiBenedetto) Our present surrebuttal testimony is offered to address the rebuttal testimony of the various NRC Staff panels on the technical issues in this proceeding.

V. TERMINAL BLOCKS

A. Overview

Q77. The next issue is the terminal block issue. Have you reviewed the Staff's Rebuttal Testimony on this issue?

A. (Love, Jones, DiBenedetto) Yes, we have. The Staff's testimony does not change our previous conclusions. After summarizing our position, we would like to address matters raised in the Staff's Rebuttal Testimony in approximately the order presented by the Staff.

Q78. Beginning with the summary then, I observe that in Q/A 4 on pages 2-3 of his Rebuttal Testimony, Dr. Jacobus has restated his understanding of Alabama Power Company's position. Is his restatement complete and accurate?

A. (Love, Jones) It is correct in part, but it is not complete. To keep the record clear and focus this issue, our position includes the following elements:

(1) The terminal blocks at issue were qualified as of the November 30, 1985 EQ deadline, including for the instrument accuracy issue as it then existed. The terminal blocks had been tested to show that they could withstand the

accident conditions. Moreover, prior to the deadline, and as explained at a meeting with the NRC Staff in January 1984 (and as documented in correspondence of February 29, 1984 (APCo Exhibit 20)), Alabama Power Company had undertaken to use post-LOCA terminal block leakage current/IR data (the Wyle Test Report data) for determination of instrument loop accuracies. By including this inaccuracy data in the evaluation of the emergency response procedure (ERP) setpoint values prior to November 30, 1985, the terminal blocks were considered to be useable and qualified.

(2) The NRC Staff was aware of this pre-EQ deadline approach and sanctioned it in the December 1984 SER. Implicit in our position is the fact that by the time of the January 1984 meeting, the Sandia terminal block testing and the instrument accuracy concern as subsequently discussed in Information Notice 84-47 was well known to the NRC Staff. (See Mr. Shemanski's oral testimony, Tr. 679-80). At no time did the Staff express a problem with our approach.

(3) The issue of instrument loop accuracies (uncertainties) continued to evolve after the November 30, 1985 EQ deadline. In 1986 and 1987, in light of this evolution, Alabama Power Company sought to revise terminal block inaccuracy contributions to be used in loop accuracy calculations. Alabama Power Company utilized IR data from the

CONAX report for Connectron blocks (taken during the cooldown phase of the simulated LOCA testing). It was this post-deadline (1986 and 1987) treatment of terminal block contributions to the total loop accuracy which was reviewed during the November 1987 inspection and cited as a violation based upon the latest NRC approach to this issue at the time. This post-deadline approach was explained in APCo Exhibit 52. It was further documented in the November 24, 1987 JCO (APCo Exhibit 59) which was prepared, in response to the NRC Staff's concerns, for a November 25, 1987 meeting in Atlanta.

(4) IN 84-47 (Staff Exhibit 48), the Sandia testing and reports upon which it was based, NRC Regulatory Guide 1.89, Rev. 1 (June 1984), and 10 CFR 50.49 do not indicate that instrumentation terminal blocks are considered unqualified unless they can function at peak-LOCA conditions. It has been our consistent position -- apparently not recognized by the post-November 30, 1985 NRC Staff -- that instrument accuracies need not be maintained throughout peak LOCA conditions for qualification or for inclusion in loop accuracy calculations, because the instrument circuits at issue at Farley Nuclear Plant are not needed during these conditions. The instrument accuracy data utilized in our post-deadline approach to loop accuracies was adequately representative of the accident conditions for Farley Nuclear Plant at the times in which

these instruments would be needed to perform their safety functions.

(5) Existing tes data for GE and States terminal blocks, including SAND83-1617, support the Alabama Power Company position that terminal blocks in instrumentation circuits would have been able to meet their performance (safety related) requirements when the instrument circuits were required to function for automatic or operator actions during design basis accidents.

(6) The Sandia terminal block test data presented in SAND83-1617, and referenced in NUREG/CR-3418 (August 1984) (Staff Exhibit 73) and NUREG/CR-3691 (September 1984) (Staff Exhibit 74), does not lead to the conclusion that the terminal block effects on instrument accuracies are significantly different from those used by Alabama Power Company for conditions representative of the Farley Nuclear Plant. In our post-deadline approach, we utilized an IR value of 1E7 ohms based on CONAX data. The Sandia data in fact supports this value for use in loop accuracy calculations as discussed below.

(7) Only a small number of the total Reg. Guide 1.97 variables are at issue. Reg. Guide 1.97 instruments provide post-accident monitoring information to the operator.

Therefore, by the NRC Staff's own measure of the significance of EQ issues, this is an issue with relatively low significance.

Q79. Now that you have summarized Alabama Power Company's position on this issue, please explain the focus of this Surrebuttal Testimony.

A. (Love, Jones) This testimony responds to the Staff's Rebuttal Testimony. The following basic points are made below.

First, Dr. Jacobus's discussion of the "progression of information" on this issue is misleading. We will clarify the pre-EQ deadline basis for qualification of terminal blocks, and then go on to discuss the 1987 post-deadline basis for qualification that was the focus of the inspection. We will also show how Dr. Jacobus's use of the temperature from the SCEW sheet is in error, and ignores the other pre-EQ deadline information available to him.

Second, we will respond to the Staff's assertions that there has been no evolution on this issue. In fact, there has been a clear evolution -- and neither Staff witness seems to even understand or acknowledge what was established with the NRC Staff on Farley instrument terminal blocks prior to November

30, 1985. In these first two sections, we will also address the Staff's latest "clearly should have known" arguments.

Third, we will explain again our approach -- post-EQ deadline -- to qualification of terminal blocks for instrument accuracy. We will show that the Sandia data relied upon by Dr. Jacobus actually supported our use of an IR value of 1E7 ohms. This IR value is appropriate for the instrumentation involved, given Farley-specific design basis accident conditions.

Fourth, we will rebut Dr. Jacobus's critique of our similarity evaluation supporting use of data from a Connectron terminal block. In fact, the Connectron block is dimensionally quite similar to the States and GE terminal blocks at issue. Nonetheless, the similarity analysis is ~~now~~ beside the point. The Sandia data confirms conclusively our 1987 approach from a performance perspective.

(DiBenedetto) Next, I will address the Rebuttal Testimony as it relates to my Direct Testimony on this issue.

(Love, Jones) Finally, we will provide some overall conclusions and perspectives on the issue.

B. Information Available on Qualification Environmental Conditions

Q80. In his Rebuttal Testimony, Q/A 5, at pages 3-6, Dr. Jacobus provides one explanation of "the progression of Alabama Power Company's information to you that forms the basis for their position." The point seems to address the temperature for which these terminal blocks should be qualified. Would you like to provide your views on this issue?

A. (Love, Jones) Yes. Dr. Jacobus attempts to describe the "progression of information" on the required qualification temperature for these terminal blocks. However, he has not accurately described what Alabama Power Company, in fact, did on this issue.

Dr. Jacobus references the peak temperatures of the SCEW sheets (Staff Exhibits 69 and 70) as the basis for qualification of the GE terminal blocks and the States terminal blocks. However, with the exception of the SCEW sheet, Dr. Jacobus does not describe or acknowledge any of the information which was available to the NRC Staff, and was previously accepted by the Staff, regarding the requirements for qualification of terminal blocks in instrument circuits. This information included the minutes of the January 1984 meeting with the NRC Staff (APCo Exhibit 20) accepted in the final NRC EQ SER (APCo Exhibit 21).

As testified to previously, the minutes of the January 1984 meeting explicitly state that "post-LOCA," not "peak-LOCA," terminal block leakage current (IR) data from the Alabama Power Company Wyle Test Report on States terminal blocks would be used for instrument accuracy purposes. Dr. Jacobus is illustrating that in November 1987 he was inspecting Farley EQ files based only on his current 1987 level of knowledge and understanding of this issue, without regard for the Farley-specific pre-deadline documented basis.

However, more importantly with regard to the SCEW sheet values, the Staff is now implying that these peak temperatures lead them to believe that the basis for terminal block performance in instrument loops was peak-LOCA temperatures. (See also Dr. Jacobus at Tr. 708-709, 739). Frankly, this is not a credible assertion. An EQ engineer knowledgeable in the derivation of the SCEW sheet and the history of terminal block qualification programs certainly should have known the meaning and significance of these numbers.

The SCEW sheet, as explained in our Direct Testimony, was prepared for each model of equipment and provided a summary level comparison of the peak-specified and peak-tested environmental parameters. These included temperature. The SCEW sheet was not intended to be the single document for explaining the performance qualification of terminal blocks in instrument loops. For the States terminal blocks and GE terminal blocks included with the GE electrical containment penetrations, the terminal blocks were tested to and did successfully withstand the required peak temperatures specified on the SCEW sheet. The ability of these terminal blocks to survive (withstand) the peak test temperatures and recover without significant degradation qualified the terminal blocks for the anticipated peak harsh environmental conditions at Farley. This has always been our claim as reflected on the SCEW sheets. However, Alabama Power Company has never claimed that the instrument circuit performance in terms of instrument loop uncertainty contributions should be based on peak conditions.

Q81. What is the significance of the withstand temperature for the terminal blocks as referenced in the SCEW sheets?

A. (Love) The fact that these terminal blocks will withstand peak-LOCA/High Energy Line Break (HELB) conditions, and recover, is important. It shows that the terminal blocks will survive the accident to the post-accident phase during which the associated instrument loops are needed to operate to provide information to the operators.

As we discussed before, and will discuss further below, IR values recover as temperature drops. The fact that a terminal block must withstand the harsh LOCA conditions does not mean that IR data for instrument accuracy needs to be based on these same peak-LOCA conditions. I believe Dr. Jacobus understands this distinction, but is simply extracting the SCEW sheet value out of context, to confuse the issue.

Q82. In his discussion of the "progression of information," Dr. Jacobus goes on to discuss (Rebuttal Testimony, at pages 4-5) some of the discussions on the peak qualification temperature issue during the November 1987 inspection and during the November 25, 1987 post-inspection meeting in Atlanta. Could you give your perspective on these interactions?

A. (Love, Jones) First, Dr. Jacobus discusses the documented questions and answers from the inspections. He refers particular. to Alabama Power Company's response to EQ Question No. 26. (Staff Exhibit 71). This references Alabama Power Company's EQ Action Items 018 and 067 (APCo Exhibit 52), which were <u>post-EQ deadline</u> activities addressing the contribution of terminal block leakage current to instrument loop uncertainty. They address the use of data for IR taken from the CONAX IPS-107 test graph. Dr. Jacobus claims that from this information he was still unable to determine that Alabama Power Company's approach was not based on peak LOCA conditions. In his testimony he states, "Interestingly, there is no mention in that document of the temperatures when the insulation resistances were measured, nor is there any argument that the blocks are not required at peak LOCA conditions." He next states, "The temperatures at which IR measures were performed is clearly not obvious from the plot that is cited from the CONAX report." (Rebuttal Testimony, at page 4).

These are all very odd statements. EQ Action Items 018 and 067 made explicit reference to the CONAX IPS-107 test graph from which the value of 1E7 ohms was extracted. (APCo Exhibit 53). Dr. Jacobus had access to and reviewed the CONAX report prior to the November 1987 meeting in Atlanta. All of the information needed to determine which DBE test temperatures corresponded to the IR data points contained on the graph can be easily determined from this information. In his Direct Testimony on this issue, at page 4, Dr. Jacobus clearly recognized (and faulted) the basis for qualification for instrument accuracy. He stated there that the "data that was taken from the CONAX report was taken at 150°F or less."

Therefore, it seems clear that it was known that the basis for our 1987 position on this issue (1E7 ohms) was taken below peak-LOCA conditions. Despite the smokescreen in the Rebuttal Testimony, the true issue is that Dr. Jacobus believes the value of 1E7 ohms to be too high, and that only lower IR values at peak-LOCA temperatures must be used. We addressed this point at length in our Direct Testimony on the issue, at pages 117-125, and will address it further below. We continue to believe that the IR value we utilized for the 1987 ERP calculations (1E7 ohms) was appropriate for the States and GE terminal blocks.

Q83. Do you agree with Dr. Jacobus when he states at the conclusion of his answer to Q5 (Rebuttal Testimony, at page 6) that "APCo still has not defined what temperature they feel the blocks need to be qualified to based on the circuit-by-circuit analysis that they claim to have used as a basis for qualification all along"?

A. (Love, Jones) No. As stated above, Alabama Power Company clearly defined in the January 1984 meeting with the NRC Staff, as documented in Alabama Power Company's February 29, 1984 letter (APCo Exhibit 20), that the leakage current (IR) data from the Wyle test report (APCo Exhibit 50) was recorded post-LOCA after the cooldown. These were the leakage current (IR) values on which the Westinghouse pre-EQ deadline circuit-by-circuit (or instrument loop) analysis for ERP setpoint values were based. Since the Staff never disagreed with the approach prior to the EQ deadline, we probably should not be here today. This accepted basis for terminal block accuracy should be the benchmark for EQ compliance as of the EQ deadline.

Nonetheless, since the Staff has made the 1987 post-EQ deadline instrument accuracies the issue, we will attempt to clarify below any remaining confusion with regard to the 1987 instrument loop uncertainty calculations and the basis for terminal block contributions used in these calculations. As will be clear from the discussion below, this issue is more involved than simply picking a peak LOCA test temperature and then concluding that the IR data corresponding to that temperature would result in unacceptable loop accuracies.

Q84. Dr. Jacobus discusses the relevant EQ requirements and standards at length in his Rebuttal Testimony, at pages 8-11, leading to a conclusion that -- for instrument accuracy purposes -- these blocks needed to be qualified for peak LOCA conditions. Do you concur?

A. (Love, Jones) No, and we believe Dr. Jacobus is omitting several very important references. While we agree that the applicable requirements for the qualification of the States and GE terminal blocks were the DOR Guidelines for Farley Unit 1 and NUREG-0588, Category II, for Farley Unit 2, we do not concur that these requirements indicated that values of leakage current or insulation resistance had to be taken during the peak of the design basis accident (DBA) qualification testing and used in calculating instrument loop accuracies. As stated in our previous testimony, and as agreed to by the NRC Staff in January 1984, and in the subsequent SER, using post-LOCA terminal block leakage currents for these calculations was acceptable to the Staff.

The pre-EQ deadline NRC Staff and Alabama Power Company understanding of instrumentation terminal block qualification can be stated as follows: If the terminal blocks could be shown to perform their required functions prior to reaching the worst-case peak LOCA temperatures, survive the worst-case peak LOCA temperatures, and recover function after cooldown, they were considered qualified. Inherent in this understanding was that no automatic or operator actions were required during the worst-case peak LOCA temperatures or prior to cooldown. Both the States and the GE terminal blocks used at Farley were demonstrated by design basis accident testing conducted in accordance with the requirements of the DOR Guidelines and NUREG-0588 to meet these qualification criteria for instrument circuits. If this were not the case, it is not conceivable that the Staff would have issued the December 1984 SER.

Q85. Was this approach ever documented?

A. (Love, Jones) Yes, as we have discussed previously, in the February 29, 1984 correspondence memorializing the January 1984 meeting. (APCo Exhibit 20). In Attachment 2, at page 6, our approach (accepted at the meeting and in the December 1984 SER) was described as follows (emphasis added):

> NRC Comment
>
> Address the current leakage of States Terminal Blocks and its effects on equipment within the scope of 10CFR50.49.
>
> APCO Response
>
> The environmental qualification test report for States Company Terminal Blocks, Wyle Laboratories Report 44354-1 provides the values of leakage currents. The States Terminal Blocks were LOCA tested with an applied voltage of 137.5 VDC which is the normal operation voltage of the terminal blocks. Instrumentation was attached to the terminal blocks at the conclusion of the LOCA test and leakage current values were recorded. The values of leakage current were recorded from terminal point-to-point and point-to-ground on the States Terminal Block. Also included were conductor-to-conductor and conductor-to-ground leakage current. These values were recorded for multiple combinations with an applied voltage of 137.5 VDC.
>
> The test leakage current values are being used in the development of the revised FNP Emergency Operating Procedures (EOPs) presently being prepared by Westinghouse/APCo.

Q86. Are there any clear regulatory requirements indicating that instrumentation must be demonstrated to maintain a specified (fixed) level of accuracy (or functional performance) at worst-case peak LOCA conditions in order to be considered qualified?

A. (Love, Jones) Neither the regulations nor the regulatory guidance requires or suggests that instrumentation terminal block functional performance must be demonstrated during an environmental service condition such as peak LOCA temperature if no safety function is required coincident with this condition. The regulatory guidance actually supports our conclusion that qualification of instrumentation terminal block functional performance can be based on the environmental service conditions which will be experienced when the terminal block safety function is required. (All of this presumes the capability to withstand or survive the complete time-dependent LOCA environmental conditions as discussed above, which is not an issue for these terminal blocks (See Dr. Jacobus's oral testimony, at Tr. 696).)

First, 10 CFR 50.49(e)(1) provides (emphasis added):

> (e) The electric equipment qualification program must include and be based on the following . . .
>
> (1) Temperature and pressure. The time-dependent temperature and pressure at the location of the electric equipment important to safety must be established for the most severe design basis accident during or following which this equipment is required to remain functional.

Under this regulation, an environmental profile is established for the entire event. However, functional qualification can be based on the time in the accident event when the equipment is required to function.

NRC Regulatory Guide 1.89, Rev. 1 (June 1984) is another important reference. (APCo Exhibit 35). Referring first to Section B, second full paragraph on page 1.89-2, the first sentence of this paragraph starts with the following statements:

> It is essential that safety-related electric equipment be qualified to demonstrate that it can perform its safety function under the environmental service conditions in which it will be required to function and for the length of time its function is required. . . .

The next paragraph states:

> The following are examples of considerations to be taken into account when determining the environment for which the equipment is to be qualified:

Consideration (3) states:

> [E]quipment required to initiate protective action would generally be required for a shorter period of time than instrumentation required to follow the course of an accident. . . .

Section C.1 states:

> Section 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," of 10CFR Part 50 requires that safety-related electric equipment (Class IE) as defined in paragraph 50.49(b)(1) be qualified to perform its intended safety functions.

This regulatory guidance supports our position that qualification of instrumentation terminal blocks can be based on the environmental conditions which will be experienced when the terminal block safety function is required. Here, as we discussed in our Direct Testimony, our position is that the affected Reg. Guide 1.97 instruments which included the terminal blocks at issue did not need to function at peak LOCA conditions.

Q87. In his Rebuttal Testimony, at page 11, Dr. Jacobus restates the Reg. Guide 1.97, Rev. 2, guidance. He concludes from the guidance that it is required to demonstrate "functioning through the peak LOCA conditions for the terminal blocks that are required after that time." Do you agree with his interpretation of this guidance?

A. (Love, Jones) No, we do not agree with his restatement of the guidance. Unlike Dr. Jacobus, we do not interpret the regulatory guidance as saying that an instrument which has no required function during peak LOCA conditions must function through the peak LOCA conditions. What is important is withstand and recovery capability. For the terminal blocks at issue, that capability has been shown.

Q88. Dr. Jacobus's Rebuttal Testimony (Q/A 8, at pages 11-12) again refers to IN 84-47 (Staff Exhibit 48) and NUREG/CR 3691 (Staff

Exhibit 74), which are based on the SAND83-1617 data. Dr. Jacobus argues that these documents provide the basis for why Alabama Power Company should have clearly known that terminal blocks in instrument circuits had to function at the peak temperatures of the worst-case design basis LOCA accident. Is this position clearly supported by these documents?

A. (Love, Jones) No. As testified to previously (see our Direct Testimony, Q/A 98, at pages 107-108), we followed the guidance provided in IN 84-47 (Staff Exhibit 48) during the pre-EQ deadline qualification of the terminal blocks. The relevant action statement of IN 84-47 was quoted in our Direct Testimony, at page 108. Consistent with that statement, from a pre-deadline perspective, we had taken steps to ensure that the terminal block performance would be addressed in emergency procedures. Since IN 84-47 followed closely after our meeting with the NRC Staff in January 1984, we had no basis to question our agreed-upon approach.

Moreover, a total reading of IN 84-47 will not yield any statement regarding the necessity to demonstrate function at the peak temperatures of worst-case design basis accidents. Also, it is a matter of fact that a complete reading of NUREG/CR-3691 (Staff Exhibit 74) and NUREG/CR-3418 (Staff Exhibit 73) (SAND83-1617) will not provide a clearly stated basis for the post-EQ deadline and present Staff's position on this issue.

Q89. In the Staff's Rebuttal Testimony (Q/A 9, at pages 12-14), the Staff is presenting additional arguments as to why Alabama Power Company "clearly should have known" from IN 84-47 and the Sandia reports that the Farley instrument terminal blocks were not qualified as of November 30, 1985. Do these additional arguments have any substantive basis?

A. (Love, Jones) Aside from the ridiculous implication on the bottom of page 13 that Mr. DiBenedetto is in some misquoted way agreeing that the instrument terminal blocks had to be used during peak conditions of the accident prior to November 30, 1985, the only other new information expounded seems to be a reference to Figure 8-3 on page 85 of NUREG/CR-3691. The Staff states that this figure demonstrates vividly the effects of terminal block leakage currents on an actual pressure transmitter circuit.

Alabama Power Company agrees with this observation. In fact, the figure shows vividly that as the temperature of the terminal block decreases with the simulated design basis accident temperature from its peak of 175°C to 161°C, and then to 95°C, the terminal block leakage current decreases and the transmitter signal level returns to its base value. This is also described in SAND83-1617 (Staff Exhibit 73) and depicts the terminal block test leakage current effect on transmitter response for the second of the three DBA test profiles (SAND83-1617, Figure 2, page 9) to which this terminal block was exposed. We would like to explicitly point out that the curve on Figure 8-3 shows when the cooldown from 161°C (321.8°F) to 95°C (203°F) is initiated, the transmitter signal current returns linearly to base level with time. This figure supports exactly our pre-EQ deadline position, as discussed in the January 1984 meeting and documented in Alabama Power Company's February 29, 1984 letter to the NRC. (APCo Exhibit 20). This position was that post-LOCA leakage currents (IR) could be used in the pre-November 30, 1985 Westinghouse EOP setpoint analysis.

It is also interesting that the Staff's Rebuttal Testimony now seems so dogmatic on the issue that peak LOCA conditions were essential (See, e.g., Q/A 9 at pages 12-14). This was not Dr. Jacobus's position in his Direct Testimony, at page 5, where he recognized that peak LOCA data was not needed under certain conditions. In any event, it is certainly stretching the truth to now claim (almost 8 years after-the-fact) that IN 84-47 and the Sandia reports put Alabama Power Company somehow on notice of this issue.

The same can be said for IN 85-39 (Staff Exhibit 77) referenced in the Rebuttal Testimony, at page 14. That Notice has nothing to do with terminal blocks; rather, it related to resolving Franklin TER-identified problems. For terminal blocks in instrument circuits, we had a proposed resolution. The very purpose of the January 1984 meeting with the Staff was to discuss resolutions to Franklin open items. Our resolution on this issue was accepted.

C. Evolving Requirements

Q90. In the NRC Staff's Rebuttal Testimony, under the subheading "Evolving Requirements," at pages 16-27, the Staff has testified that there was no new post-EQ deadline knowledge applied by the NRC Staff in their findings or their assessment of a violation regarding this issue. Does Alabama Power Company concur with this testimony?

A. (Love, Jones) Absolutely not. The present NRC Staff continues to direct their arguments back to what a licensee should have been able to clearly determine from IN 84-47 when it was issued prior to November 30, 1985. The present Staff has applied their post-EQ deadline understanding of this document during and following the November 1987 Farley inspection, without any apparent attempt to review or consider the Farley-specific pre-EQ deadline NRC documentation, which provided the agreed-upon basis for NRC acceptance of the instrument terminal block qualification as of November 30, 1985. The present Staff then asserts that there is no evolving standard because IN 84-47 was issued in 1984 prior to the deadline. However, by refusing to view that document in context, they cannot do anything but apply an evolving standard.

Q91. Is there any evidence that the Staff witnesses were involved in the 1984 NRC Farley-specific reviews of this issue, or that they attempted to determine, or even cared to determine, the pre-deadline NRC documented basis for instrument terminal block qualification for Farley Nuclear Plant prior to conducting the November 1987 inspection?

A. (Jones, Love) None which is apparent to us. In fact, quite to the contrary. In Dr. Jacobus's deposition he responded to questioning related to Alabama Power Company's November 1988 response to the Notice of Violation on terminal blocks. He discusses, starting on page 133, line 9, Alabama Power Company's arguments related to pre-deadline matters. He states:

> A. . . . Then it [the NOV response] goes on to discuss things about what happened back in 1984, which I was not privy to, so I don't really have any comments. I wouldn't know what happened back in 1984.

Q. As far as the SER and the meetings with NRC?

A. That's correct.

Then, later in the deposition, starting on line 19 of page 134, Dr. Jacobus states:

A. . . . Then at that point, it [again, the NOV response] goes on to say that GE terminal blocks any question [sic] is similar to the States terminal blocks, and somewhere they talked about the States terminal blocks. That's talked about up above about the 1984 meetings, the States terminal blocks, so they say that the GE blocks are similar to what the States blocks -- Alabama Power shouldn't clearly have known because of the SER, TER arguments.

Q. And you already stated that you're unfamiliar with those arguments or at least you were not around at the time?

A. I was not around at the time, and I have not been provided any copies of things that went on at that time.

Q. Anything else in there that you care to comment on?

A. Well, with regard the fact that the staff presumably prepared an SER that said that Alabama -- "that the Alabama Power Company equipment qualification program is in compliance with the requirements of 10 CFR 50.49, that the proposed resolution for each item of the environmental qualification deficiencies identified for Farley 1 and 2 is acceptable."

Presumably the terminal blocks were one of those issues, one of these deficiencies identified. I don't know for certain that that's the case, and according to this, what the NRC then said is that their proposed resolution is acceptable with the assumption that that proposed resolution will be implemented correctly, I assume. And so the question then becomes, was the proposed resolution implemented in an acceptable fashion, and I don't know the details of that.

Q. You don't know what the proposed resolution was. But ased on your review of the files, what's your opinion on whether or not it was implemented?

A. I don't know what the proposed resolution is, but if I assume that the proposed resolution was to come up with an adequate qualification, then clearly it was not implemented.

From these st tements of Dr. Jacobus, it is very obvious that no attempt was made by the present NRC Staff to determine what the Farley-specific agreed upon pre-EQ deadline basis for NRC compliance or resolution of this issue was. Instead, the witnesses categorically claim -- without really knowing -- that there has been no evolution.

Q92. Mr. Luehman, at pages 18-20 of the Rebuttal Testimony, also attempts to address the evolution argument. Would you care to respond to Mr. Luehman?

A. (Jones) Yes. Mr. Luehman is simply restating the position that IN 84-47 provides a basis for the Staff's "clearly should have known" finding. He also tries to show that terminal blocks were being inspected for qualification in the pre-deadline time frame. However, Mr. Luehman is again missing the point. He seems to think a "clearly should have known" finding can be based on indications that terminal blocks needed to be qualified prior to the deadline. That really is not in dispute. We knew the terminal blocks needed to be qualified for their application in instrument circuits and we had an accepted basis to do just that. Under the Modified Enforcement Policy, the real point is whether we "clearly knew or should have known of the lack of proper environmental qualification." (Staff Exhibit 4, Enclosure, at page 1) (emphasis added). We clearly did not know and clearly should not have known that our qualification approach was not sufficient for all the reasons we have discussed.

Q93. In Q/A 13 and the following series of questions and answers (Rebuttal Testimony, at pages 17-27), the Staff witnesses discuss actions taken by other licensees responding to concerns regarding the use of terminal blocks on instrumentation circuits. Does Alabama Power Company have a response?

A. (Love, Jones) Yes. We believe that the circumstances surrounding other plants' and other licensees' decisions to remove specific types of terminal blocks in specific instrument circuit applications, and to replace them with qualified splices, have no direct bearing or significance with regard to our compliance with 10 CFR 50.49 for Farley Nuclear Plant instrument applications as of November 30, 1985. The fact is, we addressed this matter prior to the deadline and reasonably believed that we had Staff approval.

All of the examples given by the Staff of inspections regarding other specific applications or interpretations of IN 84-47, and of actions taken by other licensees, certainly appear to have been a source of evolving knowledge to the current Staff. In fact, the Staff appears to have performed the inspection at Farley Nuclear Plant in November 1987 totally based on their knowledge and understanding of activities with other licensees, and failed to even consider that Alabama Power Company had -- before the November 30, 1985 deadline -- specifically established a 10 CFR 50.49 compliance basis for resolution of terminal block leakage currents in EQ instrument circuits. By 1987, the Staff was predisposed to question any use of terminal blocks in instrument circuits. This represents a clear evolution from the pre-deadline agreement for Farley and therefore is an inappropriate basis for enforcement.

Moreover, we addressed the new 1987 expectation adequately also, as addressed further below. The pre-inspection 1987 approach, based on an IR value of 1E7 ohms, was and remains a valid technical approach to this issue.

Q94. Are there any additional comments you would like to make in response to the NRC Staff's Rebuttal Testimony on "Evolving Requirements?"

A. (Love) Yes. Specifically in reference to the second paragraph on page 21 in the answer to Q14, Dr. Jacobus states that:

> In terms of performing loop accuracy calculations involving contributions of calibration equipment and other secondary effects, I would agree that APCo probably began such calculations in the same time frame as the rest of the industry. However, that is not the issue in these proceedings. The issue is specifically for not properly considering the effects of terminal blocks on the accuracy of instrument circuits. The NRC Staff expected to see acceptance criteria established for the terminal blocks (based on their required function) and then a demonstration that the terminal blocks meet those specified functional performance requirements during accident conditions as is required by regulations.

Also, beginning in the last paragraph on page 25 in answer to Q18, Dr. Jacobus states:

> In response to IN 84-47, terminal blocks were either replaced or appropriately considered as part of the loop accuracy calculations by other utilities. At that point, most utilities began considering the effects of cables, electrical penetrations, and splices also. In the evolution of loop accuracy calculations after the EQ deadline, items such as process measurement accuracy, sensor calibration accuracy, sensor temperature effects, sensor drift, rack calibration accuracy, rack comparator setting accuracy, rack temperature effects, and rack drift began

> to be considered in the loop calculations. (Staff Exhibit 76). APCO has not been cited for failure to consider these effects. They have only been cited for failing to consider the effects of terminal blocks, the issue identified in IN 84-47.

These are very interesting statements from the standpoint of the evolving interpretations of requirements by the Staff. This testimony clearly underscores the vintage of the instrument loop accuracy calculations the inspectors were reviewing and questioning at Farley Nuclear Plant in November 1987. The Staff simply is not focusing on the pre-deadline context.

As I testified in our Direct Testimony (at pages 110-112), in the 1986 and 1987 time frame, the Farley-specific emergency response procedure (ERP) setpoint calculations were being revised to include the contributions of what Dr. Jacobus has called secondary effects. From his second quote above, I assume he is defining secondary effects to include the environmental effects of cable leakage currents which were added to the terminal block leakage currents (implied to be a primary effect, although not stated as such) to determine the overall instrument loop uncertainty during design basis events. Also, I assume that it is understood that the design basis event environmental effects on the instrument sensor itself are considered a primary contributor to overall instrument loop uncertainty during postulated design basis events.

It was the results of the contemporaneous 1987 total instrument loop uncertainty calculations that were being inspected and questioned in detail at the November inspection, including the contribution of instrument cabling. In fact, at the inspector's request, Alabama Power Company had the appropriate Westinghouse engineers who had performed the 1987 Farley uncertainty calculations make a special trip to Farley Nuclear Plant during the inspection and explain to the NRC inspectors their methodology for their ongoing evaluation. It must be emphasized that in the 1987 vintage calculations, cable and other so-called secondary contributions described above were included in the calculation of the overall loop uncertainly and ERP allowance values for the measured variable.

This inspection -- and the current testimony -- should again be contrasted with the pre-deadline context. Although not stated by Dr. Jacobus, Mr. Wilson, during the November 1987 EQ inspection, reviewed the 1987 RPS/ESFAS (reactor protection system/engineered safety feature actuation system) and ERP instrumentation total loop accuracy methodology for the treatment of instrument cable minimum IR criteria. He reviewed each specific instrument cable included in the 1987

Westinghouse analysis. No deficiencies were found in this portion of the November 1987 inspection.

Prior to November 30, 1985, the Farley ERP allowance values were primarily based on the environmental effects of the instrument sensor with specific consideration of the terminal block effects using the post-LOCA criteria for terminal blocks agreed to by the NRC Staff in the January 1984 meeting. Cable effects were considered to be negligible in this pre-EQ deadline analysis. (As we have testified previously, this was consistent with the general industry approach at that time to loop accuracy calculations.) Obviously, these pre-deadline ERP calculations were not what the inspectors reviewed in their November 1987 inspection as a basis for compliance to 10 CFR 50.49. Notwithstanding the Staff's claims, there was a clear evolution between the EQ deadline and the inspection.

Q95. Are issues regarding loop accuracy calculations (and terminal block contribution) still evolving?

A. (Love) Yes. NRC Information Notices are still being issued on the effects of leakage current on overall instrument loop accuracy during postulated harsh environmental conditions. Recently, the Staff issued IN 92-12, "Effects of Cable Leakage Currents on Instrument Settings and Indications," dated

February 10, 1992. (APCo Exhibit 120). It is interesting to note that on page 2 of 2, the second paragraph states:

> The NRC is aware that many licensees are revising instrument setpoints using the latest industry standards and are assessing the effects of leakage currents. However, since most licensees for operating plants may not have addressed these effects in their original design calculations, the problem described above for Surry may be generi-.

It is also interesting to note that in the first paragraph of the Discussion, it states:

> Under conditions of high humidity and temperature associated with either a LOCA or HELB, the IR may decrease in components of the instrument loop such as cables, splices, connectors, terminal blocks, and containment penetrations. Consequently, leakage currents increase and measurement of process variables becomes more uncertain.

The third paragraph of the Discussion states:

> In June 1984, the NRC issued Information Notice (IN) 84-47, "Environmental Qualification Tests of Electrical Terminal Blocks." In this information notice, the staff identified the potentia for errors caused by leakage currents at terminal blocks when these blocks are subjected to a harsh environment.

All of the statements above exemplify the evolving understanding of total instrument loop uncertainty determinations and of the significance of the harsh environment effects on the error contribution from each loop component after the EQ deadline. Certainly, in this context, trying to base compliance on 10 CFR 50.49 as of November 30, 1985, on the chronological issue date of IN 84-47 is ludicrous.

D. **Required Qualification Temperature/ Value of IR Selected**

Q96. In the Staff's Rebuttal Testimony section subtitled, "Required Qualification Temperature/Arguments that Blocks were Qualified/JCO," on pages 32-47 (Q/A 26-39), the Staff is continuing their argument as to why the Farley required terminal block qualification temperature is worst-case peak LOCA/HELB. The Staff also argues that Alabama Power Company has not demonstrated qualification at any temperatures other than peak LOCA/HELB. Is Alabama Power Company in agreement with these Staff positions?

A. (Love, Jones) No, we are definitely not in agreement. We have in our testimony above addressed our position on the applicable regulatory requirements. Also in our testimony above, we have addressed the historical basis upon which we contend regulatory compliance should have been assessed. The cited violation and the enforcement action on terminal blocks in instrument circuits could be refuted solely on these positions. However, we also feel very strongly that the 1987 findings are technically shallow and fail to recognize the pertinent performance characteristics of qualified terminal blocks under postulated design basis accident environments.

(Love) In the testimony to follow, I will expand further on the basis for our 1987 technical positions as provided in previous testimony and discussed at the hearing. This will address the Staff's arguments in the Rebuttal Testimony. I will show that even in a 1987 context, our approach -- as documented in APCo Exhibit 52 (the EQ Action Items 018 and 067) and in the November 24, 1987 JCO (APCo Exhibit 59) -- was a valid approach.

First, in my testimony I will address existing test data, including that contained in SAND83-1617, and provide in more detail our basis and conclusions regarding the significance of this data. Specifically, I will explain the meaning of this data to the insulation resistance versus temperature characteristics of terminal blocks during design basis accident environments.

Next, I will re-look at the temperature versus time profiles of the postulated Farley-specific worst-case design basis loss of coolant accident and main steam line break (MSLB), and illustrate the portions of the curves where automatic and manual operator safety-related actions were required. I will indicate specifically which instrument signals are required for the automatic and manual safety-related actions.

Then, having defined the design basis accident temperature ranges and the length of time the instrument terminal blocks would have been required to function, I will demonstrate -- by using the terminal block IR versus temperature characteristic data -- that the instrument terminal blocks would have been capable of performing their safety functions based on the 1987 vintage analysis (and the selected IR value of 1E7 ohms). Based on this, we can conclude that the terminal blocks were qualified in 1987, even against the Staff's 1987 perspective.

Q97. Let's turn first then to the existing test data. The NRC Staff has implied extensively that the Sandia testing documented by SAND83-1617 conclusively demonstrated that, during simulated design basis accident testing of terminal blocks, the IR versus temperature is not linear on a logarithmic scale. Do you agree?

A. (Love) No. SAND83-1617 (Staff Exhibit 73) provides the data that IN 84-47 was based upon. The terminal block testing involved subjecting the blocks to successive DBA profiles, which is, of course, not realistic. In fact, Sandia tested these blocks to nea destruction, something that would not occur under the Farley-specific design basis conditions. This type of testing resulted in very conservative values of terminal block IRs for the first and second of the successive DBA tests, and IRs indicative of almost complete block degradation for the third successive DBA test.

In any event, reviewing the data for each simulated test DBA, considering the variable of time as well as temperature, I do not agree with the Staff's conclusion. During the initial increasing temperature ramp (heatup) and the decreasing temperature ramp (cooldown) of the first simulated DBA test temperature, the referenced Sandia testing does not indicate a non-linear relationship for the GE and States terminal blocks. I discussed this in oral testimony. (Tr. 1211-1222).

Q98. How does the SAND83-1617 data support your conclusion that Dr. Jacobus is in error regarding the linear relationship of IR vs. temperature?

A. (Love) This will require some explanation of the data. If you will bear with me, I will step carefully through the data and show how it supports my conclusion -- not Dr. Jacobus's.

In the Sandia testing, as documented in SAND83-1617, two phases of simulated DBA testing were conducted. The environmental temperature profile for the first phase testing

(Phase I) is shown on page 8 of the report and is entitled Figure 1, Phase I Environmental Temperature Profile. Page 9 of the report shows the environmental temperature profile for the second phase of testing and is entitled Figure 2, Phase II Environmental Temperature Profile. It is important to recognize that the Phase I test simulated two consecutive DBAs, and the Phase II test simulated three consecutive DBAs for the terminal blocks included in each phase of testing. I have marked these figures to indicate each simulated DBA on the profiles and for convenience have included them in this testimony as Figures 1 and 2.

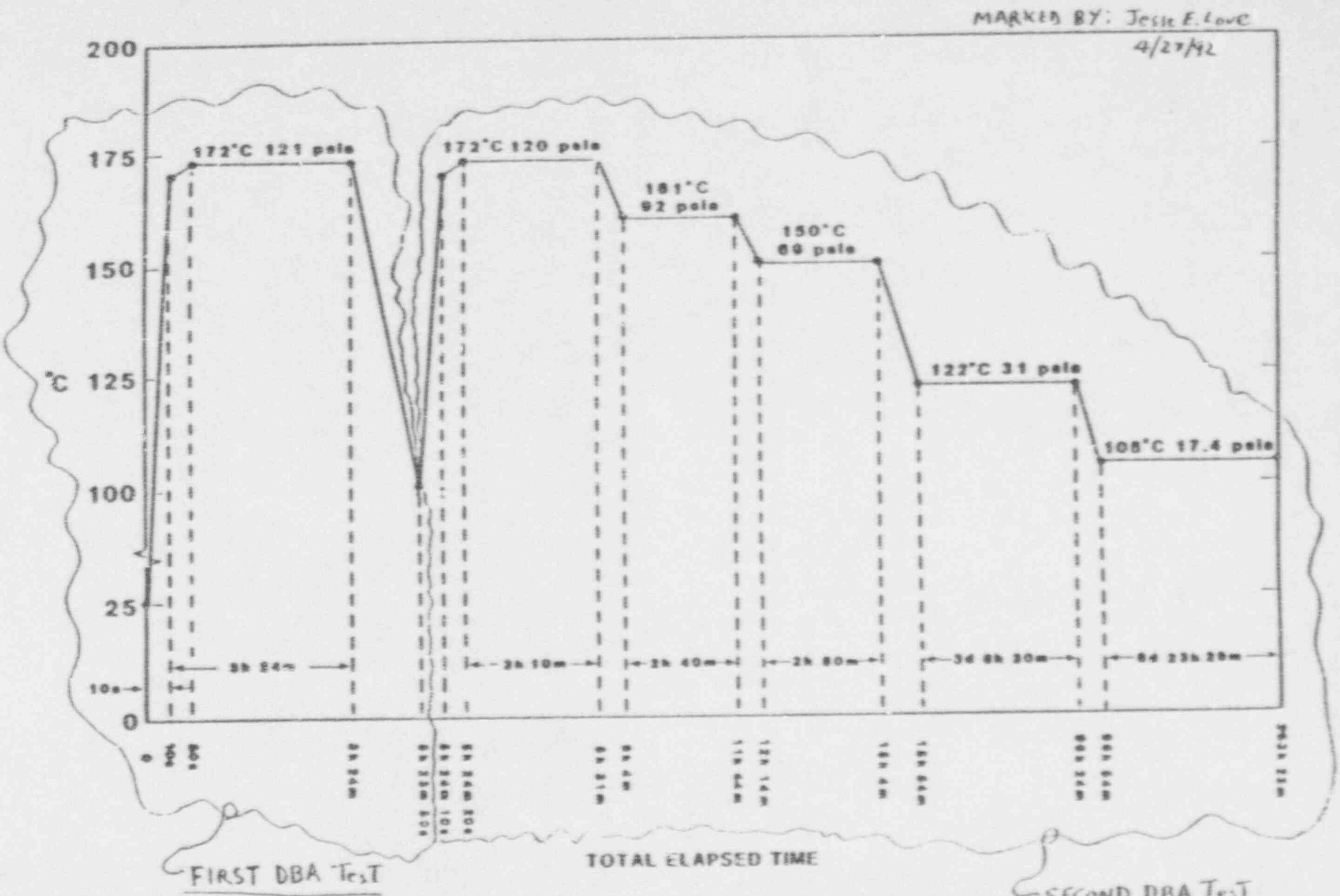


Figure 1

Phase I Environmental Temperature Profile

Surrebuttal Testimony Pg. 147

Marked By: Jesse E. Love
4/27/92

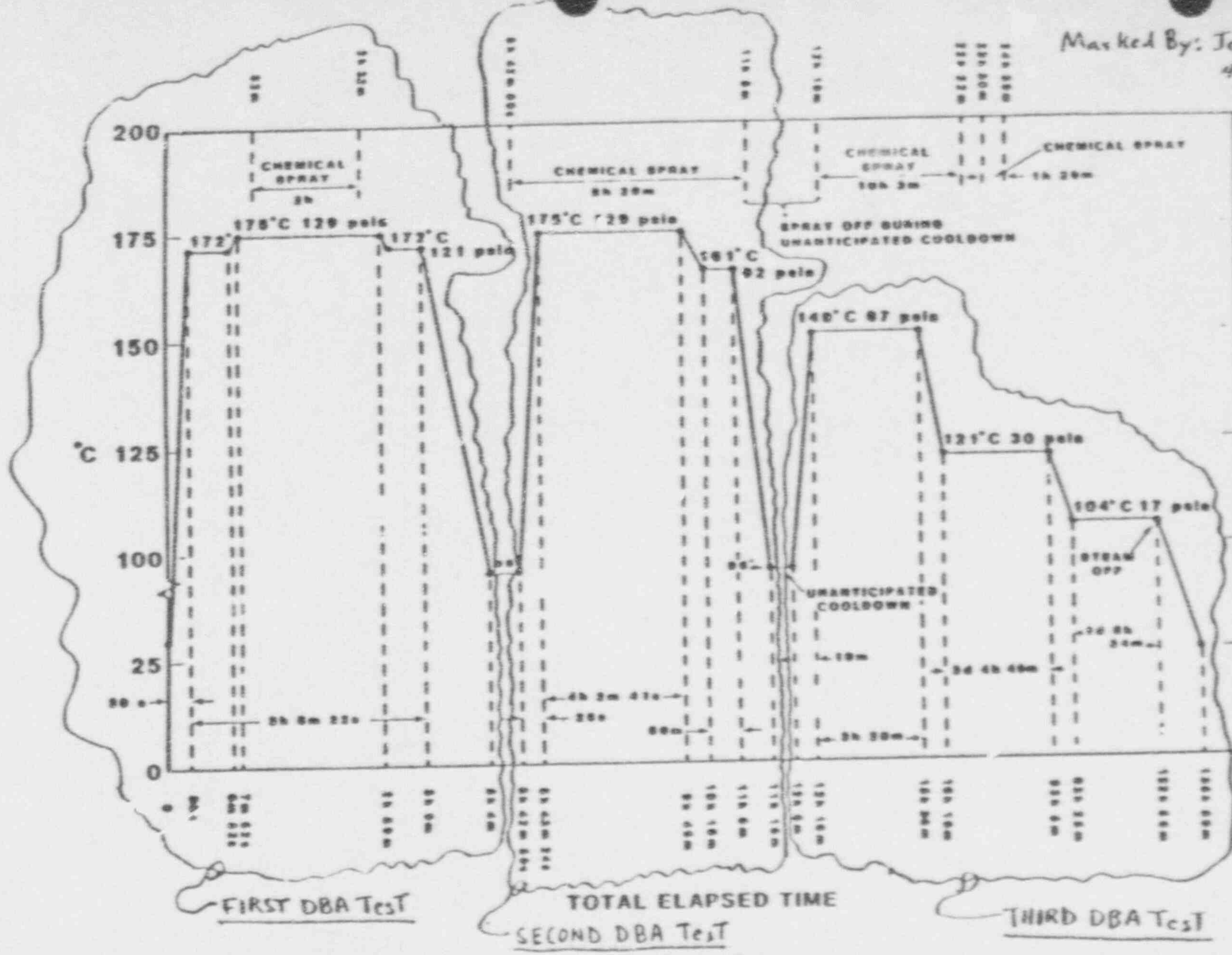


Figure 2

Phase II Environmental Temperature Profile

Surrebuttal Testimony Pg. 148

For the Phase I test, the first simulated DBA starts at time 0 and the temperature reaches 172°C (341.6°F) in 50 seconds. The peak temperature of the first simulated DBA was maintained at 172°C (341.6°F) for 3 hours and 24 minutes, after which the post-peak cooldown to 95°C (203°F) was initiated. After reaching 95°C (203°F), the second simulated DBA was initiated and the temperature reaches 172°C (341.6°F) in 90 seconds. The peak temperature was maintained on the second simulated DBA at 172°C (341.6°F) for 3 hours and 10 minutes, after which a series of stepped decreases in temperature were initiated with temperature plateaus between steps at 161°C (321.8°F), 150°C (302°F), 122°C (251.6°F), reaching the final plateau of 105°C (221°F). The temperature plateaus at 161°C (321.8°F) and at 150°C (302°F) were maintained for 2 hours, 40 minutes and 2 hours, 50 minutes, respectively, and the temperature plateaus at 122°C (251.6°F) and 105°C (221°F) were maintained for 3 days, 8 hours, 30 minutes and 6 days, 23 hours, 29 minutes, respectively.

In the Phase II test, the first simulated DBA starts at time 0 and the temperature reaches 172°C (341°F) in 30 seconds and was increased to 175°C (347°F) in 7 minutes, 52 seconds. The peak temperature of the first simulated DBA was maintained at 175°C (347°F) for almost 3 hours, after which it was reduced to 172°C (341.6°F). After maintaining the temperature at

172°C (341.6°F) for a short period of time, the post-peak cooldown to 95°C (203°F) was initiated. After reaching 95°C (203°F) and maintaining this temperature for approximately ~~20~~ 40 minutes, the second simulated DBA was initiated and the temperature reached 175°C (347°F) in 25 seconds. The second simulated peak DBA temperature was maintained at 175°C (347°F) for 4 hours, 2 minutes and 41 seconds, after which it was reduced to 161° (321.8°F) where it was maintained for 50 minutes. From this temperature, the final cooldown to 95°C (203°F) was initiated. After maintaining a temperature of 95°C for less than an hour, the third simulated DBA was initiated and the peak temperature of 149°C (300.2°F) was reached in 10 minutes. The third simulated DBA peak temperature was maintained at 149°C (300.2°F) for 3 hours and 20 minutes, after which a cooldown to 121°C (250°F) was initiated. This temperature was maintained for 3 days, 4 hours and 49 minutes, followed by another cooldown to 104°C (219.2°F), where the temperature was maintained for 1 day, 5 hours and 34 minutes, prior to final cooldown.

In Staff Exhibits 50 and 51, the plots of IR vs. temperature, which are non linear, indicated as CR-151 Complete Plot, EB-25 Complete Plot, and States ZWM Complete Plot, were apparently generated by using IR data recorded during the Phase I and Phase II Sandia environmental test profiles over the complete time duration of all consecutive simulated DBAs. In other words, these Staff plots of Phase I and Phase II data were made without regard for when in time (First DBA, Second DBA, or Third DBA) the temperature related IR data was recorded. These plots simply represent the lowest value of IR at a corresponding test temperature regardless of when in the test temperature vs. time profile they were measured.

Since several consecutive DBAs were applied to the terminal blocks, they experienced the same temperatures more than once, as is evident from a review of Figure 1 and Figure 2 and the description of these profiles above. I believe that in order to understand properly the real meaning and significance of the data, the temperature related IR data for the terminal blocks should be reviewed in sequential test time (i.e., starting at time zero and reviewing the IR vs. temperature as it changes during each of the heatup, peak, and cooldown periods of the simulated temperature versus time profiles.) This review of the Sandia data results in a totally different perspective on the meaning of this data than that now presented by Dr. Jacobus. I want to also emphasize that I presented this perspective clearly to Dr. Jacobus in November 1987. He refused to acknowledge it at that time.

Q99. After reviewing the Sandia data as you have explained, what have you determined?

A. (Love) A review of the Sandia data from this perspective yields an insulation resistance vs. temperature characteristic that is linear on a semi-log plot for the GE and States terminal blocks for the temperatures critical to the Farley-specific functions.

In my oral testimony (Tr. 1211-1222), Page 210 (Figure A1-21) of SAND83-1617 was used to illustrate this perspective and the basis for our JCO presentation in Atlanta in which we concluded that the safety function of the instrumentatio terminal blocks could and would be accomplished. Since Dr. Jacobus in his Rebuttal Testimony continues to "suggest" that the Sandia data contained in this report does not indicate a linear relationship, I will further expand on what this data indicates by referring to additional Sandia data as represented in SAND83-1617.

Q100. What is the additional Sandia data you are relying on as the basis for your conclusion?

A. (Love) The following are the pages from the Sandia report which I would like to introduce:

- PAGE 129, APPENDIX 1, Five-Number Summaries of Leakage Current and Insulation Resistance Data
- PAGE 142, FIGURE A1-1, Box and Whisker Plot of Insulation Resistance for TB 1, Phase I

- PAGE 136, TABLE A1-2a, Five-Number Summaries of Insulation Resistance, Phase I Terminal Blocks
- PAGE 137, TABLE A1-2b, Five-Number Summaries of Insulation Resistance, Phase I Terminal Blocks
- PAGE 146, FIGURE A1-5, Box and Whisker Plot of Insulation Resistance for TB-5, Phase I
- PAGE 138, TABLE A1-2c, Five-Number Summaries of Insulation Resistance, Phase I Terminal Blocks
- PAGE 139 TABLE A1-2d, Five-Number Summaries of Insulation Resistance, Phase I Terminal Blocks
- PAGE 147, FIGURE A1-6, Box and Whisker Plot of Insulation Resistance for TB-6, Phase I
- PAGE 210, FIGURE A1-21, Box and Whisker Plot of Insulation Resistance for TB-9, Phase II previously entered as (APCo Exhibit 111) and (Board Exhibit 1).
- PAGE 174, TABLE A1-5e, Five-Number Summaries of Insulation Resistance G, Phase II Terminal Blocks.
- PAGE 175, TABLE A1-5f, Five-Number Summaries of Insulation Resistance G, Phase II Terminal Blocks.

APPENDIX 1

Five-Number Summaries of Leakage Current and Insulation Resistance Data

Sections 4.3.3 and 4.4.2 discuss the presentation of the data in a five-number summary format. This appendix compiles the data in this format in both tabular and graphic form. The tabular arrangement for the data is:

	median	
lower quartile		upper quartile
lower extreme		upper extreme

The graphic format is:

upper extreme

upper quartile

median

lower quartile

lower extreme

The graphical presentation is commonly referred to as a box and whisker plot for obvious reasons.

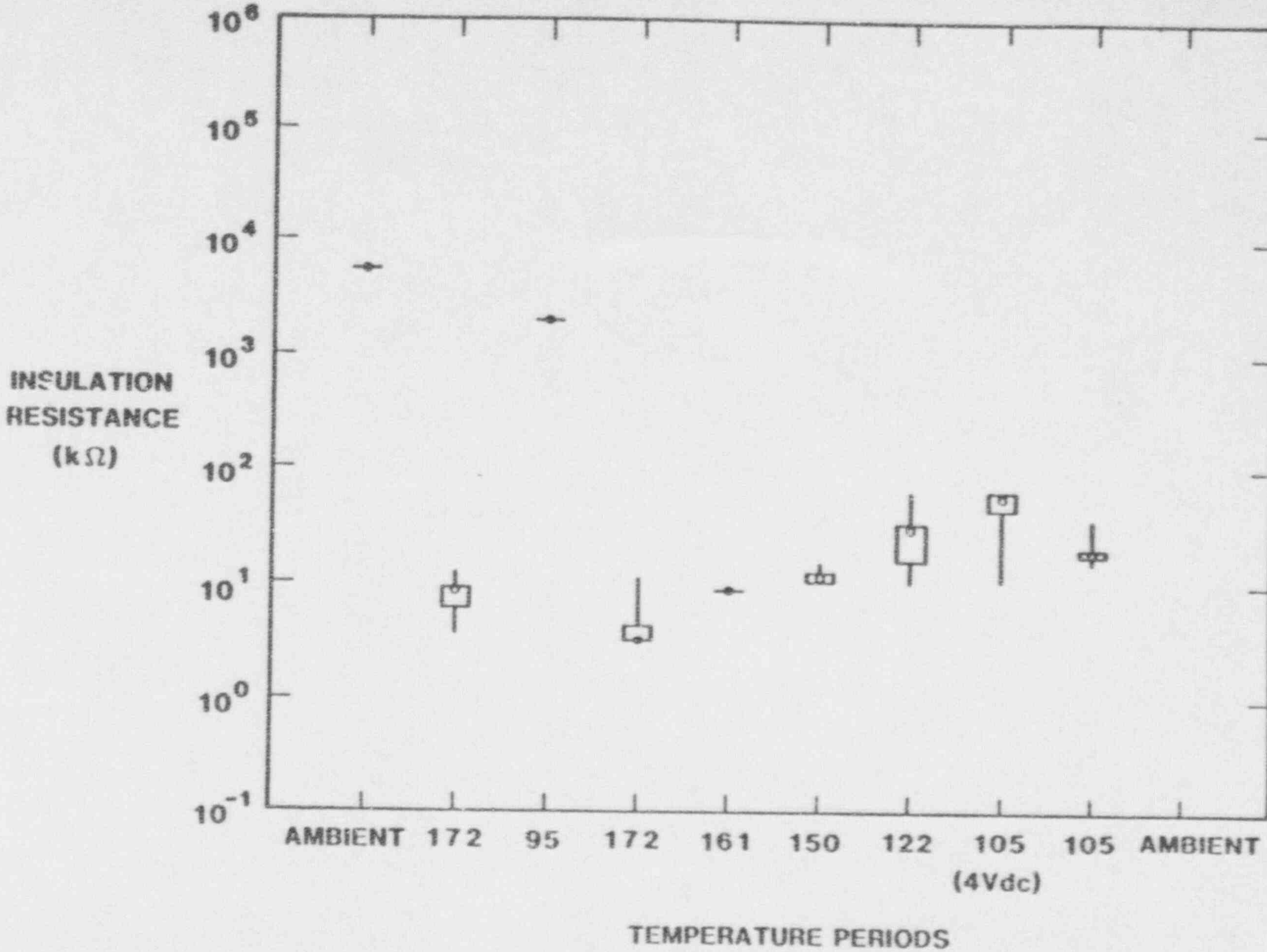


Figure A1-1

Box and Whisker Plot of Insulation Resistance for TB 1, Phase I

TABLE A1-2a

Five-Number Summaries of Insulation Resistance, Phase I Terminal Blocks
(Kohms)

	Ambient		Peak 1 172°C		95°C		Peak 2 172°C		161°C	
TB 1	5.40E+03		8.52E+00		1.98E+03		3.32E+00		8.46E+00	
	5.39E+03	5.40E+03	6.07E+00	8.96E+00	1.98E+03	1.98E+03	3.20E+00	4.24E+00	8.41E+00	8.81E+00
	5.39E+03	5.40E+03	3.61E+00	1.22E+01	1.96E+03	1.98E+03	2.97E+00	1.11E+01	8.01E+00	9.17E+00
TB 2	5.27E+03		6.14E+00		4.09E-02		3.41E-01		2.12E+00	
	5.27E+03	5.27E+03	5.65E+00	6.23E+00	4.09E+02	4.09E+02	3.05E-01	4.40E-01	1.45E+00	2.46E+00
	5.27E+03	5.27E+03	3.39E+00	2.11E+01	3.99E+02	4.09E+02	2.66E-01	2.54E+00	7.33E-01	3.94E+00
TB 3	4.92E+03		5.76E+00		2.30E+03		4.36E-01		2.48E-01	
	4.92E+03	4.92E+03	5.49E+00	6.01E+00	2.30E+03	2.30E+03	3.61E-01	5.26E-01	2.28E-01	2.84E-01
	4.92E+03	4.92E+03	3.55E+00	2.10E+01	2.28E+03	2.30E+03	2.95E-01	2.30E+00	2.02E-01	3.20E-01

TABLE A1-2b

Five-Number Summaries of Insulation Resistance, Phase 1 Terminal Blocks
(Kohms)

	150°C	122°C	105°C	105°C (4 Vdc)
TB 1	1.12E+01 1.02E+01 1.21E+01 9.74E+00 1.50E+01	2.91E+01 1.55E+01 3.27E+01 9.57E+00 6.34E+01	Sub 1: 5.80E+01 5.05E+01 6.47E+01 1.04E+01 6.50E+01 Sub 2: 4.50E+01 3.05E+01 5.23E+01 1.57E+01 5.94E+01 Overall: 5.41E+01 4.32E+01 6.22E+01 1.04E+01 6.50E+01	1.85E+01 1.81E+01 1.93E+01 1.49E+01 3.66E+01
TB 2	7.02E+00 6.12E+00 8.76E+00 2.03E+00 9.82E+00	1.51E+01 1.09E+01 2.08E+01 3.14E+00 7.10E+01	Sub 1: 1.58E+01 1.19E+01 1.87E+01 1.69E+00 1.88E+01 Sub 2: 1.43E+01 1.09E+01 1.56E+01 8.24E+00 1.63E+01 Overall: 1.47E+01 1.13E+01 1.74E+01 1.69E+00 1.88E+01	1.05E+01 1.01E+01 1.09E+01 7.55E+00 1.78E+01
TB 3	4.24E-01 3.64E-01 8.22E-01 2.40E-01 1.45E+00	9.87E+00 7.67E+00 1.26E+01 5.72E+00 2.65E+01	Sub 1: 1.32E+01 1.00E+01 1.49E+01 1.45E+00 1.50E+01 Sub 2: 1.07E+01 7.28E+00 1.31E+01 3.69E+00 1.45E+01 Overall: 1.28E+01 9.21E+00 1.46E+01 1.45E+00 1.50E+01	4.99E+00 4.80E+00 5.35E+00 3.17E+00 1.30E+01

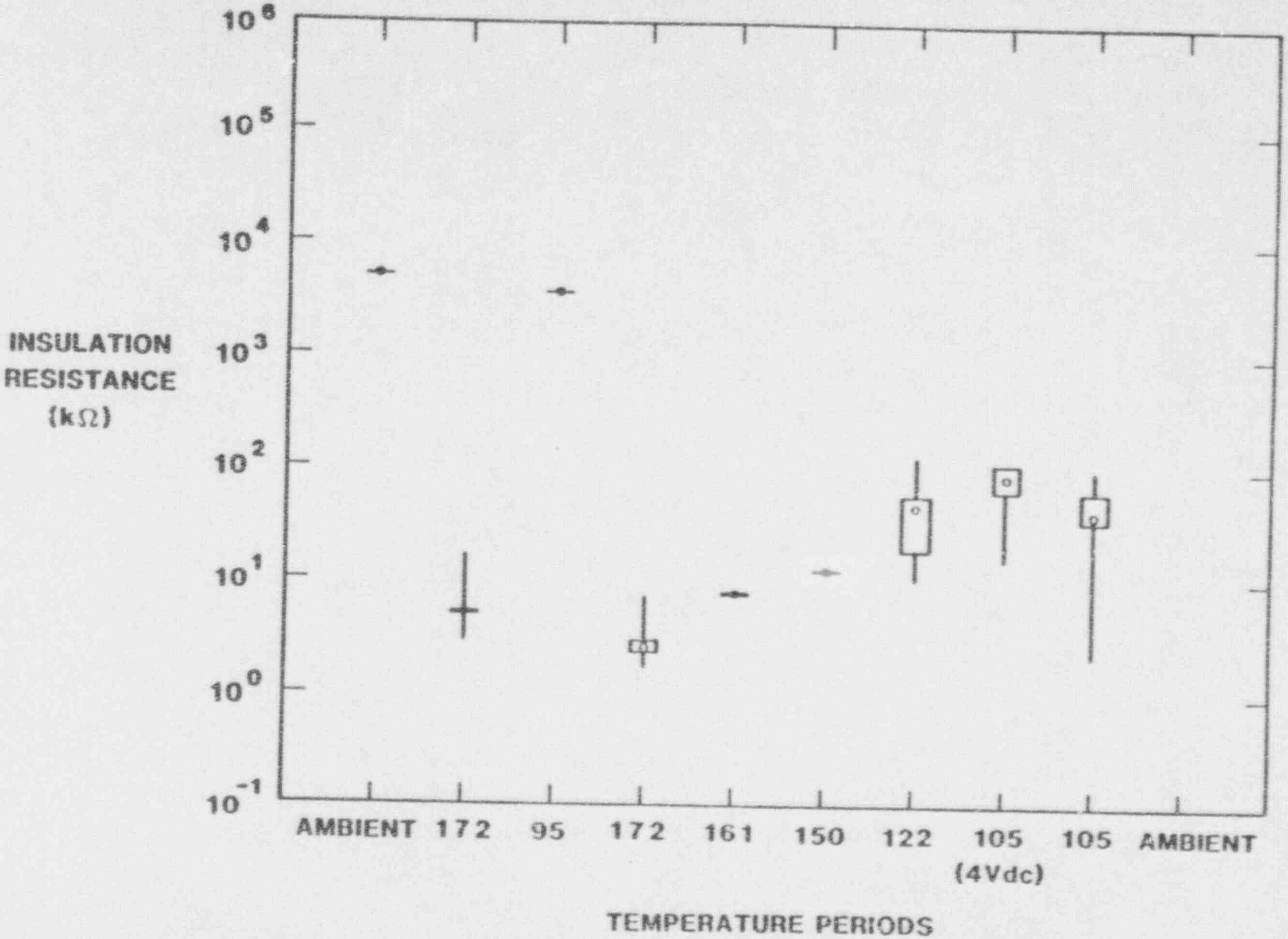


Figure A1-5

Box and Whisker Plot of Insulation Resistance for TB 5, Phase I

TABLE A1-2c

Five-Number Summaries of Insulation Resistance, Phase I Terminal Blocks
(Kohms)

	Ambient	Peak 1 172°C	95°C	Peak 2 172°C	161°C
TB 4	5.01E+03	5.05E+00	3.21E+03	2.41E+00	7.11E+00
	5.01E+03 5.01E+03	4.71E+00 5.09E+00	3.21E+03 3.21E+03	2.27E+00 2.80E+00	7.00E+00 7.37E+00
	5.01E+03 5.01E+03	2.68E+00 1.24E+01	3.20E+03 3.21E+03	1.63E+00 7.65E+00	6.54E+00 7.67E+00
TB 5	5.16E+03	5.28E+00	3.63E+03	2.55E+00	7.91E+00
	5.16E+03 5.16E+03	5.04E+00 5.33E+00	3.63E+03 3.63E+03	2.39E+00 2.98E+00	7.75E+00 8.17E+00
	5.16E+03 5.16E+03	3.12E+00 1.74E+01	3.61E+03 3.63E+03	1.67E+00 7.32E+00	7.46E+00 8.56E+00
TB 6	5.78E+03	1.14E+01	4.69E+03	8.20E+00	1.54E+01
	5.78E+03 5.78E+03	1.01E+01 1.16E+01	4.69E+03 4.69E+03	7.69E+00 8.62E+00	1.53E+01 1.57E+01
	5.78E+03 5.78E+03	9.06E+00 1.57E+01	4.58E+03 4.69E+03	6.63E+00 1.93E+01	1.52E+01 1.61E+01

TABLE A1-2d

Five-Number Summaries of Insulation Resistance, Phase 1 Terminal Blocks
(Kohms)

	150°C	122°C	105°C	105°C (4 Vdc)
TB 4	1.07E+01 1.05E+01 1.09E+01 9.94E+00 1.11E+01	3.10E+01 1.22E+01 4.39E+01 6.76E+00 9.30E+01	Sub 1: 6.69E+01 5.98E+01 7.28E+01 1.41E+01 7.29E+01 Sub 2: 1.14E+02 1.03E+02 1.17E+02 4.70E+01 1.23E+02 Overall: 7.00E+01 6.05E+01 1.17E+02 1.41E+01 1.23E+02	4.38E+01 4.34E+01 4.46E+01 3.46E+01 6.04E+01
TB 5	1.29E+01 1.27E+01 1.31E+01 1.25E+01 1.36E+01	4.67E+01 1.94E+01 5.90E+01 1.12E+01 1.30E+02	Sub 1: 1.03E+02 8.52E+01 1.17E+02 1.40E+01 1.17E+02 Sub 2: 6.32E+01 4.84E+01 6.83E+01 2.69E+01 7.88E+01 Overall: 8.85E+01 6.62E+01 1.13E+02 1.40E+01 1.17E+02	4.17E+01 3.64E+01 6.43E+01 2.21E+00 1.03E+02
TB 6	2.34E+01 2.19E+01 2.55E+01 2.11E+01 3.16E+01	1.25E+02 3.46E+01 3.51E+02 3.32E+01 4.82E+03	Sub 1: 2.89E+02 2.44E+02 3.33E+02 1.98E+01 3.36E+02 Sub 2: 2.78E+02 1.14E+02 3.03E+02 5.55E+01 3.79E+02 Overall: 2.79E+02 2.15E+02 3.25E+02 1.93E+01 3.79E+02	6.41E+01 6.06E+01 6.89E+01 2.52E+01 9.70E+01

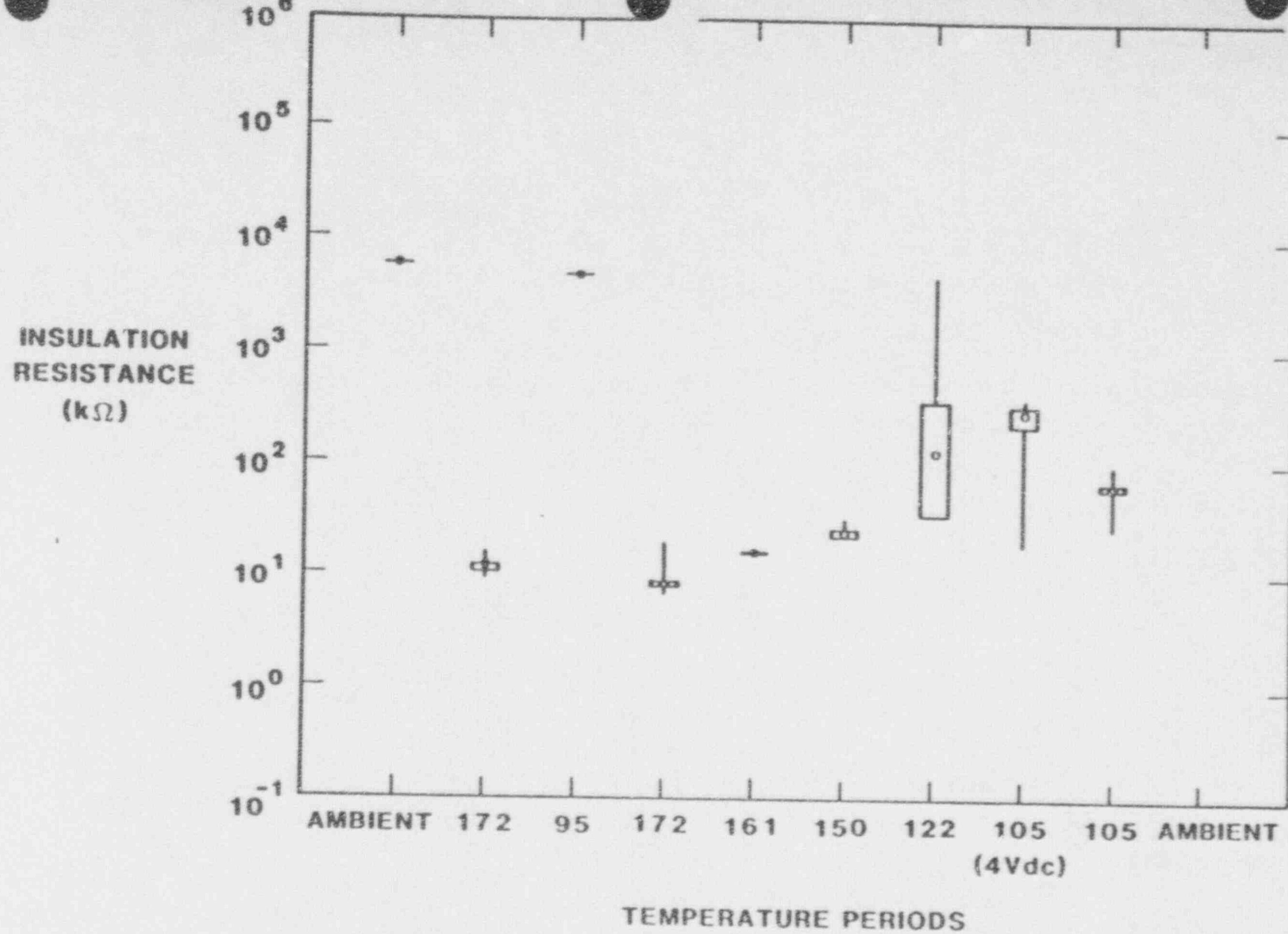


Figure A1-6

Box and Whisker Plot of Insulation Resistance for TB 6, Phase I

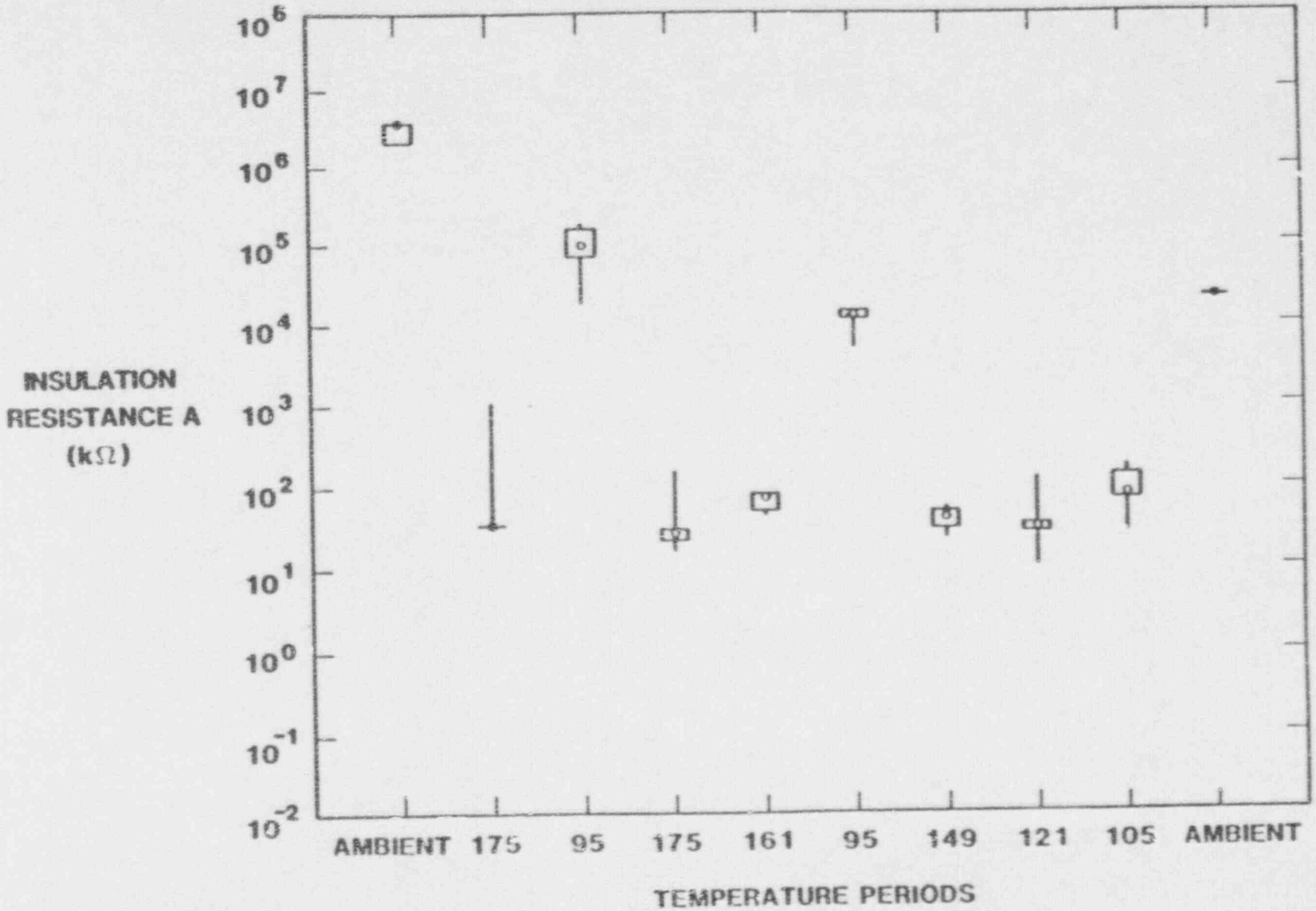


Figure A1-21

Box and Whisker Plot of Insulation Resistance A for TB 9, Phase II

TABLE A1-5e

Five-Number Summaries of Insulation Resistance G, Phase II Terminal Blocks
(Kohms)

	Ambient	Peak 1 175°C	95°C	Peak 2 175°C	161°C
TB 7	7.66E+06 7.66E+06 1.15E+07 3.28E+06 1.15E+07	4.04E+01 3.48E+01 4.09E+01 1.28E+01 9.94E+02	8.98E+03 6.81E+03 1.50E+04 7.99E+02 1.84E+04	Sub 1: 1.08E+01 1.01E+01 1.27E+01 9.54E+00 2.01E+01 Sub 2: 1.30E+01 1.07E+01 1.34E+01 7.90E+00 1.58E+01 Overall: 1.33E+01 1.26E+01 1.38E+01 7.90E+00 2.01E+01	2.33E+01 2.15E+01 2.37E+01 1.82E+01 2.80E+01
TB 8	2.30E+07 1.15E+07 2.30E+07 5.75E+06 2.30E+07	9.93E+01 1.17E+01 1.14E+02 2.34E+00 6.25E+02	5.76E+06 4.60E+06 5.76E+06 2.97E+03 1.15E+07	Sub 1: 8.52E+00 7.68E+00 8.93E+00 5.84E+00 1.99E+01 Sub 2: 2.02E+01 1.17E+01 2.70E+01 6.44E+00 3.42E+01 Overall: 1.23E+01 1.04E+01 1.28E+01 5.84E+00 3.42E+01	4.37E+01 4.33E+01 4.61E+01 4.26E+01 4.90E+01
TB 9	2.30E+07 2.30E+07 2.30E+07 2.30E+07 2.30E+07	5.92E+01 5.66E+01 6.08E+01 5.58E+01 1.96E+03	2.23E+05 1.83E+05 3.83E+05 3.72E+04 4.89E+05	Sub 1: 2.40E+01 2.27E+01 2.58E+01 2.21E+01 2.26E+02 Sub 2: 4.00E+01 3.81E+01 4.15E+01 3.38E+01 4.46E+01 Overall: 3.67E+01 3.30E+01 3.81E+01 2.21E+01 2.26E+02	1.11E+02 9.28E+01 1.19E+02 9.28E+01 1.26E+02

Five-Number Summaries of Insulation Resistance G, Phase II Terminal Blocks
(Kohms)

TB	95°C	149°C	121°C	105°C	Ambient
7	4.73E+02 4.56E+02 6.52E+02 4.42E+02 6.52E+02	1.57E+01 1.54E+01 1.61E+01 1.41E+01 1.77E+01	Sub 1: 1.56E+01 1.48E+01 1.76E+01 8.00E+00 4.72E+01 Sub 2: 3.73E+01 2.39E+01 4.14E+01 1.08E+01 5.23E+01 Overall: 1.53E+01 1.38E+01 2.10E+01 8.00E+00 5.23E+01	Sub 1: 1.56E+02 1.38E+02 1.80E+02 8.97E+01 1.97E+02 Sub 2: 6.52E+01 6.13E+01 6.72E+01 2.74E+01 7.28E+01 Sub 3: 4.73E+01 3.73E+01 4.73E+01 3.73E+01 4.73E+01 Overall: 6.48E+01 5.89E+01 6.77E+01 2.74E+01 1.97E+02	1.99E+02 1.95E+02 2.00E+02 1.93E+02 2.01E+02
8	3.17E+04 1.99E+04 9.67E+04 1.69E+04 9.67E+04	3.52E+01 2.93E+01 4.59E+01 2.60E+01 4.88E+01	Sub 1: 2.21E+01 1.91E+01 2.40E+01 3.77E+00 3.09E+01 Sub 2: 2.34E+02 1.73E+02 3.05E+02 2.13E+01 3.50E+02 Overall: 2.18E+01 1.46E+01 7.61E+01 3.77E+00 3.50E+02	Sub 1: 2.14E+02 2.14E+02 2.73E+02 7.57E+01 2.73E+02 Sub 2: 7.65E+02 6.35E+02 8.16E+02 5.23E+02 8.31E+02 Sub 3: 1.18E+03 9.88E+02 1.40E+03 4.58E+02 1.49E+03 Sub 4: 8.33E+02 5.58E+02 8.33E+02 5.58E+02 8.33E+02 Overall: 8.60E+02 7.36E+02 1.09E+03 7.57E+01 1.49E+03	5.06E+05 4.46E+05 7.12E+05 3.35E+05 2.85E+06
9	2.24E+04 2.21E+04 3.60E+04 1.54E+04 3.60E+04	5.95E+01 4.44E+01 6.38E+01 4.03E+01 9.97E+01	Sub 1: 1.97E+02 1.86E+02 2.18E+02 1.11E+02 3.17E+02 Sub 2: 1.63E+02 1.18E+02 1.*8E+02 6.77E+01 2.27E+02 Overall: 1.37E+02 1.15E+02 1.71E+02 6.77E+01 3.17E+02	Sub 1: 1.45E+02 1.26E+02 1.65E+02 1.03E+02 1.82E+02 Sub 2: 3.98E+02 3.91E+02 4.09E+02 2.03E+02 5.20E+02 Sub 3: 8.78E+01 6.41E+01 8.78E+01 6.41E+01 8.78E+01 Overall: 1.72E+02 1.42E+02 3.81E+02 6.41E+01 5.20E+02	1.14E+05 1.12E+05 1.14E+05 1.09E+05 1.16E+05

(It should be noted that the data contained in the five-number summary tables is the same data which is being graphically depicted on the Box and Whisker plots as discussed in SAND83-1617, Sect. 4.3.3, page 40.)

A review of the data presented in these figures for the Phase I First DBA and Second DBA, and of the data for the Phase II First DBA and Second DBA, supports our conclusions reached on the linearity of the terminal block IR vs. temperature characteristic presented in the 1987 JCO. (APCo Exhibit 59). As testified to previously, the JCO used an IR vs. temperature characteristic plotted from Figure A1-21 based on the First DBA.

As the temperature axis on the SAND83-1617 Box and Whisker plots is following the environmental temperature profiles of each consecutive test DBA, and indicating the test temperature where the data was recorded, it is not to scale. I have re-plotted the IR vs. temperature data contained on these figures for the States and GE terminal blocks using the median, upper quartile, and lower quartile IR data for temperature as documented in the five-number summary tables for each applicable terminal block. Unlike the Sandia report, I also used a linear temperature scale on the temperature axis of each figure. (Plotting the SAND83-1617 data in this format was only performed to assist in the realization that the States and GE terminal block IR vs. temperature is not non-linear as Dr. Jacobus has in the past contended and is still suggesting.)

Figure IR-1, which I have included in this testimony for the States ZWM terminal block, was based on the Phase I First DBA and Second DBA data contained on Page 138, TABLE A1-2c, and Page 139, TABLE A1-2d, of SAND83-1617 -- for terminal block 6(TB6). Figure IR-1, Plot (A), is for IR vs. temperature of the First DBA cooldown from 172°C to 95°C, and uses the available IR data as documented at 172°C and 95°C. Plot (B) is for IR vs. temperature of the Second DBA cooldown and uses the available data as documented at 172°C, 161°C, 150°C, 122°C, and 105°C. Both Plot (A) and Plot (B) were made by drawing a line through the median data points.

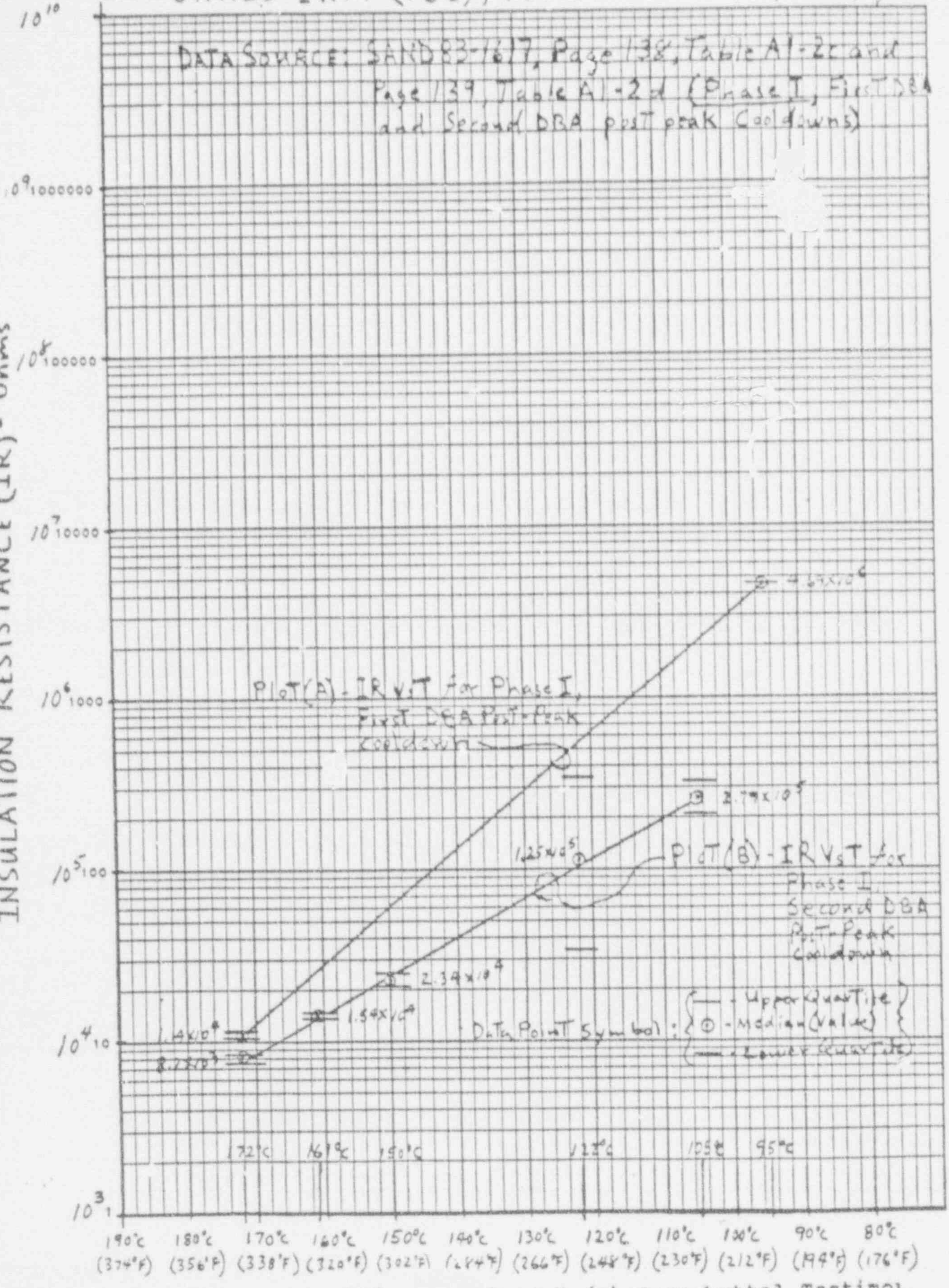
Figure IR-2, which I have included in this testimony for the GE CR-151B terminal blocks, was based on the Phase I First DBA and Second DBA data also contained on Page 138, TABLE A1-2c, and Page 139, TABLE A1-2d, of SAND83-1617 -- but for terminal block 5 (TB5). Plot (A) depicts the IR vs. temperature of the First DBA cooldown from 172°C to 95°C, and uses the available IR data as documented at 172°C and 95°C. Plot (B) depicts the IR vs. temperature of the Second DBA cooldown and uses the available data as documented at 172°C, 161°C, 150°C, 122°C and

105°C. Plot (A) and (B) were made by drawing a line through the median data points.

Figure IR-3, which I have included in this testimony is for the GE EB-25 terminal block, and contains four plots of IR vs. temperature. Plot (A) and Plot (B) are based on the Phase II (2) First DBA and Second DBA data contained on Page 174, TABLE A1-5e, and Page 175, TABLE A1-5f, of SAND83-1617 -- for terminal block 9(TB9). Plot (A) shows the IR vs. temperature of the Phase II First DBA cooldown from 175°C to 95°C using the documented IR data at 175°C and 95°C. Plot (B) shows the IR vs. temperature of the Phase II Second DBA cooldown and uses the available data as documented at 175°C, 161°C and 95°C. Plot (C) and Plot (D) are based on the Phase I First DBA and Second DBA data contained on Page 136, TABLE A1-2a, and Page 137, TABLE A1-2b, of SAND83-1617 for terminal block 1(TB1). Plot (C) shows the IR vs. temperature of the Phase I First DBA cooldown from 172°C to 95°C, and uses the available IR data as documented for these temperatures. Plot (D) shows the IR vs. temperature of the Phase I Second DBA cooldown and uses the available data as documented at 172°C, 161°C, 150°C, 122°C, and 105°C. Plots (A), (B), (C), and (D) were all made by drawing a line through the median data points.

FIGURE IR-1 - INSULATION RESISTANCE Versus TEMPERATURE

MODEL STATES-ZWM (TB6), 45VDC DATE 3/30/92 by: [illegible]

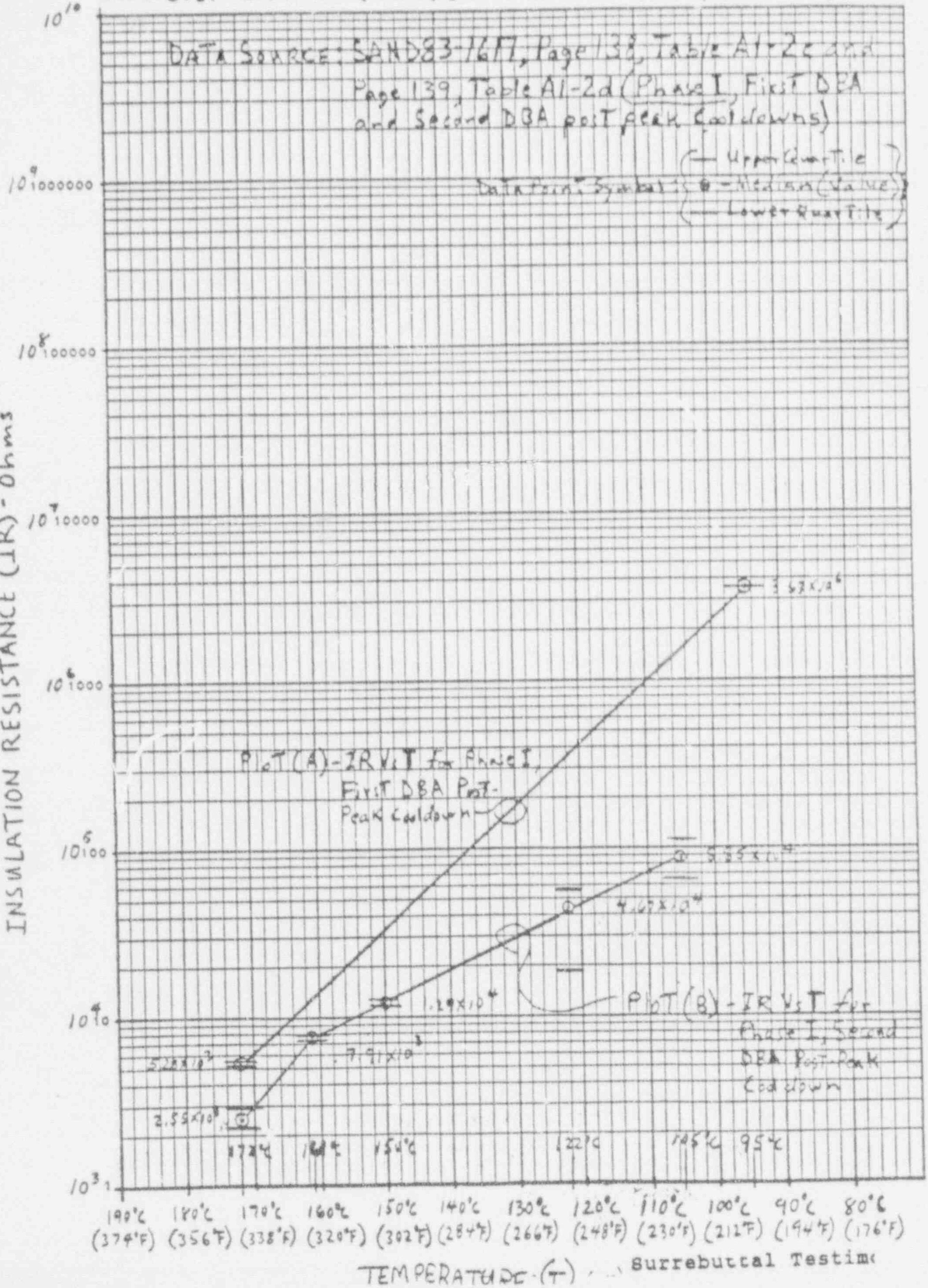


K&E SEMI-LOGARITHMIC 46 5463 7 CYCLES X 60 DIVISIONS MADE IN U.S.A. KEUFFEL & ESSER CO.

Surrebuttal Testimo

FIGURE IR-2 - INSULATION RESISTANCE Versus TEMPERATURE

MODEL G.E. - CR-151B (TB5), 45 VDC DATE 3/30/92 by: Jerrie Love

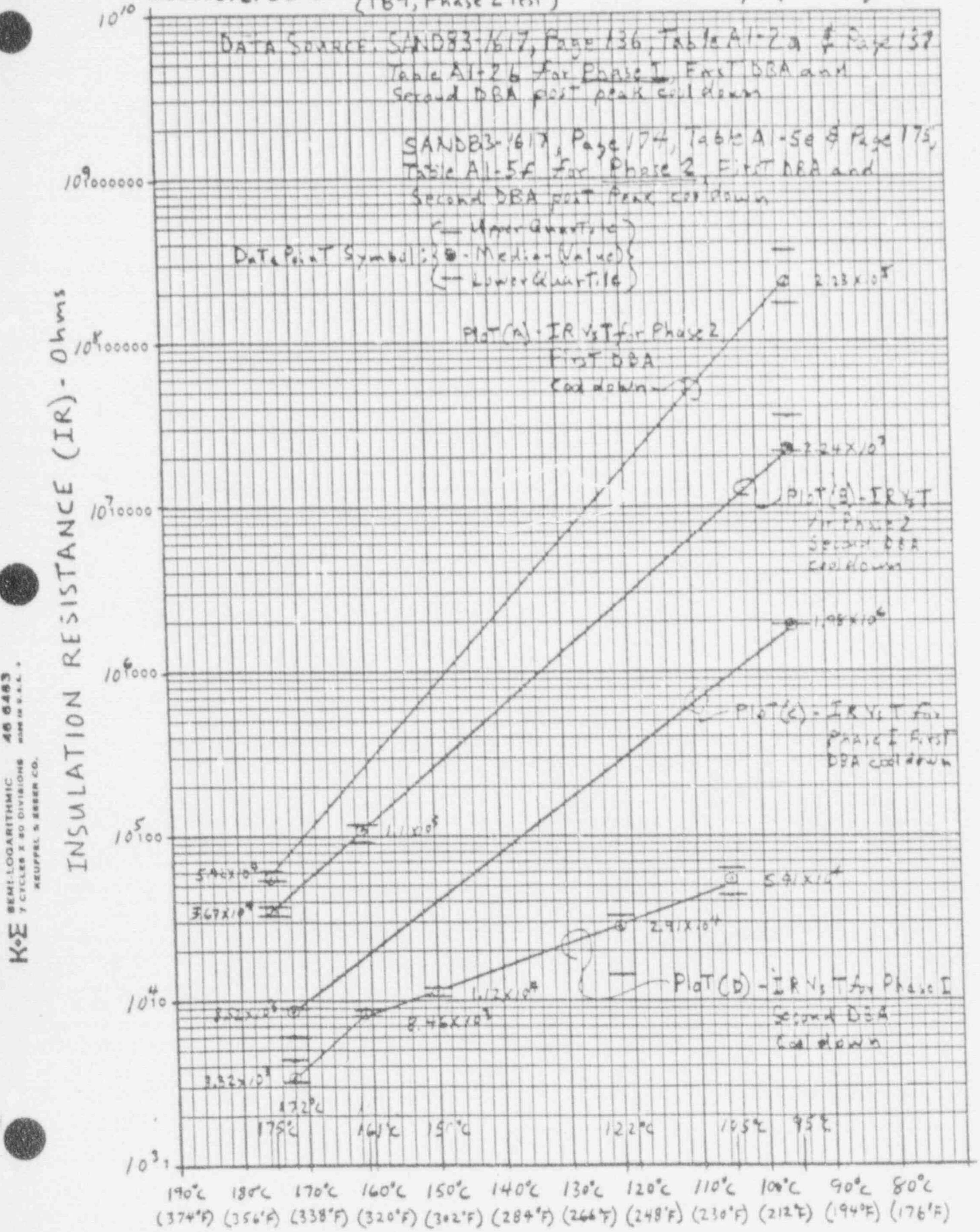


Surrebuttal Testim

K+E SEMI-LOGARITHMIC 46 6463
7 CYCLES X 60 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.

FIGURE · IR-3 - INSULATION RESISTANCE Versus TEMPERATURE

MODEL G.E. EB-25 {TB1, Phase 1 Test / TB9, Phase 2 Test}, 45 VDC DATE 3/30/92 by:



Q101. Can you illustrate your conclusions based on this data?

A. (Love) Yes. A review of the IR vs. temperature plots contained in Figures IR-1, IR-2, and IR-3 clearly shows that the data documented in SAND83-1617 demonstrates a terminal block IR vs. temperature characteristic which is linear when plotted on a semi-log scale for the cooldown period of each simulated DBA. More significantly, it demonstrates this characteristic for each terminal block using multiple media data points available from the Sandia Phase I and Phase II Second DBAs. (The only area of non-linearity is for Phase I, Second DBA, GE terminal block tests, Plot (B) of Figures IR-2 and Plot (D) of Figure IR-3 -- between 172°C and 161°C.)

Q102. From this, what conclusions can we draw regarding Staff Exhibits 50 and 51 in which Dr. Jacobus has plotted IR vs. temperature?

A. (Love) The non-linear plots by Dr. Jacobus, because of the way they are based on the Sandia data, are not representative of the terminal block performance which was demonstrated in the Sandia testing. The Alabama Power Company plot for the GE EB25 block (based on the Sandia data) utilized in the November 24, 1987 JCO (APCo Exhibit 59) is actually a more representative curve.

Q103. The IR vs. temperature plot of the SAND83-1617 data is linear, as shown in Figures IR-1, IR-2, and IR-3, for the temperatures of concern. Is there any other information in SAND83-1617 which also indicates that IR is linear with respect to temperature?

A. (Love) Yes. In the temperature ranges of significance to the Farley instrumentation terminal blocks, Figure 26 on page 48 of SAND83-1617 (Staff Exhibit 73) shows a linear change in IR vs. temperature during the cooldown periods between temperature plateaus. Also, as discussed above, Figure 8-3 on page 85 of NUREG/CR-3691 (Staff Exhibit 74) indicates a linear response of the terminal block IR for the transmitter circuit during cooldown. These are yet further indications of how the Sandia data could not possibly support a position that our 1987 analysis was in error.

Q104. In NRC Staff Exhibits 50 and 51, Dr. Jacobus has also shown graphically a plot taken from a GE Test Report. He shows that IR of the terminal blocks at temperatures from 260'F - 340'F would be a constant value of 2E4 ohms. He reiterates this conclusion in his Rebuttal Testimony at page 35, drawing data from a November 6, 1973 GE Test Report. Would you care to comment on this?

A. (Love) Yes, I would. The November 6, 1973 GE Test Report was included in a 1984 similarity analysis demonstrating similarity between States ZWM and NT terminal blocks (not an issue here, as discussed in my Direct Testimony, Q/A 85, at page 97). The IR data in this report was not used as a qualification basis for terminal blocks in instrument circuits. It also was not the qualification report relied upon for overall qualification of GE CR-151B terminal blocks at Farley Nuclear Plant. (That qualification report was APCo Exhibit 58).

In this GE test referred to by Dr. Jacobus, the terminal blocks were subjected to elevated temperatures, 260°F - 140°F, for approximately ten days. The profile consisted of five temperature plateaus non-representative of the Farley DBA profile, and involved subjecting the terminal blocks to significantly elevated temperatures for long periods of time. This profile could have resulted (and apparently did result) in degradation of the test terminal blocks, reducing their IR vs. temperature capabilities. In any event, the results of this testing are not in agreement with the results indicated for the GE CR-151B and States NT/ZWM terminal blocks as documented in SAND83-1617.

Q105. Putting the 1973 GE report aside, and returning to your earlier conclusions, what is the significance of the linear IR vs. temperature characteristic of the States and GE terminal blocks?

A. (Love) Characterization of the terminal blocks IR dependency on temperature during simulated DBAs permits the use of this characteristic in evaluating the ability of the terminal blocks to meet the required instrument circuit functions during plant specific postulated design basis events.

Q106. You mentioned above that the second step of your logic would be to re-look at the Farley-specific DBAs in order to show when the instrument loops were required to operate. Let's move on to this point. For starters, please explain the Farley-specific postulated design basis events which create the worst case environmental conditions, including temperature, inside the containment building?

A. (Love) As described in the FSAR, these worst case postulated design basis events (accidents) are large break LOCA and large break MSLB.

Q107. Does the containment temperature remain constant during a postulated large break LOCA or large break MSLB?

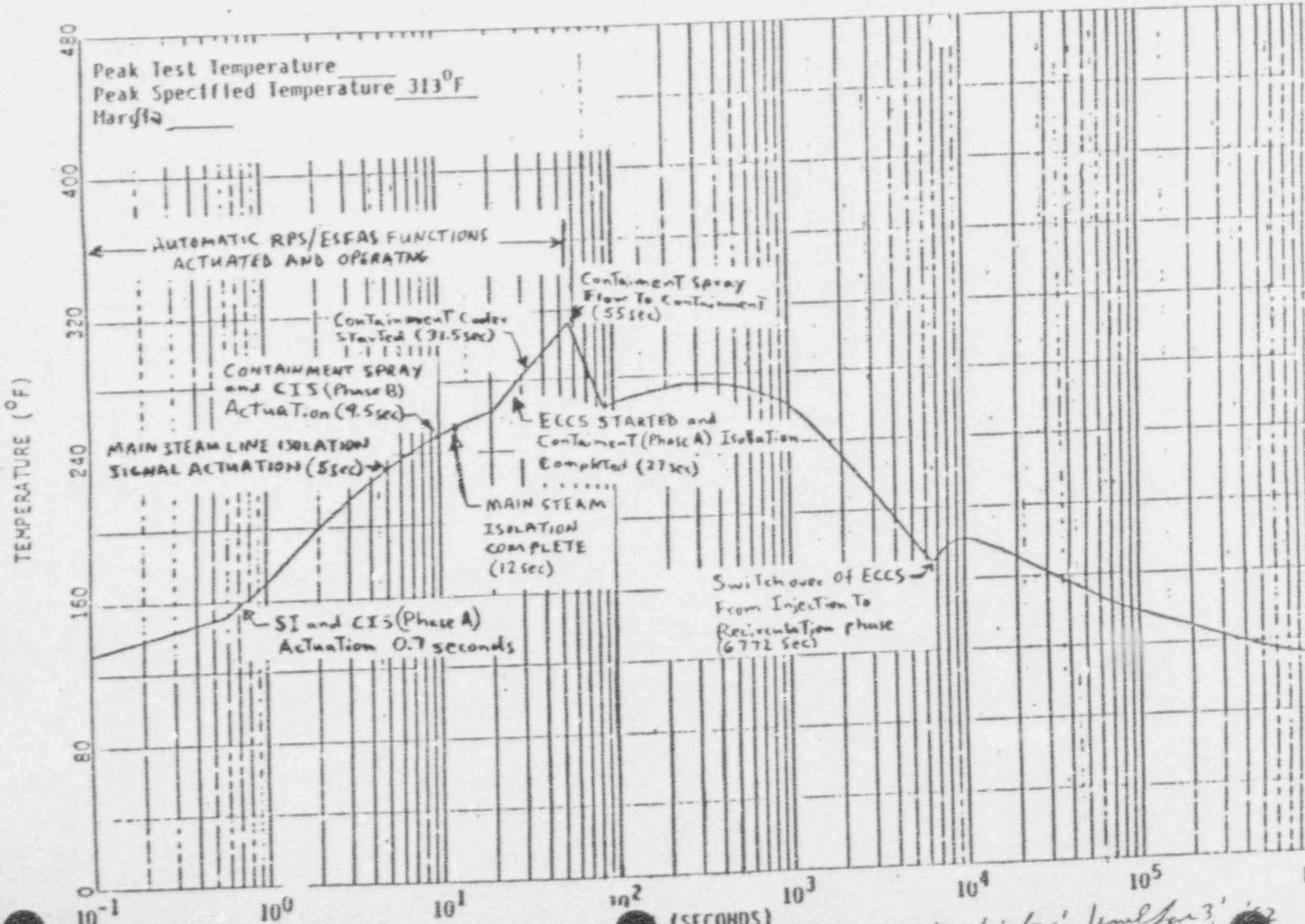
A. (Love) Definitely not. The temperature vs. time response of the containment to a large break LOCA has been shown in my

Direct Testimony (Figure 3). In the JCO presented in the November 1987 meeting with the Staff in Atlanta, the temperature vs. time response of the containment was depicted using a composite of the worst case LOCA/MSLB containment temperature curve. (APCo Exhibit 59, Attachment 2, Bates 0064097). For the sake of clarity and continuity in this testimony, I have included another copy for the LOCA Containment Temperature Profile marked as Figure 3, and have also included a copy of the MSLB Containment Temperature Profile, Figure 4, which shows the temperature vs. time response of the containment to the postulated large break MSLB. I will refer to the significance of the markings I have made on these curves below.

FIGURE 3

The specified curve is based on FSAR Curve, Figure 6.2-40

LOCA INSIDE
CONTAINMENT TEMPERATURE ENVELOPE



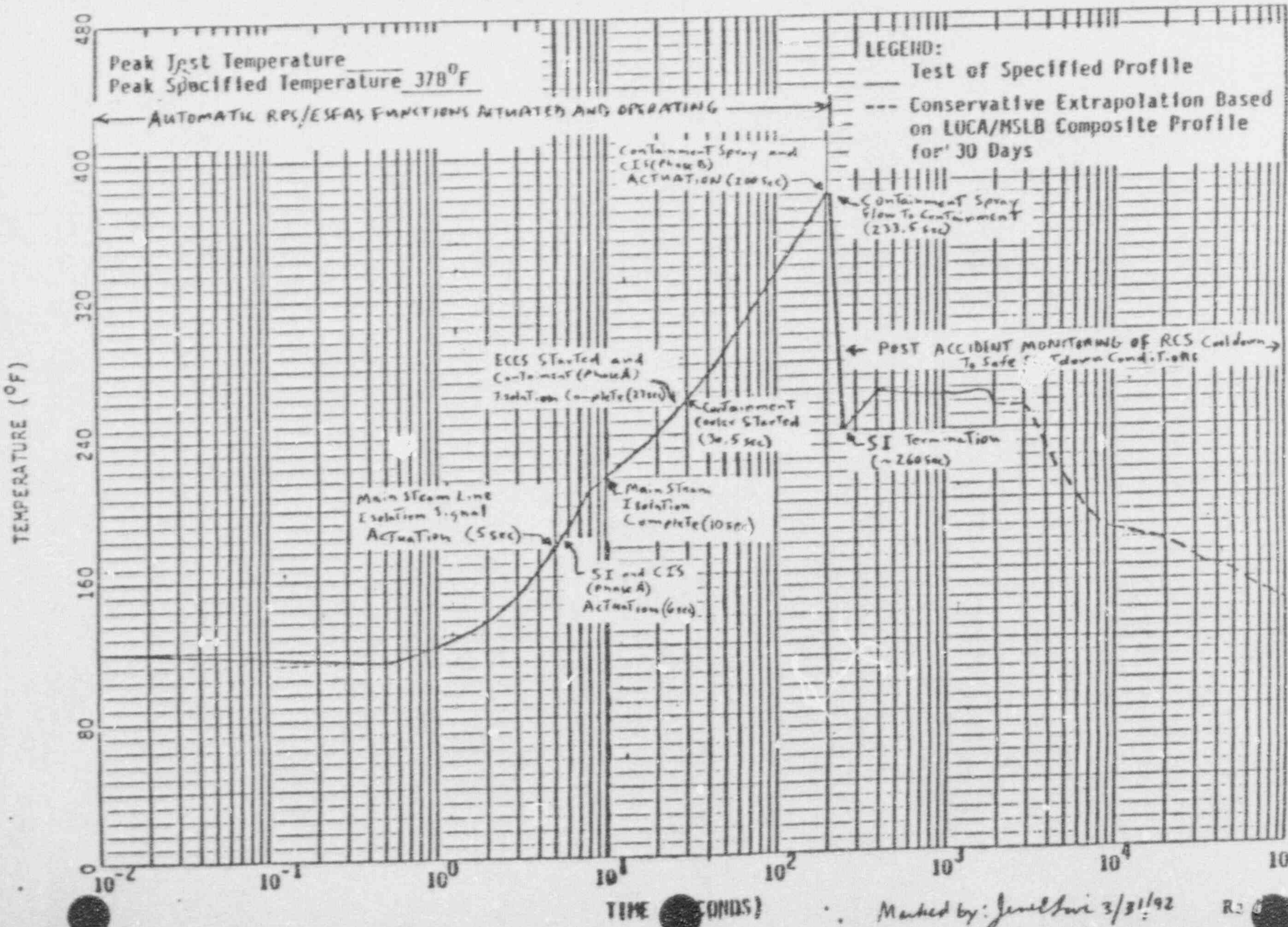
17

FNP-0-M-060

FIGURE 4

This curve is based on FSAR Curve, Figure 6.2-11

MSLB INSIDE CONTAINMENT
TEMPERATURE ENVELOPE



Surrebuttal Testimony Pg. 177

Marked by: Jewel Love 3/31/92

R:

Q108. What is the significance of the design basis large break LOCA and MSLB containment temperature vs. time response profiles with regard to the instrument loop accuracy effects of terminal blocks on overall instrument loop performance or function?

A. (Love) The documentation in the FSAR provides the bases for these profiles, including a description of the assumed automatic and manual actions required to mitigate the events and when in the events these actions are assumed to occur. The containment temperature response based on these assumptions is depicted by the large break LOCA and MSLB containment temperature profiles. The FSAR also provides a description of the instrumentation which provides the signals to initiate the assumed automatic actions and upon which the assumed manual operator actions are based.

Therefore, required instrumentation functions and the time during the event when the instrumentation functions are required have been established in the bases for the accident analyses. These considerations are not something we concocted after-the-fact -- they are reflected in the accident analyses. As stated above, the event temperature profile also reflects the containment temperature response in light of the mitigation actions being accomplished based on required instrumentation functions.

Having established the length of time or period of time during each event that the instrumentation function is required, and the corresponding temperatures for that time period from the event profile, the significance of the instrument loop accuracy effect of the terminal blocks on the required instrumentation function can be evaluated based on the IR vs. temperature characteristic of the terminal blocks over the required functional temperature range.

Q109. Can you be more specific with regard to the instrumentation loops required for mitigation of each of the applicable design basis events, and the length of time as well as the corresponding temperature range in each event when they are required to function?

A. (Love) Yes. I have already provided testimony (Direct Testimony, Q/A 110 at pages 120-21) for the large break LOCA, but I will expand upon my previous testimony regarding this event.

I have marked the copy of the LOCA Containment Temperature Profile included in this testimony as Figure 3, to show the portion of the pro le where the automatic RPS/ESFAS instrumentation accident mitigation functions are accomplished. APCo Exhibit 52, at Bates 0063876-0063879, provides a list of the specific RPS/ESFAS instrument loops which contained States and GE terminal blocks. It should be noted that the containment wide range pressure instrumentation loops which initiate containment isolation (Phase B) and containment sprays for this event do not have any instrumentation cabling or terminal blocks inside the containment building.

As can be seen from the markings I have made on the profile, the automatic RPS/ESFAS actions take place in less than 55 seconds and before reaching the peak LOCA temperature of 313°F. No manual operator action is required until switchover of the ECCS and Containment Sprays from the RWST injection to the containment sump recirculation. I have also marked this point on the profile, which occurs at 6772 seconds when the containment temperature has dropped to approximately 170°F. The primary operator instrumentation relied upon for this manual action is RWST level which is located outside the containment. The wide range containment sump level instrumentation loops with terminal blocks located inside the containment provide diverse indication to the RWST level instrument loops.

Next, I will discuss the large break MSLB. For this postulated pipe break on the secondary side of the steam generators, the required RPS/ESFAS instrument loops located inside the containment have accomplished their automatic accident mitigation functions by 60 seconds from large break initiation. As can be seen from the markings I have made on the copy of the MSLB Containment Temperature Profile, Figure 4, this action is initiated before reaching 310°F and also before reaching the peak MSLB temperature of 378°F. For this postulated event, as with the large break LOCA, the containment wide range pressure loops initiate containment sprays and have no terminal blocks located inside the containment building. No manual operator action is required for this event until termination of safety injection which is executed at 250 seconds after break occurrence when the corresponding containment temperature has cooled down to 240°F. The in-containment instrumentation loops used for this manual action are RCS wide range pressure and pressurizer level.

After safety injection termination, a controlled RCS cooldown to safe shutdown will be initiated. It is during this portion of the event that post-accident monitoring instrumentation (primarily RCS sub-cooling, wide range RCS pressure, and narrow range steam generator water level) will be utilized. This · tion of the event profile, Figure 4, starts at approximately 400 seconds after event initiation when the containment temperature is 260'F. During the rest of the cooldown, the containment temperature continues to decrease.

It should be noted that in the November 1987 JCO (APCo Exhibit 59), safety injection termination following a large secondary break MSLB was conservatively marked on the Composite LOCA/MSLB Containment Temperature Envelope, Attachment 2, Bates 0064097, at 296'F. However, as I have testified above, using the actual event specific MSLB profile, Figure 4, the safety injection termination is not required until containment temperature returns to 240'F.

Q110. Let's turn now to the third step of your logic outlined above. Referring now to the terminal block IR vs. temperature characteristic demonstrated by the SAND83-1617 data (Figure IR-3), what is the indicated terminal block IR which would exist when the manual operator actions are required for each design basis event?

A. (Love) For the large break LOCA discussed above, the required manual operator action is initiated when the containment temperature has cooled down to approximately 170'F. The corresponding IR value for this temperature taken from Plot (A) of Figure IR-3 would be greater than 2.23E8 ohms.

For the large break MSLB the required manual operator action is initiated when the containment temperature has cooled to 2.0°F. Again using Figure IR-3, the corresponding IR value for this temperature taken from Plot (A) would be 1.8E7 ohms.

During the post-accident monitoring phase of the MSLB accident recovery, the highest containment temperature is 260°F. Based on Figure IR-3, the corresponding IR value for this temperature is approximately 8.0E6 ohms.

Q111. What is the significance of these terminal block IR values?

A. (Love) Contrary to the conclusions reached and presented by Dr. Jacobus during and following the 1987 EQ inspection, these values of IR, which were determined from the available SAND83-1617 documented test data, support the value of 1E7 ohms used in our 1987 Westinghouse setpoint calculations.

I want to be clear on another point. I do not believe this analysis of the SAND83-1617 data was necessary for qualification of our terminal blocks. I have gone through this data here simply to illustrate how Dr. Jacobus is in error in his testimony. The fact is, our 1987 approach, based on data from the CONAX report, yielded very similar IR data and was an equally valid approach to addressing terminal block instrument accuracy effects.

Q112. In the 1987 Alabama Power Company JCO (APCo Exhibit 59), what is the significance of the value of 5E5 ohms for the terminal block IR established by Westinghouse?

A. (Love) As discussed in the JCO, Attachment 2 (Bates 0064091), any IR value greater than 5E5 ohms would result in instrument inaccuracy that would allow the current ERP values to be used by the operator to take ERP actions. Thus, Westinghouse was saying that the ERPs, as they existed in 1987, would remain valid for instrument terminal block IRs greater than 5E5 ohms, and was establishing an absolute minimum value of IR for which the ERP setpoint values would remain unchanged.

Q113. How does this IR acceptance criteria relate to a temperature to be used for instrument accuracy qualification?

A. (Love) Using Figure IR-3, Plot (A), to find the corresponding temperature for an IR value of 5E5 ohms, the corresponding temperature would be 154°C (309.2°F). It can also be observed that for all temperatures lower than 309.2°F, the corresponding value of IR for the terminal blocks will be greater than 5E5 ohms.

It should be noted that in the JCO (APCo Exhibit 59) Figure 1 (Bates 0064083) and Attachment 2, Figure 1 (Bates 0064096), the endpoints of the IR vs. temperature curve were also based on the same terminal block test data presented as Plot (A) of Figure IR-3. For the JCO presentation, the IR value corresponding to the endpoint temperatures of 95°C was depicted as 1E8 ohms. On Figure 1 (Bates 0064083), the IR value for the endpoint temperature of 175°C was depicted as 3E4 ohms. On Attachment 2, Figure 1 (Bates 0064096), the IR value for the endpoint temperature of 175°C was depicted as 5E4 ohms. These endpoints were visually determined from SAND83-1617, Figure A1-21, page 210, and were conservatively less than the actual median data points for the same terminal block (TB9) as documented in SAND83-1617, Table A1-5e, page 174 and Table A1-5f, page 175, which are the basis for Figure IR-3, Plot (A). Therefore, in the JCO, the IR vs. temperature curves for the terminal block resulted in the determination of a limiting temperature of 296°F for the corresponding value of 5E5 ohms.

Q114. With the Westinghouse establishment of a minimum IR value of 5E5 ohms which would support the 1987 vintage ERP values, what should have been the 1987 basis for assessing the ability of the instrument terminal blocks to perform the required safety functions during the postulated design basis harsh environments?

A. (Love) The important criterion for qualification should have been demonstration of a value of IR greater than 5E5 ohms <u>at</u>

the containment temperature conditions when the instrument terminal blocks would be required to perform their safety functions. (Again, this assumes that the terminal block would be capable of surviving and recovering from the design basis event temperature conditions which would exist when no safety-related functions were required.) The NRC Staff has acknowledged in their Rebuttal Testimony (Q/A 17, at page 24) that the established performance specification for the qualification of instrument terminal blocks was 5E5 ohms.

Q115. In this light, were the GE and States terminal blocks at issue qualified during and following the November 1987 NRC Inspection?

A. (Love) Yes, because all containment temperatures at times when the instruments were required to operate were less than 309.2°F.

Q116. As you mentioned above, the NRC Staff has finally acknowledged that the 1987 performance specification for the instrument terminal blocks is 5E5 ohms. Nonetheless, what is the significance to the rest of the Staff's arguments that the GE and States terminal blocks were not qualified even at peak-LOCA/HELB temperatures?

A. (Love) As we have discussed, qualification at peak-LOCA/HELB is not required for instrument accuracy. Nonetheless, it is interesting to point out as an additional matter that the SAND83-1617 data indicates that the terminal block temperature corresponding to 5E5 ohms is 309.2°F. The peak LOCA temperature on Farley is above 309.2°F for only seconds, and the peak surface temperature of the terminal blocks during an MSLB (considering thermal lag) is less than 300°F. Therefore, the 5 x 10^5 performance specification would be met for these events.

Q117. In the Staff's Rebuttal Testimony, at pages 42-44, Q/A 35, the Staff is stating that there is no basis to conclude that the RPS/ESFAS instrument loop terminal blocks will perform their automatic actuation function prior to reaching temperatures which could affect their required function. Do you concur with these statements?

A. (Love) Absolutely not. As shown on the actual postulated Farley design basis containment accident temperature profiles, Figures 3 and 4, the automatic actuation signals using terminal blocks will occur well within 60 seconds of the event pipe break. For the MSLB, Figure 4, the only signal which is used for automatic actuation occurring after 60 seconds is based upon the containment wide range pressure instrument loops. However, these instrument circuits have no terminal blocks located inside the containment.

Dr. Jacobus states that thermal lag is not a valid concept for determining the qualified performance of terminal blocks based again on the SAND83-1617 moisture film effect. The only technical evidence which Dr. Jacobus offers to support his assertion is a reference to Figure 25, at page 45, of SAND83-1617. I am not sure that this curve, due to its time scale in 0.5 hour increments, shows anything relative to the first 60 seconds of the transient. However, on page 42 of SAND83-1617, first full paragraph, the concept of thermal lag as it relates to the test chamber terminal block is described and acknowledged. It appears that the correct figure showing the thermal lag in SAND83-1617 is Figure 28 on page 50 of the report, as described on page 42 -- not Figure 25 as referenced by Dr. Jacobus.

Q118. In the same Q/A of his Rebuttal Testimony, at page 43, Dr. Jacobus also challenges the idea of taking credit for thermal lag during pre-peak LOCA conditions based on his illustration of the instantaneous formation of a moisture film. What is your response?

A. (Love) Dr. Jacobus is implying, by his simplistic example of breathing moist air on a cold window, that a moisture film forming on a terminal block will result in a significant reduction in the block IR regardless of the temperature of the block. This is ridiculous and totally unsupportable by the results of SAND83-1617.

SAND83-1617 clearly indicates that the IR is temperature-dependent. Breathing on a cold terminal block may result in a moisture film on the block, but will not result in significant IR reduction. There is no data in SAND83-1617 which would indicate that a moisture film -- without the presence of significant temperature -- is a valid concern.

Q119. Again in the same Q/A, this time on page 44, Dr. Jacobus picks up on the figure of 5 minutes from Attachment 2 to the JCO (APCo Exhibit 59), a letter from Westinghouse. Has he drawn a proper conclusion?

A. (Love) No. The Staff refers to Attachment 2 to the JCO (APCo Exhibit 59) indicating that, 5 minutes into the event, the LOCA conditions have already passed the peak temperature. The reference to 5 minutes in the Westinghouse portion of the JCO is to the length of time required after event occurrence for small break LOCAs and small break MSLBs. As these small break events do not result in the worst-case design basis containment accident profile, including temperature, they are not the basis for qualification. Small break LOCAs and MSLBs result in less severe accident transients and will not yield the containment peak temperatures or profiles indicated by Figures 3 and 4.

E. Miscellaneous

Q120. To wrap up this aspect of the topic, I want to turn to a few additional miscellaneous aspects of the Staff's Rebuttal Testimony. First, in Q/A 28, at pages 36-27, Mr. Jacobus infers that we should have used the Phase I SAND83-1617 test data for the GE CR 151B and States ZWM terminal blocks in the JCO. Do you concur?

A. (Love) No. The basis for not using the Phase I data was explained in Attachment 1 of the JCO (APCo Exhibit 59, Bates 0064086-0064089), and was also verbally presented by me in great detail at the November 25, 1987 meeting in Atlanta. It was, and still is, our position that the SAND83-1617 Phase II First DBA test data for the GE EB-25 terminal blocks was correctly applied and justifies our 1987 approach to instrument terminal block functional qualification.

The Phase I testing yielded lower (or more conservative) IR results than the Phase II testing. However, this data was overly conservative and not realistic for the Farley-specific applications. Rather than repeating all of the reasons again, I will refer to Figures IR-1, IR-2, and IR-3 to provide additional clarification of my basis for using the Phase II DBA data.

On Figure IR-3, I have plotted both the Phase I and Phase II(2) IR vs. temperature curves for a GE EB-25 terminal block in this figure. Plots (C) and (D) depict the IR vs. temperature characteristic which results from the Phase I First DBA and Second DBA tests. Plots (A) and (B) show the results of the Phase II(2) First DBA and Second DBA tests. From these plots of the IR vs. temperature data for the same type terminal block (GE EB-25), it is obvious that the Phase I test produced much more conservative IR data than the Phase II(2) test. "More conservative" meaning lower values of IR vs. temperature.

The Phase II First DBA profile was used for the Alabama Power Company JCO (APCo Exhibit 59) since it was very conservative in relation to the Farley large break LOCA and MSLB profiles (Figure 3 and Figure 4). A review of the Phase I First DBA test plots for each type of terminal block -- on Figures IR-1, IR-2 and IR-3 -- shows that for temperatures less than 150°C, the States ZWM and CR-151B terminal blocks both exhibit a better IR vs. temperature characteristic than the GE EB-25 block ("better" meaning that IR recovers to a higher value as the temperature decreases). In fact, the States ZWM block exhibits a better IR vs. temperature characteristic than the GE EB-25 blocks over the complete test temperature cooldown from 175°C to 95°C. Therefore, it appeared reasonable in my engineering judgment to conclude that, if a States ZWM or GE CR-151B terminal block had been included in the Phase II testing, they would have also provided superior IR vs. temperature performance to that of the GE EB-25 terminal block which was tested during Phase II. It was this engineering judgment that resulted in the 1987 decision to use the GE EB-25 Phase II(2) First DBA IR vs. temperature characteristic profile for the Alabama Power Company JCO. (APCo Exhibit 59).

In the Staff's Rebuttal Testimony, Q29 and Q45, the Staff is questioning the meaning of my statement regarding the SAND83-1617 Phase II, Third DBA test data. The meaning of my statement is quite clear. By the time the GE EB-25 terminal block (TB9) had been exposed to the Third DBA, it, as well as the associated test conductors, were degraded to the point that they could no longer recover IR with decreasing temperatures. I did not plot the Third DBA IR vs. temperature plot, but a review of the test data on pages 174 and 175 of the SAND83-1617 report will verify this statement. A comparison of the Phase I First DBA and Second DBA, and the Phase II First DBA and Second DBA plots on Figures IR-1 through IR-3, will depict the degradation effects of successive DBA simulations on the tested blocks and test conductors. A complete review of the SAND83-1617 report (Staff Exhibit 73) will substantiate the conclusion I have expressed regarding the meaning and significance of the test data. (See Staff Exhibit 73, at pages 33, 52, 94, 112, and 237).

Based upon all of the above, the SAND83-1617 data for the GE EB-25 terminal block recorded during the Phase II First DBA supports the qualification of States ZWM and GE CR-151B terminal blocks for the Farley-specific design basis accident profiles.

Q121. The NRC Staff, in their Rebuttal Testimony (Q/A 26-27, at pages 32-24), has also expressed for the first time a list of new factors which they claim needed to be considered in the 1987 basis for instrument terminal block qualification. Are these factors relevant to the 1987 functional qualification of the instrument terminal blocks?

A: (Love) No, they are not. One example is the warnings on ERPs that Dr. Jacobus refers to in Q/A 27 on page 34. These factors -- including the warnings -- are only relevant if the terminal block would not have been able to meet the 1987 Westinghouse functional performance specification of 5E5 ohms. It has been, and continues to be, our contention that the instrument terminal blocks were capable of meeting (and in fact exceeding) this functional performance specification. Therefore, no changes to the 1987 ERP values were necessary. As is clear in the excerpt from the JCO (APCo Exhibit 59) cited by Dr. Jacobus on page 34, 5E5 ohms was the acceptance criterion. Our terminal block IRs were greater. The warnings and other considerations listed by Dr. Jacobus were not necessary or relevant.

Q122. Dr. Jacobus, in his Rebuttal Testimony (Q/A 43, at page 51, and Q/A 44, at page 52) provides his opinion of what you testified to regarding the single value of 2E4 ohms contained in the March 27, 1985 GE Test Report. (APCo Exhibit 58). Do you concur with his opinion?

A. (Love) The Staff is attempting to draw an inference that an IR value of 2E4 ohms means the GE terminal block is unqualified. In my oral testimony (Tr. 1123-1126), I concluded by saying that the single value of 2E4 ohms recorded in the GE Test Report (APCo Exhibit 58) was sufficient. "Sufficient" in this context meant that it was not an abnormal value of IR for the peak test temperature experienced. The IR value meant that the block was not damaged by the peak-test temperature and, thus, could be expected to recover IR performance as the temperature decreases. This position is also supported by the SAND83-1617 test data for the GE terminal blocks. Therefore, depending upon plant-specific applications of the terminal block in instrumentation circuits, the terminal block could be qualified for post-peak conditions.

Q123. Dr. Jacobus, in his Rebuttal Testimony (Q/A 5, at page 6), is taking credit for clearly and conclusively demonstrating in the November 1987 meeting that IR was not related to temperature as indicated in the JCO. Do you agree?

A. (Love, Jones) No. This simply does not reflect what occurred. In his Rebuttal Testimony, Dr. Jacobus also implies that this was the reason that Alabama Power Company planned to replace the instrument terminal blocks. (Please refer to Sections I, II and III of the JCO (APCo Exhibit 59)). As is clear therein, Alabama Power Company chose to replace the terminal blocks to remove the point of contention, because the Staff could not understand, or would not accept, our approach.

F. Similarity Evaluation Arguments

Q124. Another topic of the Rebuttal Testimony is the analysis of similarity between the Connectron NSS-3 block tested by CONAX and the States and GE terminal blocks at issue. (See Rebuttal Testimony, Q/A 20-25, at page 27-32.) Are you familiar with this similarity evaluation?

A. (Love) Yes. We developed a documented similarity evaluation of the terminal blocks to support our 1987 approach to the instrument accuracy issue. It was included in EQ Action Items 018 and 067. (APCo Exhibit 52). We discussed it in our Direct Testimony, pages 114-15.

Q125. One of the differences between the Connectron block and the GE/States blocks that you addressed in Direct Testimony was material differences between the blocks. Why did you address this?

A. (Love) Dr. Jacobus offers curious testimony on this point. He disavows knowledge of alleged material differences. However, we only addressed this point because the Staff raised it in their own Order imposing the civil penalty. (Staff Exhibit 3, Appendix A, at page 25). I gather from this that Dr. Jacobus never read or supported the Order.

In any event, material differences should not be important to Dr. Jacobus. The block material, according to Dr. Jacobus, is irrelevant to leakage currents due to the predominant effect of ionic conduction in the exterior moisture film (a theory and hypothesis he supports for terminal blocks). (Rebuttal Testimony, Q/A 22, page 29).

Q126. The major problem Dr. Jacobus seems to be standing by now regarding the similarity evaluation is the issue of spatial separation between the poles of the terminal blocks. Can you address his Rebuttal Testimony on this point?

A. (Love) Yes. Dr. Jacobus asserts that we "did not consider . . . that the step design [of the Connectron NSS-3] effectively increases the distance between adjacen terminals." We certainly did consider this factor and concluded that it was not significant <u>for the blocks at issue</u>. (<u>See</u> Direct Testimony at page 115). The basis for my conclusion was that the spatial separation -- including both the horizontal and vertical separation -- is simply not very different for these terminal blocks.

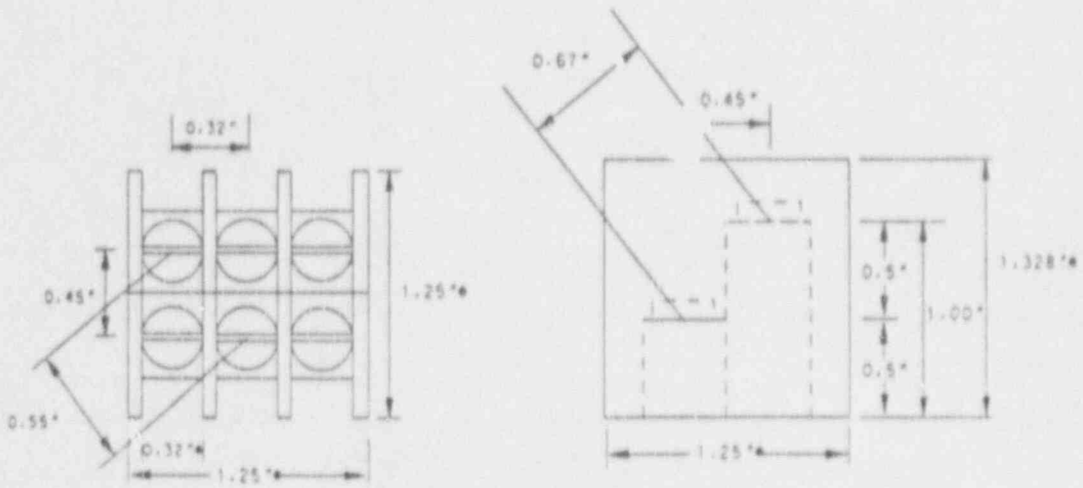
Dr. Jacobus uses an extreme example of a terminal block with a one foot vertical step between poles. While this is effective to illustrate a theoretical point, it has no bearing on our terminal blocks. The dimensions of the blocks at issue are significantly smaller than Dr. Jacobus's example, and all are effectively similar notwithstanding the step design of the Connectron NSS-3.

In the similarity analysis which I prepared to compare the Connectron NSS-3 terminal blocks to the other plant-specific terminal blocks, including States ZWM/NT and GE CR-151B blocks

(APCo Exhibit 52), I prepared a table, on page 3 of 4, showing the center-to-center pole spacing of each block and other relevant physical factors. In this table for the Connectron block, I indicated the center-to-center spacing as 0.320 inches, which is the correct dimension from a plan view. Also included in the similarity analysis was Attachment 3, which provided electrical, dimensional, and physical information for the Connectron block. All of this information supported my conclusion that the three types of blocks at issue were similar.

To address Dr. Jacobus's testimony here, I will use dimensional information from the similarity analysis and explain why the step arrangement is of no significance. Figure 5 is a diagram which depicts the Connectron NSS-3 block in plan and end views. The spacings are shown, considering both horizontal and vertical dimensions. The vertical spacing of the steps is not one foot, but approximately 0.50 inches.

CONNECTRON INC. NSS3 TERMINAL BLOCK ASSEMBLY



PLAN VIEW

END VIEW

NOTES

1. * INDICATES DIMENSIONS AS GIVEN IN CONNECTRON, INC. CATALOGUE.
2. OTHER DIMENSIONS WERE DETERMINED BASED ON ENGINEERING JUDGEMENT AND THE FOLLOWING ASSUMPTIONS:
   - THE LOWER TERMINAL POLE STEP HEIGHT WAS DETERMINED TO BE APPROX. ½ THE HEIGHT OF THE UPPER TERMINAL POLE HEIGHT PER THE VENDOR PICTORIAL INFORMATION AND ATTACHED DRAWING.
   - THE POLE TO POLE DIMENSION OF 0.45" WAS BASED ON GIVEN DIMENSIONS AND THE DIMENSIONS OF A 6-32 ROUND HEAD SCREW (HEAD DIAMETER OF 0.25")

R.J. Puhl 7/6/92

DRAWN BY: S. L. HARSHBERGER CHECKED BY: R. J. PUHL

As shown on the figure, the separations between terminals, considering the step design, range from 0.50 to 0.67 inches. These spacings are comparable to the center-to-center spacings of States NT/ZWM and GE CR-151B terminal blocks (0.6250 inches for the States, and 0.5625 inches for the GE). Therefore, the terminal blocks are dimensionally similar.

As an engineering matter, this dimensional similarity is not a surprising matter. All of these terminal blocks are rated at 600 volts. The voltage of a terminal block will dictate the required physical spacings. The step design of the Connectron block was intended to create a smaller overall terminal block with the same voltage rating (and similar terminal-to-terminal spacings).

Q127. In the Staff's Rebuttal Testimony, on pages 30-32 (Q23 and Q24), additional new issues regarding similarity of GE, Connectron and States terminal blocks are raised. Are any of these new similarity issues relevant?

A. (Love) Dr. Jacobus, in his answer to Q23, is pointing out that the GE and Connectron blocks are molded as a single piece of insulating material, barriers and all. He is noting that in contrast, the States terminal block is a sectional block.

Next, he indicates that differences such as these were not addressed in the similarity analysis.

The Alabama Power Company similarity analysis to which he is referring (APCo Exhibit 52) did not repeat this analysis, which was already performed in SAND83-1617. The States terminal blocks (sectional blocks) were indicated on page 52 of SAND83-1617 to have exhibited among the highest measured terminal-to-terminal insulation resistances of any terminal blocks tested. This is also evident by reviewing my Figure IR-1 in comparison to Figure IR-2. Because this sectional block was shown by Sandia to be the best from a performance perspective, it is completely unnecessary to demonstrate similarity to molded blocks with lower IR vs. temperature characteristics.

In the answer to Staff Rebuttal Question 24, Dr. Jacobus again expounds on the danger of drawing similarity conclusions regarding terminal blocks which are to be operated near their performance limits and states that subtle differences between blocks can make a difference. Dr. Jacobus is being very vague about what should and needs to be evaluated for a similarity analysis. Nonetheless, I believe that performance is the final proof of similarity. The IR vs. temperature data contained in SAND83-1617 confirms similarity of performance for the GE and States terminal blocks. The data shows that their performance is very similar, with the States block being superior to the GE block. A review of the IR vs. temperature plots for the Phase I, First DBA and Second DBA as shown on Figures IR-1, IR-2, and IR-3 show this performance similarity. Also, for the specific design basis event temperatures where performance is important, similarity between the Connectron terminal block IR (1E7 ohms) and the GE terminal block IR was demonstrated in preceeding testimony.

G. <u>Mr. DiBenedetto's Testimony</u>

Q128. Mr. DiBenedetto, have you read the Rebuttal Testimony of Dr. Jacobus and Mr. Luehman with respect to the Staff's concerns on terminal blocks? What, if any, comments do you have?

A. (DiBenedetto) Yes, I have read the referenced testimony. I have many comments and opinions relating to the new testimony. However, rather than address the testimony point by point, I think it is more relevant and beneficial to describe the circumstances relating to the use of terminal blocks in the Farley Nuclear Plant instrument circuits and how qualification for the intended function is attained and concluded.

First, statements made by Dr. Jacobus allude to an assertion that Alabama Power Company never identified at what temperatures the blocks would operate. The Company's position that the blocks would perform their intended function prior to exposure to the design basis event simply indicates that their function is completed during their normal operating temperature environmental range (typically 80 - 140°F). The Reactor Protection System is designed to monitor critical parameters of reactor operation (i.e., pressurizer level, reactor water level, containment pressure, steam generator water level, etc.) all of which sense changes and are pre-set (safety limit setpoints, trip setpoints, pump actuation, valve closure, etc.) to perform a function when one or more of the setpoints are sensed. The circuitry and logic is redundant and complex and not an issue here. Upon sensing a rapidly changing parameter (e.g., loss of level, increase in containment pressure, increase in radiation, etc.), the logic system initiates a protective feature. The protective features range from containment isolation to activation of containment spray in the case of a LOCA. All of these actions occur within the first few seconds of the event, well before the peak environments are reached.

Once these actions have been accomplished, the terminal blocks are not required, nor are the instruments. However, since the instruments and terminal blocks will experience exposure to the "harsh" or elevated environments, assurance must be provided that they will not fail in a manner detrimental to the safety of the plant. Terminal blocks have been tested more than any other piece of electrical equipment. One fact that is evident and obvious from all the testimony proffered is that the terminal blocks did not exhibit any permanent damage. Additionally, the terminal blocks exhibited a recovery of electrical capability as environmental conditions subsided.

Q129. What is the import of these observations?

A. (DiBenedetto) These observations basically support the conclusion that during the short term (i.e., onset of the accident, first few seconds), the terminal blocks are not challenged. During the time period when the reactor protection features are performing their functions automatically (i.e., the injection phase of accident recovery where no operator action is required or permitted), the terminal blocks will experience and be exposed to accident environments and their electrical properties will be diminished. However, as previously stated, the terminal blocks as well as the instruments do not have any function to perform. They just must not fail. Ample terminal block testing demonstrated that they do not fail. (In fact, this was well documented in the report I provided to Dr. Jacobus during the November 1987 inspection.) The testing of the individual instruments demonstrates that they do not fail. Instrument testing has demonstrated that during the onset of the accident, the time they are required to function, their accuracy remained within the specified band of ±8%.

During long term cooling, defined as the operational period where coolant injection has been terminated and switched to coolant recirculation, post-accident conditions require monitoring. This is a time in the accident scenario where containment temperatures and pressures return to near normal conditions. Observations of terminal block behavior during testing show that the blocks recover and very little leakage current is observed (e.g., insulation resistance values return to near normal). The instruments associated with these circuits have demonstrated, through testing, that they also perform as intended within specified accuracy limits (i.e., post-accident accuracy ±25%). Functioning during peak LOCA conditions is not required. The instruments and the terminal blocks must not fail and must be capable of functioning in the post-accident long term recovery period. These features have been demonstrated.

Q130. Do you have a perspective on Dr. Jacobus's use of a qualifying temperature drawn from the SCEW sheet?

A. (DiBenedetto) Yes. He is avoiding the real issue here. The SCEW sheet is not, contrary to statements by Dr. Jacobus, a basis for the qualification of the equipment. It merely presents the conditions that the equipment will experience and the conditions to which it was tested. Similarly, the report I prepared relating to the tested terminal blocks mentioned above was prepared not to show qualification, but instead to demonstrate that our views and conclusions on the survivability of the blocks were indeed supported.

Q131. IN 84-47 is reported by the Staff witnesses to have put utilities on notice relating to the concerns about using terminal blocks in instrument circuits, can you comment on this?

A. (DiBenedetto) Yes, IN 84-47 (Staff Exhibit 48) did indeed present the NRC's concerns relating to the use of terminal blocks in instrument circuits. It also suggested three steps that a concerned utility could take to rectify the situation if a significant problem with leakage current was determined to exist. The Staff is also correct in pointing out that most utilities replaced terminal blocks with splices as a result of reviewing IN 84-47 and performing their own evaluation. However, Alabama Power Company, in its evaluation, segmented their use of terminal blocks and determined, as stated above, that leakage current effects, at the time of the terminal block usage in the Farley-specific accident scenario, was not a concern. IR values were within acceptable criteria and were factored into the loop calculations for inclusion in ERPs.

H. Conclusions

Q132. Do you have any additional conclusions on this issue?

A. (Love, Jones) Y . The NRC is basing a "clearly should have known" finding on th ssue extensively -- if not completely -- on IN 84-47. However, as discussed above, this completely ignores the 1985 basis for qualification of terminal blocks in instrument circuits at Farley Nuclear Plant. That basis was documented (APCo Exhibit 20) and accepted prior to the deadline -- in full awareness of the issues that were involved in IN 84-47. This is simply an evolutionary issue we should not be debating today in the EQ enforcement context.

As we have explained, the Staff's position today is taken in complete disregard for both the technical and regulatory context of this issue in 1984 and 1985. Dr. Jacobus and Mr. Luehman simply weren't there. Nobody else from the NRC Staff has even acknowledged reviewing the Sandia data post-deadline, much less pre-deadline.

From our perspective, Dr. Jacobus, an NRC contractor, staked out a singular position on the issue at the 1987 inspection. As a result, we developed the JCO in the short time after the inspection, before the November 25, 1987 meeting. However, he would not accept our position in the November 1987 meeting either, or at any subsequent time. NRC Staff management has never stepped in to allow an impartial, objective review of the issue, including at the November 1987 meeting. We believe our technical position would be validated by such a review. Moreover, the technical dispute that arose in 1987 was certainly not one we clearly could have known or anticipated prior to November 1985, and the data does not support a violation.

IN 84-47 was based upon the Sandia testing and summary reports discussed above. A thorough review of that data shows conclusively that our 1987 qualification basis was a valid basis. The Sandia data, therefore, does not support a violation -- much less a "clearly should have known" finding. Our review presented here conclusively demonstrates the lack of merit to the Staff's technical position. This cannot be dismissed as some "after-the-fact" analysis. What we have done here is explain again the position we took in 1987. Our pre-inspection analysis existed, was documented, and was valid -- as confirmed by the Sandia data adopted by the Staff.

MR. REPKA: At this point, Your Honor, I would like to introduce the physical evidence of the terminal blocks at issue in this proceeding. I will go through these one by one. There are several different makes and models.

The first exhibit number is APCo Exhibit 130, and I'll ask that that be handed to Mr. Love.

[Exhibit proffered to Witness Love.]

MR. REPKA: We have two copies, again, of each of these.

BY MR. REPKA:

Q Mr. Love, can you tell me what that is?

A [Witness Love] Yes. It's a States Company ZWM terminal block.

Q And is that a fair and accurate representation of the terminal blocks that -- the States terminal blocks -- States ZWM terminal blocks, as they have been discussed in your testimony?

A [Witness Love] Yes, it is.

JUDGE BOLLWERK: All right.

At this point, let the record reflect that APCo Exhibit 130 has been marked for identification.

[APCo Exhibit No. 130 was marked for identification.]

MR. HOLLER: If I may, with the Board's permission, perhaps it would be easier to present it to Mr.

Love and our witness could just take quick look at them, as well. It might make it easier.

MR. REPKA: Dr. Jacobus, I'll have you look at the same exhibit, what's been marked as licensee's Exhibit 130, and I'll ask you the same question. Is that a fair and accurate representation of a States ZWM terminal block?

WITNESS JACOBUS: Yes, it is.

BY MR. REPKA:

Q Mr. Love, the next terminal block I am handing you has been marked as licensee's Exhibit 131. Could you describe what that is?

A [Witness Love] Yes. This is a States Company NT terminal block.

Q And is that a fair and accurate representation of States NT blocks as discussed in your testimony?

A [Witness Love] Yes, it is.

MR. REPKA: And I'll ask again that the same block be handed to Dr. Jacobus, or Dr. Jacobus, have you see that?

WITNESS JACOBUS: Yes, I've seen that one. I agree that that is a States NT block.

JUDGE BOLLWERK: Let the record reflect that APCo Exhibit 131 has been marked for identification.

[APCo Exhibit No. 131 was marked for identification.]

MR. REPKA: Okay.

Our next number, obviously, is licensee's Exhibit 132.

BY MR. REPKA:

Q Mr. Love, I am handing you what's been marked as licensee's Exhibit 132. Could you explain what that is?

A [Witness Love] Yes. This is a General Electric CR-151B terminal block.

Q And that's a fair and accurate representation of the GE CR-151B as that is discussed in your testimony.

A [Witness Love] Yes, it is.

MR. REPKA: Dr. Jacobus, is that --

WITNESS JACOBUS: I agree that's a CR-151B block. I am not sure if that is the only CR-151 type of block that was used in the Farley plant.

WITNESS LOVE: I'm not sure I understand the question. Is it relation to B's or D's?

WITNESS JACOBUS: Yes.

WITNESS LOVE: CR-151B's were the terminal blocks used at Farley nuclear plant.

WITNESS JACOBUS: But there were D's used elsewhere?

WITNESS LOVE: No, not to my knowledge, but instrument circuits, I am certain they were used.

MR. REPKA: Let me just get this straight.

BY MR. REPKA:

Q Mr. Love, you testimony is that is a GE CR-151B.
A [Witness Love] Yes. I'm only saying this is GE CR-151B.
MR. REPKA: And Dr. Jacobus, is there any dispute that that's a GE --
WITNESS JACOBUS: I agree that's a GE CR-151B.
MR. REPKA: Thank you.
JUDGE BOLLWERK: All right.
Let the record reflect that APCo Exhibit 132 has been marked for identification.
[APCo Exhibit No. 132 was marked for identification.]
BY MR. REPKA:
Q Mr. Love, now we're handing to you what's being marked as licensee's Exhibit 133.
MR. REPKA: And we're showing that to Dr. Jacobus, also.
BY MR. REPKA:
Q Mr. Love, could you explain what that is?
A [Witness Love] Yes. This is a GE, General Electric, EB-25 terminal block.
Q Is that a fair an accurate representation of the GE EB-25s as they are discussed in your testimony?
A [Witness Love] Yes, it is.
WITNESS JACOBUS: I agree.

JUDGE BOLLWERK: All right.

Let the record reflect that APCo Exhibit 133 has been marked for identification.

[APCo Exhibit No. 133 was marked for identification.]

MR. REPKA: We are now handing to both Dr. Jacobus and Mr. Love what's been marked as licensee's Exhibit 134.

BY MR. REPKA:

Q Mr. Love, can you explain what that is?

A [Witness Love] Yes. It is a Connectron NSS-3 terminal block.

Q Mr. Love, is that a fair and accurate representation of the Connectron NSS-3 terminal block, as discussed in your testimony?

A [Witness Love] From the physical dimensions and the orientation, configuration of the block, yes. I am aware that the terminal block tested, which was a Connectron block, in the CONAX IPS-107 report was dimensionally equivalent to this block.

However, it was made from a different base insulating compound, which was polysulfone. This particular block, as it is now made, uses nylon.

So, this is a physical representation, but it is not the same material. The material in the IPS-107 blocks was polysulfone for the bulk insulating material, for the base material.

WITNESS JACOBUS: I have no knowledge of precisely what was tested, but I do agree that that is currently what Connectron sells, is an NSS-3 block.

BY MR. REPKA:

Q And Mr. Love, that, I understand, is a recently-purchased NSS-3 Connectron block.

A [Witness Love] That is correct.

JUDGE BOLLWERK: All right.

Let the record reflect that APCo Exhibit 134 has been marked for identification.

[APCo Exhibit No. 134 was marked for identification.]

MR. REPKA: With that, Alabama Power Company moves the admission of licensee's Exhibit 130, 131, 132, 133, and 134 into evidence.

MR. HOLLER: The staff does not object to these exhibits being moved into evidence, sir, but I would ask if it might be helpful to this proceeding if we perhaps rectified the question that came up in the identification of the blocks that were employed.

To make things clear, we have no objection to moving these exhibits into evidence.

JUDGE BOLLWERK: All right.

MR. REPKA: I'll just add that there is no issue in this proceeding as to whether NSS-3 Connectron blocks were ever installed in the Farley nuclear plant.

MR. HOLLER: No, sir. The question goes to which of the GE CR-151 blocks were installed.

JUDGE BOLLWERK: With that caveat, APCo Exhibits 130 through 134 will be received in evidence.

[APCo Exhibit Nos. 130 through 134 were received in evidence.]

JUDGE BOLLWERK: Anything else?

MR. HOLLER: Yes, sir. I would just ask, if Alabama Power doesn't object -- I don't mean to make a lot of this. It's just that the following testimony may be easier if we establish now which of the blocks were there.

MR. REPKA: I have no objection.

WITNESS LOVE: The terminal blocks and instrumentation circuits manufactured by General Electric that are issue here for Farley nuclear plant and instrumentation circuits are General Electric CR-151B, as in baker, not D.

CROSS EXAMINATION

BY MR. HOLLER:

Q If I may, Mr. Love, the information that was provided to us during discovery included qualification package on the General Electric blocks, and in there, a reference is made to a General Electric model CR-151D as being located in electrical penetration assembly junction boxes. Maybe you could clarify that.

A [Witness Love] I'm not sure what you're looking at.

MR. HOLLER: If the Board will bear with us, I'm showing the witness a copy of that. I don't know if there is a need to introduce that into evidence. You could just clarify which of the blocks there are.

MR. REPKA: No objection to that.

[Pause.]

MR. HOLLER: Let me pass Mr. Repka a copy. It's the only one I have. The witness is directed to Bates page 004242 in that particular document.

[Pause.]

WITNESS LOVE: The CR-151D terminal blocks addressed here appear to be -- and I believe this is accurate, that they are in control of low-voltage power circuits not on instrument circuits.

I'm not saying there are no CR-151D terminal blocks in Farley nuclear plant. I'm saying that the ones at issue here for instrumentation circuits are CR-151B's.

MR. HOLLER: Yes, sir, that's what we're interested in.

BY MR. HOLLER:

Q So, it is your testimony that the blocks employed in the instrumentation circuits were limited to CR-151B's.

A [Witness Love] Yes, that is my testimony.

MR. HOLLER: I would just if Dr. Jacobus has any comments in regard to that.

WITNESS JACOBUS: I obviously have no way to prove or disprove that statement.

MR. HOLLER: Yes, sir.

As I explained to the Board -- I thank you for the indulgence -- it was so we were clear on that issue.

JUDGE BOLLWERK: Thank you. I think that's very prudent.

Anything else with respect to the exhibits, then?

MR. REPKA: Nothing else with respect to exhibits.

MR. HOLLER: No other questions on that.

JUDGE BOLLWERK: I guess we're ready for cross examination then.

CROSS EXAMINATION

BY MR. REPKA:

Q Dr. Jacobus, your first review of the use of terminal blocks in instrument circuits in Farley nuclear plant was in 1987. Is that correct?

A [Witness Jacobus] That is correct.

Q At that time, I take it you reviewed, among other things, what has been marked as APCo Exhibit 52 in this proceeding, and that is the response to EQ action item 018 and 067, terminal blocks/loop accuracy?

A [Witness Jacobus] That is correct.

Q And that's the discussion of the use of CONAX test report IPS-107. Is that correct?

A [Witness Jacobus] Yes, it is.

Q And the value there used for that report, the analysis done at that time, by Alabama Power Company, used an insulation resistance value of 1E7. Is that correct?

A [Witness Jacobus] That is correct.

Q When you conducted your review in 1987, did you, at that time, review the Alabama Power Company February 29, 1984, letter that has been marked as APCo Exhibit 20 in this proceeding?

A [Witness Jacobus] No, I did not.

Q And I believe you have already testified in sworn testimony that, at the time of the inspection, you had no knowledge of the pre-deadline approach by Alabama Power Company to this issue. Is that an accurate statement?

A [Witness Jacobus] That is correct. I had access to what was provided to me in the qualification file and in response to questions, and that was never introduced to us.

Q Before, during, or following the inspection, were you ever instructed by anyone within the NRC that the basis for your review was compliance pre-deadline? That is, compliance and knowledge prior to November 30, 1985.

A [Witness Jacobus] I'm not sure I quite follow the question. I obviously -- if you're asking the question did I know that the modified enforcement policy was based on compliance as of November 30, 1985, the answer is yes.

Q You knew there was a deadline of November 30, 1985.

A [Witness Jacobus] Absolutely.

Q Did anybody ever instruct you that, in terms of determining compliance, you were to look at a state of knowledge as it existed prior to that deadline?

A [Witness Jacobus] That was implied in knowing that the modified enforcement policy applied as of November 30, 1985.

Q But you were never given any explicit instructions on that.

A [Witness Jacobus] No, I don't believe anybody was, other than knowledge that that was there and that that would -- in enforcement proceedings -- that that would be an important question.

Q You've already testified, also, I believe, that --that you were not involved in the enforcement process on this issue. Is that correct?

A [Witness Jacobus] Only to the extent of the meeting on or about November 24, 1985, at the Atlanta offices, if that is considered part of enforcement.

Q Would you consider that to have been an enforcement meeting?

A [Witness Jacobus] I don't believe that it was so considered.

Q And you did not review the notice of violation.

A [Witness Jacobus] No, I did not.

Q Nor did you review Alabama Power Company's response to that notice of violation.

A [Witness Jacobus] I did review the response after it was provided, at some point. I don't recall exactly when I got the relevant sections. Somebody sent me several pages out of the response. I don't remember exactly when that was.

Q Can you give me a general timeframe on that? Are talking 1987 or 1990?

A [Witness Jacobus] I believe it was probably -- I suspect it was not terribly long after the response was received, but I cannot be certain at all. I have a copy now.

Q Did you have any formal responsibility with respect to that response?

A [Witness Jacobus] No, I did not.

Q Likewise, the order that was issued by the NRC in 1990, did you review that order?

A [Witness Jacobus] No, I did not.

Q Turning back to the inspection in 1987, at that time are you aware of whether the NRC reviewed loop accuracy calculations for instrument circuits?

A [Witness Jacobus] Please ask the question again.

Q Are you aware of whether the NRC, during the inspection, reviewed the loop accuracy calculations for instrument circuits?

A [Witness Jacobus] I am not personally aware. I believe, in the Alabama Power testimony, there was testimony that Dick Wilson reviewed some aspects of those.

Q Okay.

So, you were not personally responsible for reviewing loop accuracy calculations.

A [Witness Jacobus] No.

Q You were only looking at terminal blocks and the value of insulation resistance.

A [Witness Jacobus] That is correct.

Q Okay.

In the course of your review, did you personally or anybody else within the NRC that you're aware of review the 1984 Westinghouse loop accuracy calculations done for Farley nuclear plant?

A [Witness Jacobus] Those were never provided to us, and there was no reason for us to know that those even existed.

Q And you never asked to see that.

A [Witness Jacobus] If I had no idea that they even exist, I would certainly not ask to see them.

Q Sitting here today, can you tell me whether you have any knowledge of whether loop accuracy calculations for Farley nuclear plant changed between 1984 and 1987?

A [Witness Jacobus] I certainly believe that the loop accuracy calculations did change.

Q Would those changes have included -- those changes, I take it, would have involved the value of insulation resistance for terminal blocks.

A [Witness Jacobus] I am not aware of what actually happened, precisely. According to Alabama Power, it, of course, did include that. I don't believe that that should have been required to be done had it been done properly the first time.

Q Okay. But it also included other changes, also, to loop accuracy calculations.

A [Witness Jacobus] That is correct.

Q So, the loop accuracy calculations involved a number of evolving things.

A [Witness Jacobus] That is correct, to the best of my knowledge.

Q So, the 1987 calculations clearly were distinct from the 1984 calculations.

A [Witness Jacobus] They were different.

MR. HOLLER: I was going to ask you to clarify which calculations you're referring to, sir, for the witness. If the witness understands it, that's fine.

WITNESS JACOBUS: I understood.

BY MR. REPKA:

Q Just so that we're all clear here, I would like to refer you to a copy of 10 CFR, section 50.49. Do you have a copy of that?

A [Witness Jacobus] I don't have that with me at this point. I am fully familiar with it. If you read it, I should recognize it.

Q Section 50.49(b) includes a list of electrical equipment important to safety covered by this section. Are you familiar with that list of equipment?

A [Witness Jacobus] Yes, I am.

Q And number one is safety-related equipment. Number two is non-safety-related electric equipment, failure under certain circumstances, etcetera, and number three is certain post-accident monitoring equipment. Are you familiar with that?

A [Witness Jacobus] I am familiar with that, yes.

Q Okay.

In subparagraph 3, the certain post-accident monitoring equipment, is it your understanding that that includes Regulatory Guide 1.97 post-accident monitoring instrumentation?

A [Witness Jacobus] My understanding is that that's particularly what that section refers to.

Q And is that what we're here talking about today in terms of the terminal blocks and instrument circuits at Farley nuclear plant?

A [Witness Jacobus] I don't believe that it is only that.

Q Okay.

There is other equipment, other than post-accident monitoring equipment, involved here.

A [Witness Jacobus] To the best of my knowledge, that's correct. That's what the Alabama Power testimony says.

MR. REPKA: Mr. Jones, let me ask you to respond to that. Are we talking about equipment other than post-accident monitoring equipment?

WITNESS JONES: Well, we're talking about, in addition, reactor protection system equipment, but you know, our position is that equipment performs its function very early in the accident, prior to seeing the harsh environment.

So, essentially what we're discussing here and what is at issue is post-accident monitoring equipment.

MR. REPKA: Thank you.

JUDGE CARPENTER: Mr. Repka, if I may, you and the staff witnesses are so close, you could almost speak without the microphones. I'm having some trouble hearing what's going on.

MR. REPKA: I'll do my best.

WITNESS JACOBUS: Both of us or just him?

JUDGE CARPENTER: Primarily him. I can lip-read you.

[Laughter.]

BY MR. REPKA:

Q Mr. Luehman, in your testimony on this issue, you have repeatedly taken the position that Alabama Power clearly should have known of this issue because of Information Notice 84-47. Is that correct?

A [Witness Luehman] That's correct.

Q Is it your testimony that replacing the terminal blocks in the instrument circuits was the only viable response of a licensee to Information Notice 84-47?

A [Witness Luehman] No, it is not.

Q Have you any -- could you help us out here, and could you explain for me any reason, as you understand it, why a prudent licensee would want to leave the terminal blocks in the instrument circuits?

Do you have any knowledge of such -- of considerations that may be relevant to that decision?

MR. HOLLER: Does the witness understand the question?

WITNESS LUEHMAN: No, I don't.

MR. REPKA: Let me try it another way.

BY MR. REPKA:

Q Could you tell me any reason that you're aware of or that you can think of today why a licensee may want to leave terminal blocks in the instrument circuits, as opposed to replacing them with Raychem splices or some other splice?

A [Witness Luehman] If they can demonstrate that the terminal blocks can perform the function, then there is no reason to replace them.

Q Other than that, you can think of no other reason why they might want to attempt to make such a demonstration.

A [Witness Jacobus] Would you like me to respond to that?

Q I'd like Mr. Luehman to try first.

A [Witness Luehman] Well, I think, like I said, if the -- if the terminal blocks can perform the function that they're required to perform and that's been demonstrated, then there is no reason that the licensee has to replace the terminal block, and I think that goes along with the answer that I gave to the previous question, which is that 84-47 did not mandate that the licensees replace terminal blocks if they could make such a showing.

Q Okay.

Let me turn to your rebuttal testimony, on page 19.

Down toward the bottom of that page, you refer to the affidavit on behalf of the Nuclear Utility Group on environmental qualification of Mr. Noonan, DiBenedetto, and LaGrange, and you quote them as saying that virtually all licensees simply replaced instrumentation terminal blocks.

A [Witness Luehman] That's correct. I see that.

Q Okay.

So, you do not mean to imply, in quoting from that affidavit, that because virtually all licensees did that, that was the only possible thing licensees could do.

A [Witness Luehman] No.

What I meant to -- what I -- what I imply here is simply that -- that it was recognized that it would be very difficult -- most licensees would realize that it was very difficult to qualify or adequately justify the qualification of terminal blocks in instrument applications, and therefore, that's why the majority of licensees chose to -- to remove those terminal blocks from such circuits, and this language would also be consistent that any licensee that chose to leave terminal blocks in such circuits would be on notice, through knowledge like this, that they must be very careful in ensuring that they had adequately qualified them, because the majority of their peer companies had found that that could not be done and changed out their terminal blocks for Raychem splices or some other device.

Q But that was not the only prudent action that could be taken.

A [Witness Luehman] I already stated that.

Q Dr. Jacobus, are you aware of any reason why a licensee may want to leave terminal blocks in an instrument circuit, rather than replacing them with splices?

A [Witness Jacobus] If I understand where your question is trying to go, I believe the answer to that would be things like the fact that it's much easier to go in and calibrate equipment; it's much easier to de-terminate a terminal block than it is to cut apart a splice.

Cost would certainly be a consideration. A Raychem splice is -- the splice material itself is not terribly expensive, compared to the cost of doing the replacement.

The outage time, the time for somebody to go in there and do it, the exposure to the people having to do it -- those are the reasons that pop right into my mind.

Q So, there are valid operational reasons for leaving a terminal block in an instrument circuit if you can show it's qualified.

A [Witness Jacobus] Absolutely.

WITNESS JONES: I'd just like to agree with Dr. Jacobus.

I think it's very important to take in those factors and considerations when evaluating replacing anything in the plant, and they can't be taken lightly and must be evaluated thoroughly, which is what Alabama Power Company did in making the determination that it made.

BY MR. REPKA:

Q With that, let me move forward in time to 1987 and your review of the approach taken by Alabama Power Company with respect to terminal blocks. Specifically now I'm referring to what has been marked as APCo Exhibit 52, and that's the EQ action items, which was the analysis addressing the CONAX data from Connection NSS-3 terminal block.

A [Witness Jacobus] Okay.

Q And you did review this document during the review?

A [Witness Jacobus] Yes, I did.

Q And this document was discussed at the November 25th, 1987 meeting in Atlanta, was it not?
A [Witness Jacobus] Yes, it was.
Q And during the inspection, did you talk to Mr. Love regarding this document?
A [Witness Jacobus] I don't recall specifically what discussions we may have had.
Q Did you talk to him about the issue of instrument accuracy and terminal blocks at all during the inspection?
A [Witness Jacobus] I talked about it with the licensee. I don't remember exactly who I was talking to at various times.
Q Did you have discussions during, surrounding or at the November 25th, 1987 meeting in Atlanta regarding this issue?
A [Witness Jacobus] Yes, we did.
Q Is it fair to say that between those two time frames, Alabama Power Company representatives tried to explain their approach to you?
A [Witness Jacobus] In terms of what?
Q In terms of its technical content and --
A [Witness Jacobus] I mean in what --
Q -- what they were trying to --
A [Witness Jacobus] In what form? I did not talk to them orally, I guess you could say, at the meeting. They

presented a JCO. If that's what you're referring to, yes.

Q But there were no other discussions other than the presentation?

A [Witness Jacobus] I don't recall any telephone calls or such where we talked about the issue, no.

Q Okay. Do you remember who made the presentation for Alabama Power Company at the meeting?

A [Witness Jacobus] I believe Jesse Love made part of it. I think Mr. McDonald spoke for a while. I'm not certain.

Q And at that meeting and in those discussions, did the JCO, which has been marked and admitted -- I'm referring to the November 24th, 1987 JCO marked as APCo Exhibit 59. That also was discussed?

A [Witness Jacobus] That was discussed in fair detail at the meeting, yes.

Q Including, I take it, the basis and assumption for -- that are documented in that JCO were explained or attempted to be explained?

A [Witness Jacobus] To a certain extent, yes. I'm not sure the entire basis for all the statements was discussed during that meeting.

Q Do you have a copy of that document in front of you?

A [Witness Jacobus] APCo 59?

Q APCo 59.

A [Witness Jacobus] Yes, I do.

Q Let me ask you to turn to Figure 1, which is Bates number 0064083.

A [Witness Jacobus] My copy, unfortunately, does not have Bates numbers, but I believe that's the terminal block insulation versus temperature plot.

Q That's correct.

A [Witness Jacobus] Okay.

Q Was that figure discussed at the meeting?

A [Witness Jacobus] Yes, it was.

Q Do you remember any discussion of the basis for that curve at the meeting?

A [Witness Jacobus] Yes, I do.

Q I take it you disagreed with the curve and the shape of the curve?

A [Witness Jacobus] Yes, I did.

Q But did you have any confusion as to what the basis for that curve was?

A [Witness Jacobus] In terms of the fact that it was based on the two endpoint values of insulation resistance in the Sandia test for a particular terminal block. I understood that perfectly.

Q And did you also understand that the two endpoints were taken from the first -- what's been referred as the first DBA of the Phase 2 Sandia testing?

A [Witness Jacobus] Yes, I did.

Q In the February hearings in this proceeding -- I'm referring to transcript page 768 -- you were asked a question by Judge Carpenter regarding the shape of this curve, and one of your responses -- transcript, 768 -- Judge Carpenter asked you, "In presenting this data to you and to the NRC, did Alabama Power indicate that they had ignored the data at the intervening temperatures?" Your response aws, "They didn't explicitly state that, but, of course, all they showed was the endpoint data. So all you can assume is that they didn't consider the remaining data."

A [Witness Jacobus] Okay. I'm not with you yet, but I assume you've read it correctly.

Q Okay. So your testimony at that time was that Alabama Power Company did not consider the remaining data. Were you referring to the remaining data from the first DBA of the Phase 2 testing?

[Witness Jacobus] No. I was referring to the remaining data in the test report.

Q Okay. So is it your testimony that you perfectly understood the basis for that curve, including the endpoints, but it was your position that Alabama Power Company ignored the remaining data from other DBAs within that Phase 2 testing?

A [Witness Jacobus] No, I didn't limit it to the other data from the Phase 2 testing; both the Phase 1 and the Phase 2 testing. The Phase 1 testing is the phase that tested the actual terminal blocks that were used in the Farley plant.

Q Judge Carpenter went on to ask you, "Did you or anyone at the meeting," referring to the November 25th, 1987 meeting, "inquire as to why they hadn't considered the intervening data?" And your answer, "Well, my best guess is that the intervening data shows that it is not linear, and that's not the answer they needed to show."

Are you familiar with that?

A [Witness Jacobus] Okay. Yes. I have that right here.

Q Were you trying to suggest in any way in that testimony that Alabama Power Company was consciously ignoring data in order to reach a desired result?

A [Witness Jacobus] I don't know for sure what they were trying to do. All I can do is see the data that they have presented and show whether or not it is the proper data.

Q Okay.

A [Witness Jacobus] I can't -- I would really be speculating if I went further than that to say what their underlying reason for doing that was.

Q Okay.

So you had no knowledge prior to the meeting, or subsequent to the meeting and prior to this testimony in February, as to what Alabama Power Company's basis was for using exclusively Phase II first DBA data in that JCO curve?

A [Witness Jacobus] Run that by me one more time, please.

Q You had no knowledge at the meeting in November 1987, or at any time subsequent, and prior to this testimony in February, as to what Alabama Power Company's position was regarding why it used only the data from the first DBA of the Phase II Sandia testing?

A [Witness Jacobus] There was some information in that regard in, I believe, a memo from Mr. Love to somebody. It may have been an attachment to the JCO that explained that the reason they did not use the Phase I data. Let me pull it out so that I am accurate in giving the information.

I believe it was Attachment 1 to the JCO, which I believe I received separately from the JCO. The original copy of the JCO that I received is titled Justification for Continued Operation Unit 1 Terminal Blocks Used in Instrument Circuits (minus Attachment 1).

Then, at some point, I did receive Attachment 1. I am not sure when that was, but Attachment 1, I believe, unfortunately, I don't have Bates page numbers on mine, so I can't refer to it.

MR. HOLLER: If Dr. Jacobus could identify the title, perhaps we could help the Board and give them the corresponding Bates numbers.

WITNESS JACOBUS: APCO 59 is the exhibit number.

MR. HOLLER: But the title of Attachment 1, just so we make sure.

WITNESS JACOBUS: The title of Attachment 1 is Additional Clarification Regarding the Qualification of States NT/ZWM and GECR151B Terminal Blocks at Farley Nuclear Plant Units 1 and 2 and Low Voltage RPS/ESFAS and ERP Transmitter and RTD Circuits.

MR. HOLLER: For the record, that would be Bates No. 0064084.

WITNESS JACOBUS: Do you want to give me a copy with the numbers on it?

MR. BACHMANN: Yes.

WITNESS JACOBUS: I believe what I would refer to is Bates 64088. There it talks about the electrical configuration of the Phase I test, and Alabama Power's stated basis for not using that data.

BY MR. REPKA:

Q So you were aware of that stated basis?

A [Witness Jacobus] Yes, I was.

Q And that was explained to you at the meeting in

November of 1987?

A [Witness Jacobus] Yes, it was, and I did not agree with it.

Q But you were aware that there was a basis?

A [Witness Jacobus] Yes.

Q When you referred to th attachment, you said you weren't sure you got it at some time subsequent. Can you fix that . little more closely in time, and are we talking November?

A [Witness Jacobus] I got it November 24th at 10:50 a.m.

Q That helps immensely.

A [Witness Jacobus] Actually, I may have gotten it November 25th at 8:34 a.m. It looks like it was originally faxed to somebody November 24th at 10:50, and then probably to me on 11/25 at 8:34.

Q But there was documented rationale for why Alabama Power Company drew the curve the way it drew it, based on for why they used the data they used?

A [Witness Jacobus] To a certain extent, yes.

Q You didn't agree with it?

A [Witness Jacobus] Yes, I will accept that.

Q You referred particularly to the so-called "serpentine connection" in the Phase I data, is that correct?

A [Witness Jacobus] I referred to it?
Q The discussion in here.
A [Witness Jacobus] Yes, the discussion in here on 64088, under Electrical Configuration of Phase I Test, does go into the serpentine configuration.
Q And that was one of the stated rationale for not using Phase I data from the Sandia report?
A [Witness Jacobus] That was so stated.
Q With respect to the Phase II data, do you disagree that Sandia, in fact, used successive DBAs in that testing in their profile?
A [Witness Jacobus] It depends how you define DBA. The intent of the testing was to expose it to the IEEE-323 standard profile for qualifying equipment for a single DBA in a generic sense. In that sense, there is one DBA.
I believe Alabama Power's argument is, you can subdivide that into three DBAs, each of which envelopes the Farley Plant conditions. Therefore, they consider it as three DBAs. In fact, it was intended to represent one generic DBA according to 323 1974.
Q In November 1987, did you understand that Alabama Power Company had taken such a position that the Phase II data, in fact, represented, or could be construed to be three successive DBAs?
A [Witness Jacobus] I don't recall at this time

those discussions exactly, what there were of those.

MR. REPKA: Let me turn to Mr. Love.

Mr. Love, in November 1987, was there any discussion by you or anyone else from Alabama Power Company of the Phase II data, what the company's position was with respect to the shape of the profile?

WITNESS LOVE: Yes. I believe that that was explained, and we attempted to make that basis clear.

MR. REPKA: And you explained why you used the data from what you have characterized as the first DBA in the Phase II testing?

WITNESS LOVE: Yes, that is true.

BY MR. REPKA:

Q Dr. Jacobus, within the Phase II testing, would you agree with me that there was, because of the successive nature of the DBAs, from one DBA to the next there was some terminal block degradation in performance?

A [Witness Jacobus] There appears, based on the data, that there may have been some. There are also other factors of which I admit Alabama Power does not have complete access to that would tend to change that conclusion somewhat.

For example, the data at 95 degrees C between the first and second transient, the first and second transient was not really taken exactly at 95 degrees C.

I have brought with me some data that I was able to dig up that shows the actual exact temperature profiles, if you wish to see that, and allow --

Q I have no desire to see that.

MR. HOLLER: If Dr. Jacobus needs it for his answer.

MR. REPKA: I am not sure that is really germane to my question.

WITNESS JACOBUS: Your question was, was there degradation, and one of the things that tends to imply that there was degradation is looking at the straight line drawn between the two end points from the first --

Let's use the surrebuttal testimony of Alabama Power, and it will become somewhat more clear. If you turn to what Mr. Love has referred to as Figure IR-3 on page 170 of his surrebuttal testimony, I think the explanation will become somewhat more clear.

MR. REPKA: I'm with you.

WITNESS JACOBUS: If we look at plots A and B on that page, plot A is the first -- what has been referred to as DBA -- we'll use that terminology -- and plot B, which is the second DBA, it would appear that, going from plot A to plot B, the terminal block performance has degraded.

However, if you look at the actual temperature at which the right end point of plot A was taken at, you will find that the temperatures in the test chamber fell down as low as 72 degrees C when that data was taken.

In plot B, the right end point was taken at temperatures between 90 and 100 degrees C, it would appear.

BY MR. REPKA:

Q It would appear from what?

A [Witness Jacobus] From actual plots of the temperatures that were taken during the test.

Q Published plots?

A [Witness Jacobus] Not published plots.

Q Data available to Alabama Power Company?

A [Witness Jacobus] No. But it is -- it is incumbent upon Alabama Power Company, if they're going to use data out of a test report, to know completely the source of that data, what it means, how it was taken, and what its uses are.

Q I'll submit to you that Alabama Power Company is not using the data from the Sandia report to qualify its equipment.

A [Witness Jacobus] You're the one who is asking me questions about that data, and your testimony is the one that says that it shows that -- that they will work.

Q Okay. Let me back up. My question to you was --

JUDGE CARPENTER: Mr. Repka, if I could interrupt, you know, you all are jumping from document to document. Please be merciful. Let the Board catch up with you. Which page are you looking at?

MR. REPKA: I believe Dr. Jacobus is looking at page 170 of the surrebuttal testimony. That's a figure that has been labeled as IR-3, insulation resistance versus temperature.

JUDGE CARPENTER: I have it now. Thank you.

BY MR. REPKA:

Q Dr. Jacobus, you were referring to the end points that are shown on the plot between 100 degrees C and 90 degrees C, the right side of the plot, as it were?

A [Witness Jacobus] The data points at what's identified here as 95 degrees C.

Q And you're telling me that the data points are wrong, because they are not based on the real temperature.

A [Witness Jacobus] The real temperature during the time that data was taken was not exclusively at 95 degrees C.

Q And that real temperature was or was not available to Alabama Power Company?

A [Witness Jacobus] That was not, the idea being, in the test report, that 95 degrees C was chosen as the temperature that would represent roughly what happens during cooldown, and 95 degrees C, if you happen to know anything about Albuquerque, you would recognize that is roughly the saturation temperature of steam at the ambient pressure in Albuquerque, and that was chosen as a number to represent "cooldown."

It was never intended to be used to draw straight-line plots between -- between data points. There was lots of data at temperatures in between those points, and -- and there would be no need to draw that kind of a line.

MR. REPKA: Okay.

I'm going to Alabama Power Company and ask for a response to that.

WITNESS JONES: I just want to make sure I'm clear, Dr. Jacobus. Are we stating here that the data in the Sandia report is wrong?

WITNESS JACOBUS: The data is not wrong. The data is taken -- it's represented as a temperature of 95 degrees C. If you're aware of qualification tests, you will know that, when there is a cooldown between the two transients, the temperature is not controlled.

There is no effort to control that, and I think, certainly, Mr. DiBenedetto is well aware of that fact. Because there was a desire to know what happens in the cool-down portion of the test, Mr. Kraft chose a value of 95 degrees C to represent that.

WITNESS LOVE: I might just add that -- I mean that's -- I guess I'm very surprised in that the data is recorded indicating a temperature and also indicates that there were many, many data points at that -- at that value, and that was the reason for drawing the whisker plot for having the median point, the lower, and the upper quartile point at that temperature.

So, I am totally confused by this at this point.

WITNESS JACOBUS: The idea was never to take those end points and draw a straight line. There was ample data at interim temperatures that it was inconceivable that somebody would -- would do such a thing.

JUDGE CARPENTER: Let's go back to how we got started on this, which is your comment, as I think I heard -- and I was also fumbling with papers.

The Sandia data do not demonstrate any degradation of these phenolic/glass-filled blocks after they're exposed to design basis accidents, harsh environments. There is no suggestion of that.

WITNESS JACOBUS: No, I did not say that.

JUDGE CARPENTER: Then I stand corrected. I believe you said some.

WITNESS JACOBUS: Yes.

JUDGE CARPENTER: So, tell me what you mean by some.

WITNESS JACOBUS: Well, it's very difficult to determine precisely. It would appear -- you can look -- referring, for example, to the figure IR-3 on -- on the surrebuttal testimony at page 170 -- are you with me there?

JUDGE CARPENTER: I have the figure.

WITNESS JACOBUS: Okay.

If you will notice, between the two data points at 175 degrees Centigrade, the top one, at 5.92 times 10 to the 4 -- do you see that one?

JUDGE CARPENTER: Yes.

WITNESS JACOBUS: That was taken during the first transient.

The lower one, at 3.67 times 10 to the 4, was taken during the second transient. Okay?

Presumably, we could assume, roughly, that the degradation between the first and the second exposure to 175 degrees C is represented by the difference between those two points, in a rough sense.

JUDGE CARPENTER: I don't believe I'd go quite that far. There may be some bounding limit on how small these values can get. So, I don't think that really answers the question.

Why do you not look at the block's performance at the beginning of the exposure to the environment and the block's performance at the end of the exposure at roughly the same temperature?

If you think there is a real significance in 5 to 10 degrees Centigrade that can account for several orders of magnitude, we need to hear about it.

WITNESS JACOBUS: Okay.

I think, if I understand correctly, what you're saying is look at the pre-test data and the post-test data at ambient temperature?

JUDGE CARPENTER: In answering the question did the test environment cause a permanent change in the block?

WITNESS JACOBUS: Right.

JUDGE CARPENTER: Does the block come back out of it just the way it went in?

WITNESS JACOBUS: The answer to that question is no, and let me expound on that just a little bit.

If you read in the test report, Mr. Kraft says that there is roughly a two-order-of-magnitude permanent degradation in the terminal block insulation resistance from pre-test to post-test.

JUDGE CARPENTER: Thank you. That specifies what you meant by some.

WITNESS JACOBUS: Now, let me go on. I have to finish this answer.

Those are at dry conditions. Those are not at wet, moist conditions. The thing we're concerned about here is what happens under wet, moist conditions. Okay?

So, looking at the pre-test dry versus the post-test dry gives you no idea of what happens during the high-moisture part of the accident. Okay?

Because the moisture on the terminal block is the governing mechanism, the insulation resistance of the film itself is much, much lower than the insulation resistance of the terminal block material itself.

JUDGE CARPENTER: I can't avoid, Mr. Repka, asking a question.

Where in the Sandia report are there observations to support what you just said, measurement of the bulk block resistant when it's saturated in a steam environment and has taken up all the water it can take and all the chemical degradation reactions that can go on in that block between the glass fill and the phenolic have taken place? I haven't seen measurements of the bulk resistance of the material. If I missed it, tell me.

WITNESS JACOBUS: Okay. The bulk resistance in the material is very, very high. That is not a concern at all in these proceedings. It's the moisture film itself, it's a film of water on the terminal block that can form and evaporate that is what causes the decrease in insulation resistance. It has nothing to do per se with the block material itself.

If the material has a resistance of --

JUDGE CARPENTER: You are testifying to that, and I'm simply asking you where I can find the data.

WITNESS JACOBUS: Well, there are a number of places. I'll have to -- it may take me a few minutes. Perhaps it would be better if we do that at a recess and I give it to you afterwards or I can --

JUDGE CARPENTER: That's fine.

WITNESS JACOBUS: -- take the few minutes now.

JUDGE CARPENTER: That's fine.

WITNESS JACOBUS: Okay.

JUDGE CARPENTER: Excuse me for interrupting, Mr. Repka.

MR. REPKA: Are we taking a few minutes to look at data? Is that where I understand we are?

WITNESS JACOBUS: Let me at least make a note.

JUDGE CARPENTER: All I did was clarify what the word "some" meant, was my purpose.

WITNESS JACOBUS: Right. What I was trying to do is clarify it in terms of the wet conditions, and there were subsequent wet conditions at the same temperature at 340, roughly 340 degrees, 172 degrees C. There were two measurements taken at different times into the accident. So you are looking at data at the same temperature, but under the wet conditions that are applicable during the accident.

JUDGE CARPENTER: I think it may be useful for me to acknowledge that I've probably spent 200 hours reading Staff Exhibits 73 and 74. I've consulted with a number of experts on conductivity at the Bureau of Standards, et cetera, and I'll have some questions this afternoon.

WITNESS JACOBUS: Okay.

JUDGE CARPENTER: So those details, I thank you for reminding me, but don't be surprised if I'm familiar with them.

WITNESS JACOBUS: All right.

MR. REPKA: Judge Carpenter, are you --

JUDGE CARPENTER: I don't want to interrupt any more.

[Laughter.]

JUDGE CARPENTER: I was just trying to get "some" into some number.

MR. REPKA: I have no difficultly. I was just trying to ascertain whether you were done.

BY MR. REPKA:

Q Let me try to get back to first principles here. In my simpleminded kind of way, I just want to understand, I mean, do you, Dr. Jacobus, or do you not agree that, through successive DBA cycles, there would be some degradation in the block? Just yes or no.

A [Witness Jacobus] Yes. There may be. It is not clearly established. A much more important factor --

Q Let me try something first before you tell me the rest of the important ' ctors. In your February testimony in this hearing, there was a discussion of again why Alabama Power Company chose to use data only from the Phase 2 first DBA.

A [Witness Jacobus] Okay.

Q And you said, and let me quote, "They took the data from that first transient where there was only data from ambient temperature in 340 degrees. The data I used," and I think you are referring here to your exhibits and graphs in this proceeding, "was from the second transient where, in addition to data at the peak temperature, there was data throughout the range of temperatures coming back down to essentially ambient temperatures."

Do you recall that?

A [Witness Jacobus] I recall I probably said something to that effect.

Q Okay. Judge Carpenter interjected, "So there is a certain amount of hysteresis here depending on the cycle." Your answer was, "Exactly."

Do you now disagree with that testimony?

A [Witness Jacobus] I wouldn't -- I think the word hysteresis is probably the wrong word, thinking about it more completely.

Q Well, as I understand the word, it would be there is some change or effect due to what has happened to that terminal block in preceding cycles. It's performance is going to be affected due to what it was subjected to in a prior cycle. Am I wrong?

A [Witness Jacobus] Okay. Hysteresis normally refers to, for example, a calibration curve, where you do a calibration going up in, say, pressure, and then you do the same calibration coming down in pressure.

The difference that you get between the readings at the same pressure on the way up and the way down are different. In that sense, it is exactly true that there is a hystoresis in these terminal blocks. In other words, if you applying the steam environment and the terminal block is heating up, the insulation resistance is much lower than when you are drying the terminal block, for example, between cycles, and the terminal block is cooling down and the insulation resistance recovers. So, if you went up and then came down, you would expect that the insulation resistance on the way up would be lower at the same temperature than it would be on the way down.

Q Let me try it this way. If I am going to subject to two cycles a particular terminal block, and I go up to temperature X and then down, then I start another cycle and I go up to temperature X prime, and then go down, do you expect the performance of the block between -- of X -- at X and at X-prime to be the same?

A [Witness Jacobus] X and X-prime being equal?

Q Yes. Being equal temperatures?

A [Witness Jacobus] Well, that's the data in, for example, on page 170 of the surrebuttal testimony shows that it will be slightly lower, at least for that particular terminal block. For other terminal blocks, if you look at the appropriate error bands, it's not quite so clear. It also depends on what the cooldown temperature is between cycles. It depends on a whole lot of things.

Q Okay. But that is a reason to not draw your curve, based on data from two separate cycles, is it not?

A [Witness Jacobus] If you don't have any other data from the first cycle, and you need certain data that is only available in the second cycle, no, I don't believe that's a valid reason.

Q Okay. So you would draw your curve, and, in fact, have drawn your curves based on data across cycles?

A [Witness Jacobus] Only because that's the data that's available. I have also looked at data from other tests and it confirms that that's the appropriate thing to do.

Q Okay. Alabama Power Company's position, regarding why it drew its curve, based on data from only one cycle, was well-known to you in 1987, was it not?

A [Witness Jacobus] Whether it was or was not I don't think is really that relevant.

Q I'm just asking the question.

A [Witness Jacobus] I would not agree with it then, I would not agree with it now, so --

Q Was it made known to you?

A [Witness Jacobus] As I mentioned before, I can't be certain of what exactly the discussions were in that regard.

Q This hearing was not the first time you heard that position, was it?

A [Witness Jacobus] That's correct.

Q there's something you just said a few minutes ago, in your response to Judge Carpenter, I can't resist getting a response to from the Alabama Power Company panel. You said, and I wrote this down as quickly as I could: "Bulk resistance is not at all an issue in this proceeding. What we're talking about is a moisture effect."

MR. REPKA: Mr. Love, would you like to respond to that?

WITNESS LOVE: This has been the hypothesis that Dr. Jacobus has been using ever since 1987. However, I have not seen either in the Sandia documentation demonstrated proof that the phenomena is predominated by the moisture film and ionic conduction. Bulk conduction -- the test was just simply not structured to conclusivel[illegible] that. I do not believe that it has conclusively proved that.

WITNESS JACOBUS: May I respond to that? I think that's just a ridiculous conclusion, in looking at the Sandia data. If you look at -- if you look at that data in any detail at all, it repeatedly says in there that the moisture is the effect. It demonstrates over and over again, reasons why that is the case.

WITNESS LOVE: May I just respond? I agree that there are sections of the report that attempt to prove this by analysis and various means. All I am simply saying is that the test, itself, was not structured in a manner that it could have been structured to demonstrate that the effects of bulk conduction in the terminal block and also the effects of conduction through the test leads were not the significant contributor to the values that were being determined.

There was no -- the test was not structured to be able to separate those effects. So, what it did was it provided data on the total effects, as recorded, of bulk conduction in the block, bulk conduction, as it may occur through the test leads and the conductors that were monitoring the circuits and also the effects of the moisture film. So, all those possibilities exist, and there were attempts made in analysis and documentation, to try to demonstrate that the moisture film was the predominant factor in some regime.

I am simply saying that the test, itself, through the methods that were used, did not conclusively prove that, because the test was not set up that way.

WITNESS JACOBUS: I'm not sure what Alabama Power considers conclusive proof. But, as far as we're concerned, it was conclusively shown. We have done numerous tests of cable lead wires, testing entire cables. The insulation resistance of the cable lead wires is orders of magnitude greater than insulation resistance of terminal blocks. So, the issue of cable lead wires is not an issue.

The bulk conduction through the material -- it's a phenolic material. The conduction through a material like that does not change significantly with temperature. The only thing left is the moisture film.

BY MR. REPKA:

Q Dr. Jacobus, did the Sandia testing include an elevating temperature test to the terminal blocks in a non-steam environment?

A [Witness Jacobus] No, it did not.

JUDGE CARPENTER: Mr. Repka, may I interrupt?

Dr. Jacobus, could you give me a reference to what you just testified to? I didn't see any reference in the Sandia reports to what you just testified to.

WITNESS JACOBUS: Okay. That's largely the same question that you asked before that I'll look up at the break, if you prefer, or I can do it now, if that's acceptable.

JUDGE CARPENTER: No, no. I just --

WITNESS JACOBUS: I mean, that's very related.

JUDGE CARPENTER: I just want the record to be clear that, based on two staff exhibits, the reader can't learn that. Nowhere does it say see reference so and so which shows A, that the block has negligible conductivity as installed or as delivered; and B, that conductivity doesn't change in the steam/sodium hydroxide environment.

WITNESS JACOBUS: That conductivity does not?

JUDGE CARPENTER: Yes. Resistance doesn't go down?

WITNESS JACOBUS: Due to the elevated temperature, the bulk resistivity of the block does not change appreciably, compared to the insulation resistance of the moisture film; i.e. it is an irrelevant parameter. If it changes from 10 to the 10th down to 10 to the eighth --

JUDGE CARPENTER: We're going to talk about the conductivity and moisture films after a while. But I just wanted to find out did I miss a reference? It is a very critical data point.

WITNESS JACOBUS: It may not explicitly be in there. Now, there are -- there's published data from manufacturers that gives resistivity of phenolic materials at high temperatures that you can look at. There's published -- well, not necessarily published data, but there are test reports of cables, to address the issue of the lead wires. I don't know if we want to continue with that one or not. But, in terms of bulk conduction, you can look at the manufacturer's data or other published data that tells you that the insulation resistance does not go from 10 to the 12th down to 10 to the fourth, in going from ambient temperature up to 340 degrees.

JUDGE CARPENTER: That would be remarkable if it did.

WITNESS JACOBUS: Does not change significant relative to the types of values --

JUDGE CARPENTER: I understand what you are saying.

WITNESS JACOBUS: -- that were measured in the Sandia Test. It doesn't go from 10 to the 12th down to 10 to the fourth.

JUDGE CARPENTER: My references -- you mentioned those numbers as thermistors, you know. It was very exciting when people found thermistors that changed, by orders and orders of magnitude over a few hundreds of degrees. It's a wonderful thermometer, this terminal block here, with this enormous temperature coefficient of the film.

WITNESS JACOBUS: Yes. I am not saying there is not effect of bulk condition.

JUDGE CARPENTER: That's my only point -- that it's an open question in this record.

WITNESS JACOBUS: Okay. Fine.

BY MR. REPKA:

Q Okay. Before that interlude, I think you testified that there was, in the Sandia testing, no elevated temperature test in the non-steam environment?

A [Witness Jacobus] That's correct.

Q On page three of the Sandia test report that's been marked as Staff Exhibit 73, it is observed that a submergence test indicated, and I quote: "Only slight difference between submerged and unsubmerged bloc..., with the submerged blocks being slightly better."

A [Witness Jacobus] What line are you reading from? Okay. I have got it.

Q Okay. Do you see that?

A [Witness Jacobus] Yes. Keep in mind, this is the insulation resistance after submergence, not during submergence.

Q After the submergence. So there was no monitoring done during the submergence itself?

A [Witness Jacobus] Yes there as. It says -- if you go back to the part in the report that refers to that, I can take you to that. It says the values went down to things like 10 ohms to a hundred ohms, something like that. I don't recall exactly the numbers.

During the submergence. The idea in this test was that we'll look at them after the submergence so we can see what happens when you're in a moisture environment, and you have blocks that are positively known to be contaminated with the spray solution.

Q Why isn't any effect from the chemical spray observed during the Phase II testing?

A [Witness Jacobus] Based on the data that he presents, he comes to the conclusion that the effect was not significant for the configuration used in the tests.

Q And that does not, in any way, undermine your conclusion that it is entirely a moisture film effect?

A [Witness Jacobus] I never said it was entirely a moisture film efrect. I said the moisture film effect is dominant.

Q The fact that there was no effect of the chemical sprays doesn't change your hypothesis?

A [Witness Jacobus] There was an effect to the chemical sprays.

Q There was or there wasn't?

A [Witness Jacobus] I am thinking back to the submergence test where there was positive contamination imparted on the terminal blocks, and it says the submerged blocks were lower, on page 3 that you referred to.

It says, "To check this result at the conclusion of the Phase II environmental exposure, we conducted a submergence experiment to observe the performance of terminal blocks positively known to be spray contaminated. In this test three blocks were submerged in a chemical spray, and steam condensate solution, and three blocks were left unsubmerged. IRs in a steam environment after the submergence were compared. They indicated that there was only slight differences between submerged and unsubmerged blocks, with the unsubmerged blocks being slightly better."

Q And your testimony is, the unsubmerged blocks means after -- that is a comparison after you have done the submergence, not during?

A [Witness Jacobus] That is what it says, and that is what it was.

Q But there was no effect of the chemical sprays, you are agreed with that, was observed?

A [Witness Jacobus] Being submerged in the chemical sprays, or having the chemical sprays in the test?

Q Having the chemical sprays in the test?

A [Witness Jacobus] He did not identify any positive effect of the chemical spray.

Q Would you agree with me that if bulk material conductivity was an issue here, and I know it is your position that it is not, would that result in a predictable IR versus temperature curve?

A [Witness Jacobus] It should. Bulk conductivity normally follows an Arrhenius relationship of one form or another which predicts the type of plot that Alabama Power has used in these proceedings.

Q In fact, that conclusion is supported by instrument insulation resistance testing on cables, is it not?

A [Witness Jacobus] For bulk conduction, that is correct. I have some extremely nice plots of that effect from the recent tests that I have completed.

Q Putting all that aside, and let's move on to something a little more fundamental.

Would you agree with me that regardless of the mechanism, moisture film versus bulk conductivity that a basic IR dependence on temperature has been established?

A [Witness Jacobus] Temperature is a very important factor, there is no doubt about it.

Q And you reviewed Alabama Power Company's surrebuttal testimony in this proceeding, right?

A [Witness Jacobus] I have.

Q And it is still your position that that dependence is not linear?

A [Witness Jacobus] Linear or not, it is my position that the two points that Alabama Power chose and the curve that was subsequently drawn does not square with reality, and that reality is test data from General Electric, from Wyle, from Connectron, from data that was taken and reported in the Sandia test that was done at Temple University by Solomon. The reality check just doesn't cut it.

Therefore, regardless of why it is wrong, the fact in my mind is that it is wrong. It doesn't really matter why it is wrong. You have to do a reality check.

Q You are saying it is wrong. What is the it?

A [Witness Jacobus] The results of that straight line, and using that to predict the insulation resistance versus temperature.

Q Is it the acceptance criteria used by Westinghouse that you believe is wrong, the 1E5 acceptance criteria?

A [Witness Jacobus] 1E5, are we using a new value, or are we going to use the 5E5?

Q 5E5.

A [Witness Jacobus] I have never disputed that.

Q Is it the value of 1E7 that was used in the loop accuracy calculation that is wrong?

A [Witness Jacobus] I believe that was an incorrect value to use for the insulation resistance of terminal blocks at elevated temperatures, yes.

Q And you believe that is wrong strictly because of the shape of the curve?

A [Witness Jacobus] No. I believe it was wrong because it was taken at 150 degrees fahrenheit.

Q Does it matter what temperature it was taken at, if it truly reflects the blocks involved, and its performance as it is used in applications at Farley Nuclear Plant?

A [Witness Jacobus] Wait a minute. Let's get some detail on your last statement there.

Q If you use a value of 1E7 in your instrument accuracy calculations, and that value reflects the performance off those blocks at a point in time in the Farley accident scenario of when those blocks would be used, does it matter when that value may have been taken?

A [Witness Jacobus] Yes, it matters. Of course, it matters, you can't just say, because I fortuitously selected a proper value, even if later on you show that value is acceptable, which I am not acknowledging in this matter for the record, that does not make your original analysis correct.

Q So you disagree that the proof of the original analysis is in the performance?

A [Witness Jacobus] I certainly disagree with that. You may come to the same conclusion in a hypothetical example, but that does not say that your original analysis was correct.

Q What are we talking about here. You have to agree with the analysis, or the results of the analysis?

MR. HOLLER: Let me ask if the witness understands which analysis Mr. Repka was asking about now?

BY MR. REPKA:

Q Let's talk about the APCO Exhibit 52, the analysis based on similarity to the Connectron box, test data from CONAX IPS-107 and the resulting conclusion there to use a value of 1E7. That is the analysis I am talking about.

A [Witness Jacobus] Do I have to agree with the analysis to agree with the conclusion?

Q Right.

A [Witness Jacobus] Not necessarily. If do my own analysis, and do a licensee's work for them and come to that conclusion, I can believe the answer without believing that the steps that were followed to get to that answer were appropriate.

Q So you can conceptually agree with the conclusion without agreeing with the analysis, because the conclusion may be supported by your own analysis?

A [Witness Jacobus] Or somebody else's, or whatever.

Q So the proof is in the pudding?

A [Witness Jacobus] No. That is not the proof of the analysis.

Q You may disagree with the analysis, but does not the result tend to support the original validity of an independent engineer's analysis?

A [Witness Jacobus] No. If A implies B, B does not imply A.

Q If A implies B, if Alabama Power Company says A implies B, and you say, "No, A does not imply B," then a third party says, "B is B," are you saying --

A [Witness Jacobus] B does not imply A, Philosophy I.

Q Does the fact that B has been borne out, does that not tend to enhance the credibility of the original A implies B argument?

A [Witness Jacobus] No. That does not follow basic philosophy. It does say that the conclusion is right.

Q It says the conclusion is right. You have agreed with that.

A [Witness Jacobus] If you independently show that the conclusion is right, that does not in any way imply that the analysis is right.

Q The implication you are drawing is that there is only one way to get to a result?

A [Witness Jacobus] No. Not at all.

Q So there are many ways to get to a result?

A [Witness Jacobus] You could say I pulled it out of the air. Now they later on do an analysis, and it fortuitously comes out the same way. Therefore, pulling it out of the air was correct.

Q Did Alabama Power Company tell you they pulled their answer out of the air?

A [Witness Jacobus] You know that is not true.

Q Did they tell you that?

A [Witness Jacobus] No.

Q Did they have an engineering basis for their position, regardless of whether you agreed with it or disagreed with it?

A [Witness Jacobus] They had one written down, yes.

Q Thank you.

JUDGE BOLLWERK: We're about at the time for our morning break. Are we at a breaking point, Mr. Repka?

MR. REPKA: I think this is a good time.

JUDGE BOLLWERK: All right. Why don't we take 15 minutes?

[Recess.]

JUDGE BOLLWERK: Mr. Jacobus, do you have the answer to Judge Carpenter's question? Would you like to give him that first?

MR. REPKA: I have no objection to that. Mr. Holler and I have discussed it, chough, I represented that, absent some tangent I don't know about, I could wrap up in a couple of minutes, an... ..en Mr. Holler could pick up that as part of his redirect.

JUDGE BOLLWERK: All right. Why don't we do that? That's fine. That's no problem.

BY MR. REPKA:

Q First question: Dr. Jacobus, phase one of the Sandia testing, do you know whether or not that phase one testing including chemical spray?

A [Witness Jacobus] No, it did not.

Q You've referred in your testimony in several places -- page 39 is one place -- and I think also this morning to a 1973 GE test report.

A [Witness Jacobus] The page again, please?

Q Page 39 is one page on which you referenced it.

A [Witness Jacobus] Okay. Yes.

Q I think 35 and 36 it's also referenced. It's a November 6, 1973, GE test report.

A [Witness Jacobus] Yes.

Q Are you with me?

A [Witness Jacobus] Yes.

Q The reference on page 39, is that also to the November 1973 report?

A [Witness Jacobus] Yes, it is.

Q Do you know whether that test involved an acceptable LOCA profile for qualification testing? Was the profile used in that test a LOCA profile?

A [Witness Jacobus] It was intended to be, yes.

JUDGE CARPENTER: Mr. Repka, is that test report in evidence?

MR. REPKA: That test report is not in evidence.

JUDGE CARPENTER: So, I can't follow this by looking at it.

MR. REPKA: That's not in evidence.

WITNESS LOVE: I don't know if it's in evidence.

MR. REPKA: No, it is not.

JUDGE CARPENTER: May I respectfully ask whether the parties feel that they want to make any findings with respect to that report and, if so, whether or not it might be desireable to have it in evidence?

MR. HOLLER: We certainly have a copy, Judge Carpenter, and for the staff's part, we made reference to it, and if you would find it helpful, we can have copies made and then introduce it on redirect or, probably more appropriately, in our cross examination. We could do that.

JUDGE CARPENTER: As I say, Mr. Holler, I defer to your judgement whether it's something you want to make a finding of fact about. I mean, if that's so, then we have to look at the report.

MR. REPKA: Just for clarification purposes, I'd like to ask our panel, is that November 1973 GE test report part of or has it ever been part of Alabama Power Company's basis for qualification of these terminal blocks?

WITNESS LOVE: The only purpose of that document was a -- as I believe I testified to in my surrebuttal testimony, it was attached to -- and some information was used from it in regard to a similarity analysis on materials that was done by me in the 1983-84 timeframe.

It was not used in conjunction with leakage currents and -- and the -- the effects on instrument circuits.

MR. REPKA: So, it was a similarity between --

WITNESS LOVE: Materials.

MR. REPKA: -- in the States NT versus the States ZWM.

WITNESS LOVE: It was related to the barrier between the terminal blocks, a similarity analysis I had done back in the mid-'80s on the difference in the barrier material on the blocks. So, it was for material composition analysis.

MR. REPKA: So, the company is not relying on that report as a basis for qualification with respect to the instrument accuracy issue.

WITNESS LOVE: We are not, no.

BY MR. REPKA:

Q And Dr. Jacobus --

A [Witness Jacobus] Can I respond to that real quick?

Q Let me just ask you one question. Then you can respond.

A [Witness Jacobus] Okay.

Q The difference between the States NT and the States ZWM is not in issue in this proceeding, is it?

A [Witness Jacobus] That's correct.

Q Okay.

A [Witness Jacobus] Okay.

He was fairly specific in saying we are not relying on that report for purposes of instrument accuracy. I don't know if that means we're not relying on that report at all.

However, I think the record should note that that report forms the basis for the statements in the qualification report that Alabama Power was relying on at the time of the inspection, that being the GE summary report.

I think it's called an engineering memorandum or something, and I know it's been introduced into evidence.

Q I believe that's a different report.

A [Witness Jacobus] It's a different report, but the information that is in there, though it does not explicitly reference it, refers back to that 1973 GE test report, and to say that one terminal -- the one report we used as qualification and that the basis for the values in that report, the other report that was written, we don't rely on doesn't make any sense to me.

Q I don't have any quibble that you could -- you're perfectly entitled to use something in that report as a basis to disagree with Alabama Power Company's position. I don't have any quibble with that, if it's technically valid.

What I'm just asking here is was the data in that report used to support the Alabama Power Company's position?

WITNESS LOVE: For the issue of instrumentation performance in the harsh environment, no.

WITNESS JACOBUS: Was it used for any purpose?

WITNESS LOVE: It was associated to the -- we've also testified to the -- I believe -- the '75 report for the electrical penetration assemblies, which documents the withstand capability or the ability of the block to withstand peak LOCA conditions and survive peak LOCA conditions.

In that context, it is used, but we have not used it as a basis for the performance of the terminal block; that is, the characteristic of the block to show its recovery or its ability to operate when required to operate in instrumentation circuits at Farley.

MR. REPKA: Does that include, Mr. Love, data with respect to insulation resistance post-LOCA, during the LOCA?

WITNESS LOVE: That particular report indicates a peak value of -- or the value of peak temperatures, and as we have testified to previously, that was used as the withstand capability parameter; in other words, the minimum value that would be consistent, indicating survivability I believe is the word I used or sufficient. I've -- I've testified to this previously.

MR. REPKA: Okay.

WITNESS JACOBUS: Let me comment on that, if I may.

He says that that was taken at peak LOCA conditions.

I submit that, looking at the test report, that was taken at lower than peak LOCA conditions, before peak LOCA conditions were ever attained, and in fact, it was taken at 260 degrees Fahrenheit, the temperature we are not told the blocks are required to function at.

MR. REPKA: Okay.

BY MR. REPKA:

Q So, the use you're making of this test report is you believe that this test report does, in some way, underline the power company's position on insulation resistance and the use of terminal blocks in instrument circuits.

A [Witness Jacobus] I think it's definitely a contributor to doing that, yes.

Q Okay.

Now, my question to you, which started this whole thing, is do you know whether it was a LOCA test utilized in that 1973 testing?

A [Witness Jacobus] I don't know what you mean by a LOCA test. It was an exposure to elevated temperature and pressure conditions, yes.

Q Okay.

Would that have been an acceptable qualification profile if you were reviewing it strictly as a qualification profile document?

A [Witness Jacobus] For the Farley nuclear plant? Would the profile have been acceptable?

Q Right.

A [Witness Jacobus] I would have accepted that as profile, yes.

Q Okay.

MR. REPKA: Now, I'm going to ask Mr. Love to respond to that, the issue of the GE test report and the applicability of the profile to the Farley --

WITNESS LOVE: Well, this was a very early GE test that was essentially conducted by putting the blocks in a, as I understand reviewing the reports, a very brief report, a couple of pages with some data. They put a terminal block in a pressure vessel with liquid in the vessel and then heated the liquid with CALROD heaters up to 260 degrees fahrenheit.

No measurements were taken of the block resistivity on the way up to 260 degrees fahrenheit. The block was maintained at that temperature for quite some time and then it was stepped up in temperature and values were taken at several -- values were taken at the plateaus, but the profile that was followed was not, at least in my opinion, a profile representative of what would be indicative of a PWR profile such as a Farley containment LOCA or main steamline break profile.

Mr. Jacobus was testifying he would have accepted that as a qualification profile. I can't make any statement in regard to that, but it was not a -- it was not a typical profile that would have been used in the '79/'80 time frame for the purposes of simulating a design basis accident inside the containment.

The other thing I would just like to add is that I guess I'm just surprised, because it also doesn't correlate with any of the Sandia data, I'm very surprised that Mr. Jacobus assumes that this is a very good report. It doesn't, in my mind, correlate with the Sandia data very well.

WITNESS JACOBUS: That wasn't the question. The question was would I accept it as a profile, and the answer was yes. If the question was, does the data appear to be a little bit conservative perhaps, the answer to that again would be yes. However, I normally accept things that I believe to be conservative.

BY MR. REPKA:

Q So in your opinion, the data from that testing is applicable to what we have here, the issue we have here?

A [Witness Jacobus] I believe it has some applicability. I believe you cannot just dismiss it out of hand.

MR. REPKA: Mr. Love, do you believe that data is applicable to the issue here?

WITNESS LOVE: To the instrument accuracy issue? No.

MR. REPKA: And when you state that, did you, quote "dismiss it out of hand," unquote?

WITNESS LOVE: Yes.

MR. REPKA: And did you have a basis for --

WITNESS LOVE: Well, dismiss it out of hand, no. I didn't dismiss it out of hand. Excuse me. I did not dismiss it out of hand. I have reviewed that document. I have looked at that document. As I said, that document was not used for this purpose by me, but it was available to me. I used it in a material evaluation of barrier strips which I conducted back in the mid '80s, and that's probably where Mr. Jacobus found the document. I'm not sure. I'm just guessing. But I did not arrive at this conclusion without evaluating the report and other data that we've discussed in my testimony.

WITNESS JACOBUS: I think there has been some confusion in the various proceedings here in terms of where this report came from, where we found it. I'll try to clarify it to the best of what I know.

This report was found by somebody during the inspection in a procurement file. This is the report we're referring to that was found in a procurement file. There have been some implications in the Alabama Power Company testimony that it was a penetration report that was found in the procurement file. That's not the report we were referring to, to clear that up with everybody.

BY MR. REPKA:

Q I will speculate for you, Dr. Jacobus, so you can disagree if you know otherwise, that it may have been in the procurement file as a basis for the practice of using States NT and States ZWM blocks interchangeably. Does that sound plausible to you?

A [Witness Jacobus] I don't know if it was -- I don't believe -- I have the similarity argument that was put together between the States NT and ZWM. This report may have been referenced in that. It was never -- this report was never given to us in that context, to my knowledge.

Q Right. And again, that similarity was not in issue?

A [Witness Jacobus] That's correct.

Q On Page 36 of your rebuttal testimony --

A [Witness Jacobus] Okay.

Q -- you state, beginning on the top line, "I have to continue to wonder why, with two test reports available that gave data for both of the exact blocks that were used in the Farley station, that Bechtel would attempt to use similarity analyses to qualify the blocks." Do you see the testimony?

A [Witness Jacobus] That's correct.

Q Okay. Now, you say two test reports available. Is one of those test reports the 1973 GE test report? Which two test reports were you referring to?

A [Witness Jacobus] I believe when I referred to -- when I stated -- when I made that statement, I was talking about the GE test report of 1973 and the Sandia test report. There is actually also the Wylie test report that applies only to the States blocks, okay? So it would not fit into the category of both of the exact blocks. But there is the Wylie test of the States blocks only. There could be a third report that would fall into a similar category.

Q Okay. The GE test report did test, you claim, the exact blocks, and you, as you've testified --

A [Witness Jacobus] Exact to within States NT/ZWM.

Q You feel that was useful and should have been relied upon by Bechtel?

A [Witness Jacobus] I don't necessarily say that they had to rely on that. I think it's one source --

Q But you wondered why they did not.

A [Witness Jacobus] I think it's one source of a reality check to say, is my answer right? And so I wonder why you would go through an analysis such as this and then not perform a reality check to see if it squares with real data that's available on real terminal blocks under the real conditions that we're talking about.

MR. REPKA: Mr. Love, when you did your similarity analysis, and let's back up to the 1987 time frame, and I believe we're talking about the similarity of the States in GE block to the Connectron block, did you do as Dr. Jacobus just explained? Did you make a reality check?

WITNESS LOVE: Yes, we did.

MR. REPKA: At that time, did you consider the 1973 GE report?

WITNESS LOVE: I believe, in terms of the package, at least as I have it -- and I'm not sure exactly how it was when Mr. Jacobus had looked at it, but I believe this is the package -- it did contain for not the purposes of instrument accuracy, but because I referred to it for a discussion of the NT versus ZWM, that 1973 report is in as an attachment to this document, so, I did consider that, as well as other factors.

MR. REPKA: In your engineering judgment at that time, it was not a more persuasive document than the IPS-107 report which you did utilize?

WITNESS LOVE: That is correct.

BY MR. REPKA:

Q Now, Dr. Jacobus, the second report you're referring to is the Sandia Report, Staff Exhibit 73?

A [Witness Jacobus] That's correct.

Q And the sentence we've been discussing?

A [Witness Jacobus] That's correct.

Q Now, in the Sandia testing, the exact blocks that were used in Farley Station, that's the CR-151Bs and the States blocks, were tested only in the Phase I test; is that correct?

A [Witness Jacobus] That is correct.

Q Okay, are you testifying that Alabama Power Company should have used Phase 1 Sandia data from those reports?

A [Witness Jacobus] My testimony is that, looking at that data from the Sandia Report as a reality check, leads me to the conclusion that drawing a straight line between two endpoints from that test report was not a proper thing to do.

Q Okay, so you are not saying that Phase 1 versus Phase 2 data is -- you're not saying that Phase 1 is the only data of relevance in this proceeding?

A [Witness Jacobus] I think it is in a number senses -- or at least one major sense -- much more relevant than the Phase 2 data.

Q Because it included the exact blocks?

A [Witness Jacobus] Yes.

Q You've reviewed Alabama Power Company's surrebuttal testimony; have you not?

A [Witness Jacobus] I have.

Q And you've also reviewed the November 1987 JCO; have you not?

A [Witness Jacobus] I have.

Q Let's start with the November 24th, 1987 JCO. At that time, did Alabama Power Company explain why it used

Phase 2 data rather than Phase 1 data?

A [Witness Jacobus] I think we discussed that earlier this morning, and the answer was and is yes.

Q Okay. That's been explained again in the surrebuttal testimony; has it not?

A [Witness Jacobus] It has.

Q And you still disagree that they should have used Phase 1 data instead of Phase 2 data?

A [Witness Jacobus] I think it's reasonable for them to consider the Phase 2 data. I think it's also reasonable, more than reasonable, to consider the Phase 1 data.

Q Okay, is it your testimony that Alabama Power Company has not considered Phase 1 data from the Sandia test?

A [Witness Jacobus] I believe that they considered it, and said, we're not going to use it. When I say, consider, though, I mean look at the data from that and see that it's, in fact, well below the line -- the straight line that they have drawn and come to the conclusion that the reality check says that the straight line is not appropriate.

MR. REPKA: Mr. Love, in 1987, did you -- when you were preparing the JCO, did you consider the Phase 1 data as a reality check or in any other way against the Phase 2 data used in the JCO?

WITNESS LOVE: Yes, we did.

MR. REPKA: And you rejected the Phase 1 data?

WITNESS LOVE: Yes, and for this analysis.

MR. REPKA: And did you have an engineering basis for that decision?

WITNESS LOVE: That was documented in the Attachment 1 and discussed in the January meeting on January 24, 1985. APCo Exhibit, I believe, is the correct exhibit. That's the JCO exhibit.

MR. REPKA: APCo Exhibit 59?

WITNESS LOVE: Yes. My rationale was in it.

MR. REPKA: In preparing the surrebuttal testimony in this proceeding, did you again have reason to consider the Phase 1 data?

WITNESS LOVE: Yes, I went back and reevaluated and looked at the same information I had provided before and reconsidered the Phase 1 data.

MR. REPKA: And do you continue to believe that the Phase 2 data is more meaningful for this proceeding than the Phase 1 data?

WITNESS LOVE: Yes, I do.

MR. REPKA: And you have an engineering basis for that?

WITNESS LOVE: Yes, I do. I have it documented.

MR. REPKA: Has it changed since 1987?

WITNESS LOVE: No, it has not.

WITNESS JACOBUS: Should I respond to that now or wait for redirect?

MR. REPKA: I'll be glad to hear your response, but let me preface it by saying that those questions went entirely to Mr. Love's state of mind in what he did in 1987 and 1992, and you have knowledge regarding that, I'll be glad to hear it.

WITNESS JACOBUS: Well, I have knowledge regarding his basis and why his basis was not a valid one.

BY MR. REPKA:

Q You disagree with his basis, I understand that.

A [Witness Jacobus] Okay, and I have stated the basis for that.

MR. REPKA: Mr. Love, let me turn to you. Just for the sake of the record -- and I believe this is in documents that are in an exhibit -- in very summary fashion, an you outline some of the considerations that made you use Phase 2 rather than Phase 1 data?

WITNESS LOVE: I'll just refer to APCo Exhibit 59. As I've already testified to, I haven't generated the reasons for this. I may have tried to expand or just clarify it wasn't clear what I have documented here, in other words, the bases are still the same.

One of the primary reasons which we've already talked about, which is discussed in Attachment 1 of APCo Exhibit 59, was the serpentine connection. In the Phase 1 testing, unfortunately, they -- a direct measurement of the insulation leakage current, pole-to-pole to the terminal block was not made. What they were measuring was the complete leakage path of the whole block, and then performing an analysis on the data to correct that data for leakage current, pole-to-pole, and in looking at the information that was contained in the report, it appeared to me that this was providing a very conservative several orders of magnitude lower numbers than the Phase 2 data.

I arrived at this conclusion by looking at the EB-25 block which was in both the Phase 1 and Phase 2 tests. I have gone through this in my testimony, so I don't want to repeat it. That was the primary reason.

There were other reasons that I have attached -- that I have discussed in this Attachment 1 and in my testimony. I will be glad to repeat them if anyone wants me to.

MR. REPKA: I don't think there's any need for that. Can you --

WITNESS JACOBUS: Shall I respond to that at this point?

MR. REPKA: Sure.

WITNESS JACOBUS: I remember the words. I don't remember exactly the reference. But you will find in Staff Exhibit 73, I believe in the Conclusions, -- the summary is in the Conclusions, and there is more detail in the test report, and I will read first what the conclusion says.

Conclusion Number 6 on page 126. Is everybody with me?

That conclusion reads, "The comparison between the serpentine circuit connection and the once-through connection is consistent with expected results based on parallel conducting path arguments and supports the conclusion that distributed conduction occurs in the film."

I don't recall exactly where the basis is, but there was an analysis done between the Phase 1 and Phase 2 data and that said, in general, the Phase 2 data was between a factor of 3 and 10 higher than the Phase 1 data. That is exactly the range that you would expect. Nominally, you would expect a value of 5 higher in Phase 2 than Phase 1, but because of the great deal of uncertainty and variability in the data in these kinds of tests, a range from 3 to 10 is pretty reflective of an average value of 5.

Okay, so there was an analysis done. If you would like, I'll find the reference. The point of all that being, of course, that it's perfectly reasonable to adjust the Phase 1 data as I have done. It is not a several order or magnitude difference as Mr. Love has stated.

MR. REPKA: Mr. Love?

WITNESS LOVE: I will simply refer to the Figure R-3 in my testimony, in which I have plotted both the Phase 1 and the Phase 2 data for an EB-25 block and all we need to do is look at the endpoints. At the cool condition, there is a significant difference between endpoints and perhaps something that Mr. Jacobus had said earlier that I wasn't aware of earlier may be contributing to that, but the data that is presented here shows more than a factor of 3 to 10 difference between the Phase 1 and Phase 2 data on an EB-25 block.

WITNESS JACOBUS: Is there a reason why you're comparing data for terminal-to-terminal insulation resistance from one Phase, with terminal-to-ground insulation resistance from the other phase?

WITNESS LOVE: I'm not sure I understand what you're saying there.

WITNESS JACOBUS: Well, in the original JCO, you used terminal-to-terminal data.

WITNESS LOVE: That is correct.

WITNESS JACOBUS: Now, you're coming back and using terminal-to-ground data.

WITNESS LOVE: The leakage paths -- in which test are you referring to?

WITNESS JACOBUS: In the Sandia test.

WITNESS LOVE: Which Phase?

WITNESS JACOBUS: Phase 2.

WITNESS LOVE: Which terminal block?

WITNESS JACOBUS: Terminal block 9, I believe.

WITNESS LOVE: I'm not sure I understand your --

WITNESS JACOBUS: Is there a reason why you chose to go from the terminal-to-terminal values that you used in the JCO, to the terminal-to-ground values that are now shown in Figure IR-3?

Or was that simply an error?

WITNESS LOVE: I am not understanding you. You're saying that the TB9 is terminal to ground and not terminal to terminal?

WITNESS JACOBUS: The measurements that you have put on figure IR-3 are not terminal to terminal insulation resistances as they're implied to be. They're terminal to ground.

WITNESS LOVE: And they do not include terminal to terminal contributions as well? They are not both?

WITNESS JACOBUS: No. There were three leakage pads on phase two. One terminal to an adjacent -- each adjacent terminal, and from that terminal to ground. In the JCO you used terminal to terminal.

WITNESS LOVE: That is correct.

WITNESS JACOBUS: Now you're using terminal to ground.

WITNESS LOVE: I am using the same figure for the IR-3 that I used for the JCO.

WITNESS JACOBUS: So, you're telling me it was an error, because you are not aware? I guess we need to get into this at this point.

WITNESS LOVE: I'm not sure how Mr. Jacobus is arriving at his conclusion for the data.

WITNESS JACOBUS: You refer to page 174 and 175 I believe of Staff Exhibit 73.

WITNESS LOVE: Which test report are we in, Phase II?

WITNESS JACOBUS: This is the first test report, Phase II data, SAND 83-1617. Do you agree? Are you there?

MR. HOLLER: If I may, Dr. Jacobus? Maybe while Mr. Love is looking at that, for the benefit of the Board and the others, you could re-identify the document you're looking at so that we can move between the two.

WITNESS JACOBUS: Okay. We're looking at two different documents. We are looking at Alabama Power Company surrebuttal testimony at page 170. We are also looking at Staff Exhibit 73, which is the basis of figure IR-3 on page 170 of the surrebuttal testimony. I am reading from the top right-hand corner, where it says "data sources." The second data source that's identified there is identified as SAND 83-1617, which is Staff Exhibit 73, page 174. And it tells the table number and page 175.

WITNESS LOVE: Okay. I've got it.

WITNESS JACOBUS: Page 174 and 175 says five number summaries of insulation resistance G. It's also, later on, stated that this also comes from page 210 of the Sandia report, and that that is the same data.

WITNESS LOVE: That was my understanding when we looked at this.

WITNESS JACOBUS: Okay. Now, let's go to page 210 of the Sandia report.

WITNESS LOVE: Okay. I am on page 210.

WITNESS JACOBUS: The title of that figure is box and whisker plot of insulation resistance A --

WITNESS LOVE: Oh, I see what you're saying.

WITNESS JACOBUS: -- for terminal block nine, phase two. A and G are two different things.

WITNESS LOVE: Let me --

MR. HOLLER: Please, let Dr. Jacobus finish.

WITNESS JACOBUS: A and G are two different paths. The data that corresponds to page 210 is found on pages 158 and 159, not 174 and 175. That's part of the reason things look better, because the IR-A data is lower than the IR -- IR-A is lower than IR-G.

WITNESS LOVE: I would like to explain. It appears that in preparing this. Let me back up to the JCO. I am going to start in '87. I prepared these particular graphs as part of this testimony. And I did it to document my logic and the basis for my 1987 JCO. In the 1987 JCO, as we testified to previously, we looked at page 210, which we are referring to here, which is insulation resistance A. Is insulation resistance A from page 210 terminal to terminal or is it ground?

WITNESS JACOBUS: It's terminal to terminal.

WITNESS LOVE: Okay. The graph that we used for the JCO and the data that we used for the JCO, we determined by examining this graph visually, and I believe we talked about that last time. We did not go back to the whisker data just because we were not a -- partly because of the confusion generated now. I recognize the whisker data as a source of data. Apparently I picked a G value instead of an A value. Let me come back to that. It is not going to end up being anything significant other than -- the plot I have here is terminal to ground. I did not plot pole-to-pole. But, let me go on with that.

The JCO, I want to make clear, was based on, as we've testified and as documented in the JCO, a figure, page 210, figure A1-21, which we have testified to before. And this graphically depicts that whisker and the whisker plots of the median upper and lower quartiles of the Sandia data at each of the temperature periods when it was reported in the phase II LOCA test.

In preparing my testimony, I went back and originally -- in fact I hava those graphs here. I will get tnose out and I'll resubmit them as evidence. I originally plotted this from figure 210, and I will get those out. I plotted them from the figures in this -- the box-and-whisker diagrams, by graphically trying to determine the numbers off here. Then I recognized that this data was already compiled and it would save me a lot of time.

I went into the report. Erroneously, I picked apparently the G instead of A. That is an error. However, I do have the graphs I visually prepared from for all these same terminal blocks, IR-1 through IR-3. They do not result in any significant difference to this. In fact, I would be glad to -- other than the time involved -- I would be glad to replot these from the information contained in the data summaries of the box-and-whisker diagrams. And I believe that the conclusions will end up the same.

WITNESS JACOBUS: Perhaps we should just do one thing in that regard. Let us look at the data point from phase I, at the peak LOCA temperature. I believe you have identified it as 8.52 times 10 to the third on page 170 of the surrebuttal testimony.

WITNESS LOVE: We're looking at peak numbers now?

WITNESS JACOBUS: Yes. We're looking at the peak of the 'hase I on Plot C of the peak temperature.

WITNESS LOVE: Okay.

WITNESS JACOBUS: 8.52 times 10 to the three.

WITNESS LOVE: Okay.

WITNESS JACOBUS: Okay. Now let's get the correct data from page 158 of the Sandia report.

WITNESS LOVE: I'm sorry, Mark, what was the value, again?

WITNESS JACOBUS: It's identified on your plot as 8.52 times 10 to the three.

WITNESS LOVE: You're looking at plot C?

WITNESS JACOBUS: Plot C. Is everybody there?

[No response.]

WITNESS LOVE: You are going to the box-and-whisker?

WITNESS JACOBUS: No.

WITNESS LOVE: I am looking at my graph.

WITNESS JACOBUS: Everybody has your graph, we are on plot C at 132 degrees C, you have identified the insulation resistance as 8.52 times ten to the third.

WITNESS LOVE: Yes.

WITNESS JACOBUS: Now let's go to page 158 in Staff Exhibit 73, for Terminal Block 9, Peak 1 at 175 degrees centigrade.

Does everybody see that the median value is 3.42 times ten to the one?

MR. HOLLER: Dr. Jacobus, maybe you want to describe that by the second column, or something like that, it might help.

WITNESS JACOBUS: Second column, Peak 1 175 degrees C for TB-1, and it is the top number represents the median data point. Are we all together on that?

JUDGE BOLLWERK: Is it TB-9?

WITNESS JACOBUS: Terminal Block 9.

Have you got that?

WITNESS LOVE: I see that. Yes.

WITNESS JACOBUS: If we look at the difference between 3.42 times ten to the one, and 8.52 times ten to the three, we see that it is roughly five. It is actually slightly lower than five, but th temperature in the second phase was a little bit higher, so expect it to be a little bit less than five.

That is the type of analysis that was done when Mr. Kraft came up with the statement that comparing Phase I and Phase II data was within a factor of three to ten and, therefore, it was reasonable to look at that Phase I data and multiply it by five and you will come up with some sort of reasonable average value for terminal-to-terminal insulation resistance.

That is my basis for saying --

MR. REPKA: Can you respond to that?

WITNESS LOVE: I don't have any response in regard to that, no. I still believe that the characteristic is linear, however.

BY MR. REPKA:

Q Looking at the Phase I data, Dr. Jacobus, again, you have already told us that in Phase I there was no chemical spray, is that right?

A [Witness Jacobus] That's correct.

Q In Phase I can you compare this States ZWM to GE CRR-1513 and the GE EB-25, and tell me which of those three blocks was the poorest performer?

A [Witness Jacobus] I think Alabama Power has done that in surrebuttal and with the exceptions of the peak temperatures of 175 and 161 degrees C, I think they identified that EB-25 did, in fact, perform with the lowest insulation resistance of the three.

Q That would make insulation resistances based on the EB-25 block more conservative than any IRs based on the CR-1513s and the GE EB-25, is that correct?

A [Witness Jacobus] I think that would generally be a fair conclusion over the range of temperatures where you have shown that to be the case, which is temperatures 150 degrees C and below.

Q The temperatures that Alabama Power Company maintains are relevant to this proceeding?

A [Witness Jacobus] That is, indeed, the case, but the one data point that was chosen from the EB-25, both points that were chosen for the B-25 are outside --

Let me correct that. I am not sure abcut the low temperature point. The high temperature point that was used to fix one end of the plot was based on a temperature outside that range. The other one, I am not sure what the answer is.

I believe the other end that would not apply. In fact, the EB-25 was lower at the other end.

Q In general, over those ranges, the EB-25 was the poorer performer, or the poor end performer.

A [Witness Jacobus] Over the range less than 150 degrees C. At 175 degrees C, the EB-25 was not the lowest.

Q Would you expect to see that ranking of performance to be the same in Phase II?

A [Witness Jacobus] I would expect to see a reasonably similar thing, yes.

Q Apart from all those concerns, do you have any concern as to whether the Phase II first DBA test conditions bound the Farley profile?

A [Witness Jacobus] In terms of temperature and pressure, no.

Q So that is not an issue here?

A [Witness Jacobus] That is not an issue.

MR. REPKA: Judge Bollwerk, I have no further questions at this time, but Mr. Lowe did refer to, in the case of that recent colloquy, certain earlier versions of a graph, and I would like to reserve the opportunity to talk to him and find out what those are, and see if we want to move those into evidence at some point before we complete this issue.

MR. HOLLER: The staff has no objection to that being brought up again, subject to cross-examination.

JUDGE BOLLWERK: Certainly.

Do you have any redirect, or do you just want to move to cross?

MR. HOLLER: No, sir. I definitely have redirect, one of which is to address Judge Carpenter's questions. I am looking at the time. If I could have two minutes just to consult with the witness, we may be able to fit one in before the lunch break, or it may prove, for continuity purposes, perhaps to pick up after lunch, if that is acceptable to the Board.

JUDGE BOLLWERK: Why don't you go ahead and do that.

[Brief recess.]

JUDGE BOLLWERK: What is your pleasure, Mr. Holler?

MR. HOLLER: If we may, sir, Dr. Jacobus may address Judge Carpenter's question. I think we can get that in before lunch, and that would put us at a good break point, and then return. We have one or two other questions on redirect, and then we can get into cross examination.

JUDGE BOLLWERK: All right.

MR. HOLLER: With that, sir, we've marked for identification a series of graphs which Dr. Jacobus will explain as we pass these out to the Board. This is for identification a series of graphs depicting insulation resistance versus temperature for terminal blocks marked for identification as Staff Exhibit Number 83.

REDIRECT EXAMINATION

BY MR. HOLLER:

Q I'll ask Dr. Jacobus, if you would at this time, to just identify what the charts are in Staff Exhibit 83, or should we -- maybe Staff Exhibit 84 will be helpful.

A [Witness Jacobus] May I look at a copy of that for just a second to make sure I have my copy in the same order so we don't get confused?

[Document proffered.]

WITNESS JACOBUS: What I'd like to do is to use these graphs at this point to try to address Judge

Carpenter's question regarding whether it is a bulk conduction phenomenon or some other phenomenon like moisture films as we have postulated.

JUDGE BOLLWERK: Let me do one procedural thing here. Let's let the record reflect that Staff Exhibit 83 has been marked for identification.

[Staff Exhibit 83 was marked for identification.]

JUDGE BOLLWERK: All right, sir.

WITNESS JACOBUS: What I will do first is refer Judge Carpenter to a few relevant sections of the Sandia reports, and then we'll go effectively to the bottom line from that point in looking at these graphs.

The relevant sections would be Staff Exhibit 73 on Page 42. The issue of moisture films is at least alluded to and discussed, and the conditions -- the thermodynamic conditions under which leakage currents would form and evaporate is discussed.

JUDGE CARPENTER: That's the paragraph that begins "We hypothesize"?

WITNESS JACOBUS: That's correct. Then I'm going to give you the basis for that hypothesis and some data that supports that hypothesis.

I don't claim that it's absolute 100 percent proof; I claim that it is our best engineering judgment, and now I'm going to provide you with the basis for that engineering judgment, and you may come to your own conclusions at that point, okay?

JUDGE CARPENTER: Yes. Without apology, you should realize that as a scientist, I look to see whether the data falsify the hypothesis since I never pretend to prove a hypothesis.

WITNESS JACOBUS: Okay. And what I'm going to show you is that there is no data that I have looked at that is inconsistent with that hypothesis.

JUDGE CARPENTER: Thank you.

WITNESS JACOBUS: Okay. And that would be that beginning on Page 42, and then I believe there are a bunch of data plots, and it continues on on Page 52, on the top paragraph of Page 52. So I don't know if we want to go through that in any kind of detail or if you would prefer to read through it -- or you have read through it. I understand that. That merely talks about the thermodynamic conditions where we would expect moisture films to form and then evaporate.

For example, if you are under increasing environmental temperatures with a cold terminal block, you would expect condensation on that terminal block. In contrast, as you are decreasing temperatures, the block is hotter than the environment, which causes films to evaporate or go toward evaporation, okay?

So that's one area. Do you want to talk about that or --

JUDGE CARPENTER: Since you brought it up, I'm trying to understand how the steam vapor in the Sandia exposure chamber would be limited in its condensation to only forming a film and not forming droplets.

WITNESS JACOBUS: Oh. Okay. I think I understand --

JUDGE CARPENTER: How does the water know when to stop?

WITNESS JACOBUS: Okay. Our hypothesis is discussed in fairly great detail beginning on Page 63 in Volume 2. That's Staff Exhibit 74. Okay. The idea is that you have two competing factors going on. One is you have this film which may be droplets; it may just be a nice uniform film. Probably it's not going to be a nice uniform film. It's likely going to have droplets that form on the terminal blocks, drip off.

That's one of the reasons that you see fairly great variability when you look at the five-number summaries, okay? You get a droplet on there; it reduces the insulation resistance. It drips off and the insulation resistance comes back up a little bit, okay?

So that in fact is one of the bases for saying moisture films were probably the cause. You would not expect things like one order of magnitude changes in insulation resistance at a constant temperature if bulk conduction were the only phenomenon that was important. Bulk conduction is a fairly nice parameter, nicely behaved. If it's bulk conduction, you put it at that temperature, you measure the IR now and at every minute for the next two days, and it's likely to be fairly constant. It's not going to vary over an order of magnitude as the data in the Sandia report shows that a number of terminal blocks did.

In particular, I think there are a coupl places in there where it's discussed that there were frequently cases where there were lots of outlying data at both extremes, okay? Film disappears, film reforms, a droplet forms, drips off, the insulation resistance bounces around. Okay. That's a fairly characteristic thing that indicates that it's not bulk conduction; it is moisture.

If you'll look on the graphs I just gave you, for example, the second page of -- that was Staff Exhibit --

MR. HOLLER: Let me at this time distribute copies we've marked for identification as Staff Exhibit No. 84, which are a series of graphs that Dr. Jacobus described.

WITNESS JACOBUS: No, no, I'm referring back to the IR versus temperature. It's 83?

JUDGE CARPENTER: Is there some title for Staff

Exhibit 83 as to what it is?

WITNESS JACOBUS: The explanation of the data that is on these plots is on the last two pages of the package. The plots are essentially very similar to what has been put into the APCo surrebuttal testimony as figures IR-1, 2, and 3, similar kinds of data. The explanation that is there is just how the data on the plots was determined, where the sources were.

MR. HOLLER: If I may suggest, it may be helpful for the Board, the Staff would propose that Staff Exhibit 83 be entitled Staff IR Data.

WITNESS JACOBUS: IR versus temperature data. Okay, so, if you look, for example, at the second page of that data, that is simply a plot of the States terminal block data from the Sandia test. That's the inverted triangles along with the Alabama Power plots which are the straight lines.

Okay, the two straight lines at the top, the lower one represents Alabama Power straight line in the JCO, the upper plot represents the data that is in their surrebuttal testimony that they have acknowledged now is incorrect, incorrect to what they thought it was.

MR. REPKA: I would like to respond to that characterization.

JUDGE CARPENTER: Did you say the inverted triangle?

WITNESS JACOBUS: The inverted triangles are the Sandia data as identified in the legend, the bottom item in the legend. The right-side-up triangles are also data from the Sandia, Phase 1 testing.

JUDGE BOLLWERK: Mr. Love, did you want to say something?

WITNESS LOVE: Yes, I would just like to say that the data that I have plotted here is not incorrect data. It was for the ground path. It's not incorrect data.

WITNESS JACOBUS: It's incorrect for what you had -- it is not as it was stated in the testimony.

WITNESS LOVE: I will say it is not the exact value, because I thought it was pole-to-pole, however, if I were to plot pole-to-pole, I would see a similar result and I will indicate that -- well, I'd like to ask some questions about your factor of 5, but I'll wait until later, if you'd like. I'd like to ask some questions about that.

WITNESS JACOBUS: What you will see if you look at IR-to-ground, versus IR, terminal-to-terminal, is the difference in the two straight lines that I have plotted on the second -- on every page, all three of the first pages of my plots. The lower plot is the correct terminal-to-terminal insulation resistance, the upper plot is the terminal-to-ground insulation resistance, which is correct data for terminal-to-ground, but is not terminal-to-terminal data, which is what we are interested in.

WITNESS LOVE: Well, I think we're interested in both, but I understand.

WITNESS JACOBUS: In the surrebuttal testimony, the IR-to-ground data is represented as IR, terminal-to-terminal data which, we have agreed, is incorrect.

WITNESS LOVE: I will acknowledge that.

MR. REPKA: Mr. Love, does that error in any way undermine the conclusions?

WITNESS LOVE: I do not believe so, no.

WITNESS JACOBUS: Okay, if we now look at this second page, for example, the data at 122 degrees Centigrade, you see roughly a two order of magnitude range in the insulation resistance at a single temperature. Similarly, at the 105 degree point, you see a little more than one order of magnitude difference in the insulation resistance.

It's inconceivable to me that bulk insulation resistance would vary by that great of an amount at a fixed temperature.

JUDGE CARPENTER: But you're perfectly comfortable that the film thickness varies by two orders of magnitude?

WITNESS JACOBUS: Not the film thickness, the film insulation resistance which is -- it may be because of a droplet forming and then falling off. The insulation resistance may go way up and then go down. It may be a droplet forming and then falling down.

When we say film, perhaps a better characterization of that is moisture, water droplets on the terminal block, not necessarily a very nice, uniform film on the terminal block. That's not the interpretation that we intended. The interpretation being, moisture on the terminal blocks, not bulk conduction through the terminal block phenolic material.

JUDGE MORRIS: Dr. Jacobus, for example, the data for 122 degrees, over what period of time were they taken, and how many datapoints were there?

WITNESS JACOBUS: The data at 122 degrees C, based on Figure 1 on page 8 of Staff Exhibit 73, was taken over a three-day, 8 hour and 30 minute period. Typically, data would be taken anywhere from every ten to thirty minutes during that period.

JUDGE MORRIS: And there was no distinguishable trend; there was just random distribution of the data?

WITNESS JACOBUS: That's largely true. In fact, there is another statement in this report that says that there was continuous monitoring done on strip charts. While that data is not actually reported here, it does note that there were transient effects, short term transient effects that were not captured by that data logging every ten to 30 minutes, transient values that may have been outside the range of the data that is shown in the figures that I have shown.

If you'd like a reference to that statement, I'm sure I can find it in a few minutes.

JUDGE MORRIS: I'll leave that up to you.

WITNESS JACOBUS: I mean, I represent to you that that is a statement or substantially a statement that is located in this test report, if that is sufficient. Or, if you would prefer a reference, I --

JUDGE MORRIS: I am happy with that.

WITNESS JACOBUS: Okay.

To go on -- are you --

JUDGE CARPENTER: To be sure I understand the thrust of your testimony, you are making the point that substantial variability in IR was observed?

WITNESS JACOBUS: That is correct.

JUDGE CARPENTER: Which therefore, at a minimum, is not incompatible with your water film hypothesis?

WITNESS JACOBUS: That's correct.

JUDGE CARPENTER: With some background in electrochemistry -- and I keep looking at these electrodes in some solution, either pure water or electrolyte, as representing a resistance path for electrolytic conduction.

And I have to believe that in some way, however complicated the geometry is, that that geometry will control the conduction.

WITNESS JACOBUS: Absolutely.

JUDGE CARPENTER: and to change the thickness in some irregular way or some smooth way is not my point. What you're saying -- the water comes and goes at a fixed temperature.

WITNESS JACOBUS: Well, okay. Let's go to a rough --

JUDGE CARPENTER: I am just asking you, did I understand correctly --

WITNESS JACOBUS: Yes.

JUDGE CARPENTER: -- that that's what you're testifying to?

WITNESS JACOBUS: That's correct.

JUDGE CARPENTER: And it's not just a little thinning or a little thickening, but it is very substantial?

WITNESS JACOBUS: It may well be a droplet forming on the terminal block and then dripping off the terminal block, then another droplet forming and dripping off the terminal block.

JUDGE CARPENTER: Can't we agree that the droplet would be in series with the rest of the film, and if it came and went, it still would only contribute, in part, to the resistance of the film?

WITNESS JACOBUS: That's true, depending on the exact location of the droplet. That's correct.

JUDGE CARPENTER: Well, I haven't imagined -- this is brand new. I was surprised.

WITNESS JACOBUS: That's okay.

JUDGE CARPENTER: I haven't tried to visualize this at all. I just wanted to be sure I understand what you think this is telling you.

WITNESS JACOBUS: Okay. Now, let's go one step further. I did mention that the Phase II page -- the Phase II -- the second test report, at the beginning of page 63, gives some explanation of some potential theoretical mechanism and a discussion of that mechanism of the competing factors that would be going on to cause films to form and evaporate. I don't know of you got to that section of that report. That is Staff Exhibit 74.

JUDGE CARPENTER: Would I be inappropriate identifying that portion of the report as the salty-fingerprint analysis?

WITNESS JACOBUS: No, no. This is the portion of the report that talks about theoretical considerations of moisture films and terminal blocks.

JUDGE CARPENTER: The sodium chloride solution, as I recall. It came from a fingerprint?

WITNESS JACOBUS: Yes.

JUDGE CARPENTER: So, it's a salty-fingerprint analysis. That's what -- as I understand, it's an attempt to see what a fingerprint could do?

WITNESS JACOBUS: Yes. That was part of it.

JUDGE CARPENTER: I'm familiar with what you're talking about.

WITNESS JACOBUS: Okay. Good.

Let's continue on and look at the third page of data. This third page of data, I attempted to pull together data that was not taken by Sandia. There is one point on here that is reported in the Sandia tests that have already been introduced as exhibits that was taken at Temple University. That's, in particular, one that I would like to take a look at. That's the one that is on page three of Staff Exhibit 83. It is the furthest point to the right that is labeled Solomon EB-25. Are we together at that point?

JUDGE MORRIS: Except for technically, the CONAX test point, which is further to the right.

WITNESS JACOBUS: Oh, excuse me. Let's say it this way. The point that is labeled Solomon EB-25. That is a test of an EB-25 during an increasing temperature profile to 85 degrees C. The points that have been plotted in the Alabama Power Surrebuttal and the JCO are points at 95 degrees C and below that were taken during a decreasing drying out portion of an accident exposure on the same type of block.

Okay. You see about, oh, I would say roughly two orders of magnitude lower insulation resistance, in this particular case, when the temperature is increasing, as compared to when the temperature is decreasing, down in that range of 100 degrees C. Okay. Same terminal blocks, roughly the same environmental conditions, except one is heating up, one is cooling down.

So, in essence, the Solomon data is with a nice --some sort of a "nice film" present. The data at 95 degrees C that has been used in Alabama Power's testimony, is based on relatively dry conditions, because the terminal block is hotter than the environmental temperature, hence, films evaporate.

JUDGE CARPENTER: Dr. Jacobus, this tendency of a block, and the temperature difference between a block and the ambient air, which may be saturated with water -- doesn't it depend on the dynamics, rather than simply an equilibrium?

WITNESS JACOBUS: Yes. That's true.

JUDGE CARPENTER: In Dr. Solomon's experiments, how fast did he increase the temperature?

WITNESS JACOBUS: It was roughly going from ambient temperature to 85 degrees C in 30 to 40 minutes.

JUDGE CARPENTER: Yes.

WITNESS JACOBUS: So, he was under dynamic effects.

JUDGE CARPENTER: Do you think the block would lag that severely?

WITNESS JACOBUS: So it would seem. It seems like it is a fairly long time for things to come to equilibrium. And you'll notice in a few cases, in Mr. Kraft's report, he talks about things taking one to two hours to equilibrate.

JUDGE CARPENTER: Do you recall the figure in Staff Exhibit 73 that Mr. Kraft presents, where he had a thermocouple imbedded in the block and measured the temperature of the ambient and the temperature of the block?

WITNESS JACOBUS: That would be -- there's one here on page 50 of Staff Exhibit 73.

JUDGE CARPENTER: That sounds about right.

WITNESS JACOBUS: And --

JUDGE CARPENTER: What's the time scale of the lag?

WITNESS JACOBUS: Well, it appears on page 51 -- that almost, throughout the three-hour exposure at the peak temperature, that the terminal block temperature was below the atmospheric temperature.

If you look back on Page 11, you will see that

Enclosure 2, Thermocouple Number 3, was measuring the ambient environment inside the junction box, and TC-1 is on Terminal Block 6.

JUDGE CARPENTER: Which page is that, please?

WITNESS JACOBUS: Page 11, Figure 4.

JUDGE CARPENTER: Of?

WITNESS JACOBUS: Of Staff Exhibit 73.

JUDGE CARPENTER: Maybe I misheard. You said Page 11?

WITNESS JACOBUS: Page 11 of Staff Exhibit 73. Figure 4 is a diagram of Enclosure 1 and Enclosure 2.

JUDGE CARPENTER: Oh, yes. I'm sorry. I was looking for a temperature plot with time.

WITNESS JACOBUS: Oh, no. This just shows the location of the thermocouples, Thermocouple 3 being the ambient environment in the junction box. Enclosure 2 is a junction box.

MR. REPKA: Mr. Love?

WITNESS LOVE: I don't want to interrupt, but I believe these terminal blocks in these enclosures were on stand-off insulators, which may have had something to do with that.

WITNESS JACOBUS: In Phase 1, they were not.

WITNESS LOVE: Okay.

JUDGE CARPENTER: Phase 1 and Phase 2 were different.

WITNESS LOVE: They were not. Okay. Sorry.

JUDGE CARPENTER: But your point is that you take the view that the blocks do have a substantial thermal lag.

WITNESS JACOBUS: Substantial in terms of that last bit of temperature equilibration occurs very slowly as shown on Figure 29, Page 51. And then, of course, during the cool-down, you see an exact reversal.

JUDGE CARPENTER: Why is there a change in the rate of heat transfer of the type that you are describing?

WITNESS JACOBUS: Because --

JUDGE CARPENTER: Why isn't it simply controlled by ordinary laws of heat transfer?

WITNESS JACOBUS: It is, but those are very complicated when you're talking about condensation heat transfer.

JUDGE CARPENTER: Here, we're talking about heat transfer from the block to the surrounding atmosphere on a time scale of hours.

WITNESS JACOBUS: That occurs by a number of -- the short term occurs very distinctively from the longer term differences. The short term is largely governed by things like very rapid condensation of moisture on the blocks as well as the other operative mechanisms of heat transfer, including conduction, convection and some probably small amount of radiative heat transfer.

As things begin to stabilize, the conduction becomes less of the dominant -- I mean, the condensation phenomenon becomes less of a factor in that heat transfer, in part because everything has now become quiescent. When we dump steam in there very rapidly, everything is churning around. Then after some period of time, things settle down and the heat transfer occurs relatively more slowly because the mechanism is now less condensation, it's more conduction and convection.

JUDGE CARPENTER: I'm sorry. I thought we were focused on evaporation here when we started. We suddenly got into this.

In the comparison between what Dr. Solomon measured and what was measured at Sandia, I thought your point was that his film was which way? Thicker or thinner?

WITNESS JACOBUS: Okay. He's going up in temperature, so film is filming via condensation. The block is colder than the environment. Similar if you have a camera, a 35 millimeter camera that you take inside when it's cold, the camera is cold, you take it inside a nice, warm, humid room, you get condensation on that camera, on the lens. As that temperature of the camera warms up to the temperature of the ambient, that film evaporates, that condensation evaporates, okay?

So if the block is sitting in a cold state in a high temperature steam environment, we're going to have condensation on that terminal block. Conversely, when we're cooling down, as they were in the Sandia test -- that data was taken at 95 degrees C and below -- the block is now hotter than the environment as shown by Figure 29 on Page 51. You see Thermocouple 1 is now above Thermocouple 3. So now the terminal block is hotter. So when the terminal block is hotter than the environment, the film evaporates.

Are you with me on that?

JUDGE CARPENTER: Oh, I see the plot. I'm just a little surprised at the thermal mass of the block.

WITNESS JACOBUS: Well, I mean, all I -- I look at the data in Figure 29, and if I only saw the data up to three hours, I might suspect that there was a persistent bias in the thermal couple. But during the cooldown, you see that they reverse position exactly as you would expect to happen. So the terminal block temperature lags on the way up, lags on the way down.

JUDGE CARPENTER: I see your point in the figure.

WITNESS JACOBUS: And, you know, when the terminal -- the theory says when the terminal block is colder than the environment, you get condensation, hence moisture films of some sort, hence reduced insulation resistance. When the block is hotter than the environment, the film tends to evaporate, disappears, the insulation resistances come back up. And that's what I believe you are seeing on the third page of those three graphs. I don't have any other rational explanation for that.

JUDGE CARPENTER: This point for Solomon, identified as EB-25, what's the code that lets me look at the Solomon portion of the report and know which block that is?

WITNESS JACOBUS: If we go back to -- I guess it doesn't actually tell you. The very last page, it tells you data from the Staff Exhibit 74, Sandia Report 84-0422, gives the profile and some leakage current data. I will tell you what page that came from and which terminal block.

It's basically a terminal block tested in the as-received condition.

JUDGE CARPENTER: What I'm really asking is, is it manufacturer Roman I, Model A terminal block or not? Is the EB-25 the same as a Manufacturer I Model A block?

WITNESS JACOBUS: Yes, it is.

JUDGE CARPENTER: Thank you.

WITNESS JACOBUS: And that is identified -- that data comes from page 54.

JUDGE CARPENTER: I'm looking at page 54.

WITNESS JACOBUS: You've got the right page. That is the data.

[Pause.]

WITNESS JACOBUS: To go to -- are you satisfied with that, Judge Carpenter, or do you have additional questions on that?

JUDGE CARPENTER: Well, you know, I'll acknowledge, I've got some figures also. It's fairly difficult for something like this which is a comparison of data. It takes a little while to look at where it came from and what it represents and what it doesn't represent.

But to be sure I understand, the thrust is that it's your position that this is a clear demonstration that increasing temperatures produced less than smaller leakage currents than decreasing temperatures for the reason that in the one case, the film is appearing, and in the other case, the film is disappearing.

WITNESS JACOBUS: That is our hypothesis with the exception that you said leakage currents where I think you meant to say insulation resistances. When the temperature is increasing, the insulation resistances tend to be lower than when the temperature is decreasing. I think you used leakage current for which the opposite effect holds, because leakage currents and insulation resistances are inversely related.

JUDGE CARPENTER: I accept your correction if I misspoke. But the basic thrust is that one can discern whether or not it's a film mechanism by looking at the dynamics of rising and falling temperatures?

WITNESS JACOBUS: Is your question; can you do that?

JUDGE CARPENTER: I think that's what you're telling me.

WITNESS JACOBUS: I think that's appropriate.

JUDGE CARPENTER: Fine, I understand.

WITNESS JACOBUS: One more point that you may wish to look at that gives further evidence that moisture films are important, is in Staff Exhibit 74, again, looking at those plots that begin on page 54 and are summarized on page 60.

Looking particularly at the summary on page 60, we see that a terminal block that was dipped in saturated salt solution and then dried and then exposed to a steam environment, has about an order of magnitude higher insulation resistance than a terminal block tested in a steam environment as received.

Okay, that tends to support that --

JUDGE CARPENTER: Could it be otherwise?

WITNESS JACOBUS: Excuse me?

JUDGE CARPENTER: Could it be otherwise. You dip the block in saturated sodium chloride and transfer to the block, a substantial quantity of conducting ions, could it be otherwise? It couldn't become smaller, could it?

WITNESS JACOBUS: No, it could not become smaller. It could stay roughly the same if, for example, bulk conduction through the terminal block was the dominant mechanism contributing to leakage currents. I mean, we're seeing an order of magnitude change due to some effect, and presumably it's due to this salt solution that was put on the blocks.

If the effect of moisture films were small relative to the effect of bulk conduction through the terminal blocks, then adding this sodium chloride solution may not appreciably change the -- should not change the bulk conductivity of the terminal block. The sodium chloride is only going to affect the surface conductivity.

JUDGE CARPENTER: Well, Dr. Jacobus, you know, you're testifying as to what you think the truth of the matter is. Whether it will stand scrutiny, I don't know, and I'm certainly not going to respond at this point, but it does seem to me, it does depend on the magnitudes of the two quantities, as to whether one clearly dominates the other or not.

WITNESS JACOBUS: That's true.

JUDGE CARPENTER: And, having loaded it with saturated sodium chloride which, from an intellectual point of view is interesting, I don't really know that LOCAs involve saturated sodium chloride.

WITNESS JACOBUS: Right.

JUDGE CARPENTER: So, from the point of view of just trying to understand the mechanism, that's fine. But it seems such a violent thing to do to the block in terms of its electrical resistance. But to say that, well, now, this proves that it must be a film; it could be otherwise, you know?

It's known that sodium chloride solutions conduct.

WITNESS JACOBUS: So, I'm not purporting to state that the mechanism could not change if you destroy it with conducting ions. I think that's your point. But, clearly, with the sodium chloride on there, the surface is contributing very strongly, and, in fact, clearly, the surface is then dominant.

Clearly, with the sodium chloride solution having been dried off of there, and dumping steam on it, in that case, clearly, the surface is dominating. We can't necessarily say that the surface was therefore dominating in the other case. I think that's your point.

JUDGE CARPENTER: That's my point. You got the expectable results.

WITNESS JACOBUS: That's true. I think, looking at all the evidence put together, there is nothing that would tend to indicate that that is not the case, and there are several things, in particular, that third plot of the figures, Staff Exhibit 83, comparing the two identical blocks tested under conditions where one is increasing temperature and one is decreasing temperature.

If -- I mean, under ordinary circumstances, if there was significant degradation due to exposure to the high temperature, I would expect the block that had been exposed to the higher temperature to be worse than the block that had never been exposed to the high temperature, and I don't see that effect.

JUDGE CARPENTER: I think it is convenient at this point, to save some time, for me to jump in with one more question.

As I read the Staff Exhibit 73 and 74, there are a few questions that come to mind. One in particular -- and I may misapprehend what I was looking at, so I would like your help -- in Staff Exhibit 73, at page 57 -- and I will be very candid and say this serpentine wiring arrangement is a bit of mystery to me because, as far as I can see from my knowledge of circuits from Physics I, given five parallel circuits, all I can tell you is what the resistance of the aggregate is, and not the resistance of any one. Obviously, there is some way to do that that I don't know.

This Table 8 says, "Insulation resistance and leakage currents for Phase I terminal blocks are powered individually." Does that mean there was some way of being able to look at the resistance of an individual terminal block?

WITNESS JACOBUS: Let me explain two things. First, your question, or it wasn't necessarily formed in the phrase of a question about how you could go from the serpentine configuration to terminal-to-terminal, and also give you a little bit of historical basis of why that serpentine configuration was used.

JUDGE CARPENTER: Let's take the specific case, and make it very clear. Of four resistances with a resistance value of one, and one resistance with a resistance value of ten, and all I know is the aggregate resistance in a parallel circuit.

WITNESS JACOBUS: That's correct.

JUDGE CARPENTER: How do I tell which one was ten and which one was one?

WITNESS JACOBUS: Let me put that in a little better perspective. The answer is, you don't, clearly.

However, we have five individual leakage paths between adjacent terminals of a terminal block. The same geometry, the same environmental conditions, the same everything that we know of that might be relevant, except for these little dynamic eff cts that might be going on, and, therefore, we would expect that R-1 through RR-5 would probably be the same, roughly.

That is the analysis that Mr. Kraft did between the Phase I and the Phase II data, and he said, yes, it is roughly correct. It is between three and ten, five is, therefore, a pretty good number.

All these effects you are talking about, maybe you have a droplet on one, and not on another one. That tends to affect things.

In essence, what you are doing is averaging out those effects and, in fact, realistically you are getting a non-conservative estimate of what the minimum of those five is.

Taking your example, if you have four ones and a ten, the number you would concerned with knowing is one, not ten, because, in some sense, we are trying to look at the worst that it might be. We are not trying to look at the best that it might be because we are trying to qualify a piece of equipment.

So we want to have an idea of what the worst is, and if you have your 1 ohms and your 10 ohm, you are going to conclude that the average is something like 1.25. That is above four of them and only below one of them.

JUDGE CARPENTER: Dr. Jacobus, don't belabor this, please.

What I am really interested in is why Table 8 says that Phase I terminal blocks are powered individually. How was he able to do that?

WITNESS JACOBUS: This only had to do with making terminal-to-ground insulation resistance measurements. During the Phase I all of the terminal blocks were not on the insulating standoffs as they were in Phase II. In Phase II, we could make individual terminal-to-ground leakage current measurements that could not be made in Phase I. In Phase I, all we could get is the aggregate of the leakage of every terminal-to-ground.

Looking at the terminal blocks powered individually was to look at each terminal block to ground individually for leakage current to ground.

So he powered up one because that is the only one that has any power. Everything that is leaking to ground has to be coming from that one.

JUDGE CARPENTER: Given that this is not the average five, or what-have-you, but it is a pretty good approximation of what the particular block is doing, I looked at these --

WITNESS JACOBUS: I think you are not exactly with me on that. This is not looking at individual terminals to ground.

JUDGE CARPENTER: Individual blocks.

WITNESS JACOBUS: Individual blocks, that each block has three powered terminals that would be leaking to ground.

JUDGE CARPENTER: That is not the same as the thing we were talking about earlier, the serpentine multiple block circuit. Do I understand that?

WITNESS JACOBUS: The serpentine connection was on each individual block, all of the blocks --

JUDGE CARPENTER: Each block was examined separately, even though multiple paths from the block might have been looked at?

WITNESS JACOBUS: That is correct for terminal-to-terminal behavior. Throughout the test it was looking at terminal-to-terminal behavior on each block in a serpentine configuration.

The data in Table 8 is looking at each block individually to ground because that data was not available when all of the blocks were powered at the same time because there is only one ground line to the test chamber.

JUDGE CARPENTER: Is it true then that Dr. Solomon's observations didn't include leakage to ground but only terminal to terminal, or did they include leakage to ground?

WITNESS JACOBUS: His included terminal to terminal and terminal to the ground plate of the terminal block, if the terminal block had a ground plate.

For example, the States block that has been admitted has a ground plate. The terminal block that he was using, the one that I am referring to, was an EB-25 block. He measured only terminal-to-terminal data. That is the same measurement that was made in the Phase II Sandia data on the EB-25 terminal blocks.

That's the same data that was used to draw the straight-line plots that Alabama Power used in the JCO and then again in the surrebuttal testimony.

JUDGE CARPENTER: To be specific, if you would turn to Page 53 of Staff Exhibit 74.

WITNESS JACOBUS: Page?

JUDGE CARPENTER: Fifty-three.

WITNESS JACOBUS: Fifty-three. Okay. Okay. I'm on Page 53 of Staff 74.

JUDGE CARPENTER: Right. Look at Table 5-2. It says typical leakage current data.

WITNESS JACOBUS: Yes.

JUDGE CARPENTER: Usually when I read that, I'll be a little facetious and say it means it's the best data the investigator got, but that's beside the point.

Anyway, they have this typical leakage current data. To come down to the very specific and, to me, confusing issue, this is the typical leakage current data under Dr. Solomon's conditions, and his experimental set-up was very different from Sandia.

WITNESS JACOBUS: Very.

JUDGE CARPENTER: And he gets observed leakage currents that strangely drift upward, but anyway from ten to 30 microamps.

WITNESS JACOBUS: That's correct.

JUDGE CARPENTER: And then I look at Mr. Kraft's insulation resistance and leakage currents for Phase 1 terminal blocks back on Table 8 on Page 57 that we were just looking at, and, just eyeball, you know, I see --

WITNESS JACOBUS: What page are you on?

JUDGE CARPENTER: It's the same table we were looking at a moment ago, where I started; Table 8 on Page 57 in Staff 73.

WITNESS JACOBUS: Oh, okay.

JUDGE CARPENTER: I'm comparing Kraft's results with Solomon's results. It shows just --

WITNESS JACOBUS: Wait a minute. I'm lost. Page what in --

JUDGE CARPENTER: Fifty-seven.

WITNESS JACOBUS: Fifty-seven. Okay.

JUDGE CARPENTER: And looking at these leakage currents --

WITNESS JACOBUS: Okay.

JUDGE CARPENTER: -- they are not wildly different except for the exponent, which is a factor of 1,000 different. Solomon finds milliamps and Kraft finds -- I'm sorry -- Solomon finds microamps and Kraft finds milliamps. I'm either comparing apples and oranges inadvertently or there's something I don't understand.

WITNESS JACOBUS: well, I mean --

JUDGE CARPENTER: And this, of course, is very different from your comparison on Page 3 of Staff 83.

WITNESS JACOBUS: Keep in mind now, I am -- I think it would help if you look back at the previous two figures. All I'm comparing is what Alabama Power has used in testimony to what Solomon got, okay?

JUDGE CARPENTER: I'm not challenging your figures. I'm saying can you help me understand, as I read this report just as a reviewer, why there's this apparent difference --

WITNESS JACOBUS: Okay.

JUDGE CARPENTER: -- that's a little bit bigger than the variability in the observation.

WITNESS JACOBUS: Okay. First, let's look at roughly the numbers. We have in one case 86 degrees with about, say, .03 milliamps in Solomon's test. That's Table 5-2 on Page 53 of Staff 74.

JUDGE CARPENTER: Yes. I have it.

WITNESS JACOBUS: Okay. You have .03 milliamps.

In Table 8, you see values that range from about .5, which is really just a little more than one order of magnitude --

JUDGE CARPENTER: Which column of the table are you looking at?

WITNESS JACOBUS: I'm looking at the leakage currents, terminal to terminal, weighted and average.

JUDGE CARPENTER: Thank you.

WITNESS JACOBUS: Okay? Those numbers range from about .56 to 13. Point-five-six is a little more than one order of magnitude higher than the data that Solomon got; however, the temperature is 20 degrees C higher in Table 8 than it is in Solomon's data.

We're comparing a temperature of 105 C in Table 8 with a temperature of 86 degrees C in Table 5-2. So we're --

JUDGE CARPENTER: That's correct. But depending on how long you think the temperature coefficienc is, that's either a serious failure of the comparison or it's not a very serious one.

WITNESS JACOBUS: Right. And when the --

JUDGE CARPENTER: Well, can we agree that it's of the order of 100?

WITNESS JACOBUS: On --

JUDGE CARPENTER: The mean difference. I'm sorry.

The difference of the means.

WITNESS JACOBUS: Yes. It's on the order of ten to 100, I think. If we -- let's see. I believe there is --

[Pause.]

WITNESS JACOBUS: Unfortunately, I haven't plotted up all of the EB-25 data from the Sandia test. But if we plotted that on this insulation resistance versus temperature plot, you would see that the data from Solomon's test is not radically different from the data in the Sandia test in looking at the extrapolation of the data that Sandia took versus Solomon's data.

JUDGE CARPENTER: Well, that speaks to my question, but the comparison wasn't made in the course of Mr. Kraft writing his reports. So, you see, I'm at a disadvantage simply looking at one table and another table.

I will say I'm very prejudiced by my education and experience in measuring conductance of electrolytic solutions, not under LOCA conditions, but 85 is not so wild for me and my seat-of-the-pants temperature coefficient of the order of two percents per degree, not ten percent and not any larger number than that.

WITNESS JACOBUS: Let me give you one more important distinction between the data in Table 8 and Solomon's data.

JUDGE CARPENTER: Fine.

WITNESS JACOBUS: That's the serpentine configuration that accounts for a factor of five. Keep in mind that the measured values in Table 8 are based on the serpentine configuration. Solomon's were strictly terminal to terminal. So we expect right off the bat for the data in Table 8 to be a factor of five higher than the data in Solomon's test.

WITNESS LOVE: I just had one question on that. I guess I'm curious, how do we tell in this data when the data was adjusted and when it wasn't adjusted by a factor of five?

WITNESS JACOBUS: None of the data in Mr. Kraft's report was adjusted. The adjustments were all made in my re-plotting of the data in that report.

WITNESS LOVE: So all of the data in the document here is not adjusted data?

WITNESS JACOBUS: It's not adjusted. It's clearly stated that its' based on the serpentine configuration where there are five parallel paths.

WITNESS LOVE: Just a question.

WITNESS JACOBUS: Fine.

JUDGE BOLLWERK: I think we're -- if you have nothing else that you want to say at this point, we're ready to take a luncheon break.

WITNESS JACOBUS: If Judge Carpenter has no more questions, I'm --

JUDGE CARPENTER: I have a number of more questions, but I'm also hungry.

[Laughter.]

JUDGE CARPENTER: And I'm more rational after I eat.

[Laughter.]

JUDGE BOLLWERK: Let me just ask one question of Mr. Holler. You said yesterday you thought you had about two hours of cross. Is that still true, or can you give me a ball park?

MR. HOLLER: Yes, sir, at the out-side. We may be able to economize on that, but at the out-side, I would like to at least reserve that.

JUDGE BOLLWERK: All right. Why don't we come back at 1:45, then. We stand adjourned until 1:45

[Whereupon, at 12:35 p.m., the hearing recessed for lunch, to reconvene this same day at 1:45 p.m.]

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

[1:45 p.m.]

JUDGE BOLLWERK: I think, at this point, we're ready to begin with the staff's cross examination on this, relative to the surrebuttal testimony on terminal blocks.

MR. HOLLER: Thank you, sir. I assume Dr. Carpenter hadn't more questions? I was not clear about that when we left, when we left whether he had additional questions to ask Dr. Jacobus on the Sandia report.

JUDGE CARPENTER: I thought I would let you do yours first.

MR. HOLLER: Thank you, sir.

CROSS EXAMINATION

BY MR. HOLLER:

Q If I may, sir. During your testimony this morning, gentlemen, had some testimony offered that would seem to indicate that the equipment of issue here was not (b)(1) equipment -- 10 CFR 50.49(b)(1) equipment.

Let me ask you this question. You are certainly not suggesting that the terminal blocks at issue here are not associated with instrument that was required to be qualified in accordance with 10 CFR 50.49(b)(1)?

A [Witness Love] Is this in reference to the RPS instrumentation?

MR. REPKA: Do the witnesses need a copy of the rules to answer that question?

WITNESS LOVE: Well I believe (b)(1) is the part that -- that's the general rule on components.

BY MR. HOLLER:

Q Yes, sir. Just so you're clear on what the question is -- is the 10 CFR 50.49 in all power phase, the Commissions regulations require environmental qualification of the electrical equipment important to safety covered by this section, and then lists safety-related electric equipment -- equipment that is relied upon to remain functional during and following design basis events, to ensure that these three items, one of which is the capability to prevent or mitigate the consequences of an accident.

Quite simply, my question to you, sir, is you don't disagree that this is the regulation that applied to the instrumentation circuits for which the terminal blocks are at issue here?

A [Witness Love] It refers to the -- there are actually two functions at issue here. The first function at issue, I suppose, from what we have already done in this is the reactor protection system SFAST portion, which is the pre-peak condition of the LOCA or main steamline break profile. That portion of the equipment, or the instruments that are required for reactor protection system and SFAST actuation would come under B1, that is correct.

The post-accident function of the instrumentation would come under the Req Guide 1.97 portion of this rule.

Q Let me approach it this way, and I'll come back to that question. Do you agree, from your testimony, that terminal blocks -- or rather the instrumentation circuits for which some of the terminal blocks at issue here were installed, are required on a main steamline break at a temperature of 260 degrees fahrenheit?

A [Witness Love] At 260 degrees fahrenheit, some of the instrumentation here is involved at 260 degrees fahrenheit, that is correct.

Q And am I correct, sir, or do you agree that that is during a design basis accident condition at those elevated temperatures?

A [Witness Love] I have testified and provided profiles which indicate the temperature profile for post-accident conditions, yes. I agree that those are the conditions we're talking about here.

Q But you said for post-accident. My question to you is is that not still during the accident?

A [Witness Love] It is during the postulated event, yes. During it, yes.

Q The post-accident condition -- will you agree the post-accident condition is reached when containment temperatures have reached near ambient conditions or near normal conditions?

A [Witness Love] It's on -- the post-accident monitoring is after peak conditions have been obtained and the operator responses are required as the temperature is reapproaching the cooldown or reapproaching the ambient conditions, yes.

Q Okay. Well, that doesn't quite -- it comes close -- you've said that it's post-peak. I don't disagree with that. But, I was asking you if, after post-peak main steam line break conditions and approaching -- if I was still -- and I'll refer to your testimony on page 181. I'll let you get there first.

A [Witness Love] Okay, I'm there.

Q Let me start with a fresh question, just so that we know where we are at. Is it not your testimony that some of the instrumentation circuits that employed terminal blocks are -- would have been -- well, I'll phrase it this way, because they're no longer in there -- but, at the time, 1987, the time of the inspection, that those instrumentation circuits were required to function at 260 degrees fahrenheit?

A [Witness Love] Yes. Some of them were required to function at 260 degrees fahrenheit.

Q And when they were functioning, would you call that during the dasign basis accident?

A [Witness Love] I consider this complete profile that we're referring to here in my testimony on page 181, which is the reference to the main steamline break temperature envelope -- I consider that total profile tne design basis accident for main steamline break. That is correct.

Q Okay. Is it fair to say then the requirement to environmentally qualify those instrumentation circuits is a requirement of 10 CFR 50.49(b)(1)?

A [Witness Love] It's (b)(1) and (b)(3); (b)(1) on the front, (b)(3) on the back.

Q We're still not together. Are you telling me then, sir, that with regard to, pardon me, their requirement to function at 240 degrees -- it's your testimony now that you require that to be a post-monitoring -- a post accident monitoring function?

A [Witness Love] I am simply saying that there ar two aspects discussed in 10 CFR 50.49.

Q We are quite clear on that, sir.

A [Witness Love] And the post-accident monitoring portion of or function of the instrumentation occurs after peak containment temperature conditicns.

The RPS /SFAST conditions occur prior to attaining peak accident conditions.

Q Is it your testimony, sir, that anything after the peak accident temperature condition is a post-accident monitoring condition?

A [Witness Love] Yes.

MR. HOLLER: Let me ask NRC panel if they have a response on that.

WITNESS JACOBUS: Well, basically, the post-accident monitoring is intended for monitoring, not, as I understand it, for functions where you're going to take action in response to that. Post-accident monitoring is things like high range radiation monitor where you may be taking some actions, however, that is not a primary mitigation function.

The action that has to be taken at 240 to 260 degrees, as I understand it, is a primary mitigation function and therefore falls under (b)(1).

WITNESS LUEHMAN: The only thing I would add to what Dr. Jacobus has said is, also that the -- whether you will or not actually take some action, you have to have the ability during that period -- you may have to have the ability, depending upon the equipment, to monitor those conditions so that you can take action.

The action may not have to occur if things -- everything goes a certain way, but there may have to be action to have some other mitigation happen. So, I don't think that the actual taking the action of mitigation is the lone issue; it's the ability of the equipment to see and monitor what's going on, and that the mitigation action takes place, if it's necessary.

WITNESS LOVE: In the context of our interpretation of the requirements for this instrumentation, from an EQ standpoint, we believe that post-accident instruments in the context -- can't be separated from the context of being required -- what is required for operator action.

We have addressed the instrumentation and when it would need to function in order for operator action -- manual operator action to be taken.

BY MR. HOLLER:

Q Let me try to get at it this way, so that I understand it: You agree with me, sir, going back to (b)(1), and, in particular, 10 CFR 50.49(b)(1)(iii) addresses the capability to prevent or mitigate the consequences of accidents? Then it continues on to say, "that could result in potential offsite exposures;" is that correct?

A [Witness Love] I'm sorry, could you repeat that?

Q I'll let you read it, sir. I'm reading 50.49(b)(1)(iii).

A [Witness Love] Okay, and what is the question?

Q Is it your testimony then, sir, that with regard to the main steam line break, the required operator action of terminating safety injection is not an action that's required to prevent or mitigate the consequences of the accident?

A [Witness Love] I'm not stating that. What I am stating is, in the context of -- I'm trying to define what I believe is intended by separating the two in the rule.

I mean, if it was all the same, then I don't understand why the rule has a separation. It could all be listed as (b)(1), as opposed to (b)(1) and (b)(3). Manual operator action -- all of the actions, as I've testified to, which are required to mitigate this event, main steam line break, occur automatically. They do not require any operator action.

Those automatic actions will result in the reduction of the pre-containment temperature as shown on this graph on page 177. The only operator action for the main steam line break which is required, is to terminate safety injection.

The instrumentation that he would use to terminate safety injection must be capable of providing him the information needed at a temperature much less than peak accident conditions.

Q And it's your testimony that --

A [Witness Love] And that is the post-accident -- that is the required post-accident monitoring instrumentation for this event.

Q Okay, now, Mr. DiBenedetto has testified in part of the surrebuttal testimony that post-accident monitoring is when temperatures have returned to near normal conditions. I paraphrase. I believe that's on page 205 of your testimony, sir.

A [Witness DiBenedetto] It is.

Q The paragraph begins, "During long term cooling defined as the operational period where coolant injection has been terminated and switched to coolant recirculation, post-accident conditions require monitoring. This is the time in the accident scenario where containment temperatures and pressures return to near normal conditions."

And is it your testimony now, sir, that, in fact, that 240 degrees where this action on the main steam line break is required and where, in fact, the temperature will increase to 260 degrees after that action is taken, is part of the long term cooling covered by 10 CFR 50.49(b)(iii)?

A [Witness DiBenedetto] I maintain that that is a point in time after the transients when the transients are returned back to normal conditions. I'm not sure that I could quantify 240 or 260 as near to ambient conditions, but it's in the recovery end of the accident, yes.

A [Witness Love] Recovery meaning this is the portion of the event when operator action is significant, so therefore, monitoring, post-accident monitoring is significant. There is no operator action required on the front end of the transient, the mitigating transient.

Q Gentlemen, let me ask you this way: Am I fair to say that this refinement in what is the requirement for the qualifications, was not raised by your in your response to the NOV? I'll start with that.

M . REPKA: Is the panel aware of this refinement?

WITNESS LOVE: I don't know what we're talking about. This has been the position that was taken pre-'85. I'm not sure what refinement we're talking about. This is the position, as we've testified to, that was understood between the Staff and Alabama Power Company and myself pre-1985.

We're not changing our position.

BY MR. HOLLER:

Q We'll get back to that, sir. We'll talk to that. My question to you is -- let me rephrase it so that there's no question, what I am referring to.

Are you gentlemen aware of a response to the NOV that took the position that there was not a violation of 10 CFR 50.49(b)(i)?

MR. MILLER: Are you asking for the company's legal position?

MR. HOLLER: No, I'm asking if the panel is aware, technically.

MR. MILLER: The reason we're here is that we take the position that 10 CFR 50.49 hadn't been violated. I'm not trying to be cute, but that's the question you asked.

MR. HOLLER: So it's clear for the panel in the question, we're distinguishing between a violation of (b)(i) and a violation of (b)(iii).

BY MR. HOLLER:

Q Let me try it this way, just so it's clear: Is it fair to say that your position -- your testimony is that the qualification of terminal blocks, specifically, the qualification of terminal blocks in instrumentation circuits that are used as part of the termination of safety injection at 240 degrees Fahrenheit, should be addressed as the necessity to qualify a post-accident monitoring -- or, rather, the requirement addressing post-accident monitoring?

A [Witness Love] Yes.

Q Have I confused you?

A [Witness Love] No, you haven't confused me. As I indicated on this graph, that is the post-accident monitoring phase of the transient. That is when manual operator actions --

In other words, the reactor coolant system, the accident that we have postulated here has been mitigated by the automatic actions of the RPS and SFAST system. This is the time now, the recovery phase of the accident, where the operator will be looking at the conditions of the reactor coolant system, and at which point he can control the remaining cooldowns to save shutdown. That is the post-accident monitoring phase of the event.

MR. HOLLER: I will ask the panel if they have a response to that?

WITNESS JACOBUS: Perhaps we should clarify exactly what we mean, up to what time is the accident, and when the post-accident starts. Up until now, I don't think everybody has been on common ground in talking about those terms.

MR. REPKA: Judge Bollwerk, I am not sure I see the relevance of any of this discussion. Whether or not it is a violation of B1 or B3, I think the basic point is, as the witnesses have well testified, is that the instrumentation is not required, at least in the post-accident phase, until after peak conditions. Whether that is B1 or B3, I am at a loss.

MR. MILLER: That is not a fact question, that is a legal question.

WITNESS LOVE: There is a whole separate issue identified as Regulatory Guide 1.97. Are we saying we are going to move all this stuff into that arena now instead of EQ?

I am not sure what we are trying to do here.

JUDGE BOLLWERK: There is an objection pending.

Let's see what Mr. Holler has to say.

MR. HOLLER: I think we are trying to determine if the Alabama Power Company's technical testimony is that th's equipment required qualification under Reg Guide 1.9 , the equipment that was addressed by Reg Guide 1. 7.

WITNESS JONES: Let me try to answer that.

MR. REPKA: Before you do that, Mr. Jones, I would say that I think that has been asked and answered.

Mr. Jones, go ahead.

MR. HOLLER: The answer to that is that --

JUDGE BOLLWERK: Let him answer.

WITNESS JONES: The NOV states the reason for the violation, and I am referring back to our answer and APCO's position regarding the violation, and APCO denies the alleged violation.

MR. HOLLER: Let me move on.

BY MR. HOLLER:

Q Is it fair to say that your understanding of when the terminal blocks were required to function as of November 30th, 1985, was at the initiation of the accident, to have the capability to survive the peak LOCA conditions, and then to function during the long-term cooldown after the termination of the accident?

A [Witness Love] We have testified to that in more detail but that is, in general, correct.

Q Is it your testimony, sir, that that was the understanding of the NRC?

A [Witness Love] Pre-'85, yes, sir.

Q Is it fair to say, too, in your testimony that you have pointed out a number of times, at your meeting in January of 1984 with the NRC, that you told the NRC that you were going to use the post-LOCA insulation resistance, or current leakage data measured in the Wyle Test Report for calculation of EOPs?

A [Witness Love] That is correct.

Q Inherent in that question is, it is clear that they were taking post-LOCA conditions, 70 to 120 degrees, something on that order?

A [Witness Love] That is correct.

Q I will ask you, would it be unreasonable that the NRC understood that you did not require the instruments until post-LOCA -- strike that -- that you did not require the instruments until cooldown condition that that would be consistent with taking IR measurements between 70 and 120 degrees?

MR. REPKA: That question confuses me, but I think it calls for speculation as to what was in the NRC's mind, and we don't have anybody here from the NRC who was there.

BY MR. HOLLER:

Q Let me phrase it to you this way then, sir, as an engineer, if you knew that instrumentation circuits were not required until temperatures had returned to, using Mr. DiBenedetto's words, near normal conditions, it would be unreasonable to apply insulation resistance values taken at 70 to 120 degrees in calculating the instrument error caused by that?

A [Witness Jones] If I may try to answer that, since I was at the meeting.

Q I was asking the electrical engineer, but please go ahead, whoever wants to go first.

A [Witness Jones] I didn't mean to interrupt.

Q Either one.

A [Witness Love] Again, let's put ourselves in the time frame of the 1984 meeting, in the time frame of the 1984 meeting, you are asking me for my opinion as an engineer, my opinion as an engineer, at that time, is, I was aware, although certainly not to the level of detail that I may be aware today, but I was aware of information indicating that terminal block insulation resistance does, indeed, recover with temperature, and that it is varying with temperature in a post-accident type of environment.

I believe that information, and knowing that the block recovery is very significant as the containment temperature cools down, was the common base of knowledge between ourselves, in the January 1984 meeting, and the NRC staff members that were at that meeting, and I do not believe that there was anything indicated that was refuting the fact, including the IE-8447 information as it was then understood.

It indicated a dependence on temperature, and that there was a recovery of insulation resistance as the blocks cooled down.

So for the post-accident monitoring instrumentations -- and I might add, in the context of this meeting, I recall that there was a lot of discussion about Reg Guide 1.97 because this was another regulation that the power company was trying to comply with at that time.

In this meeting, since Reg Guide 1.97 also imposed for Category I equipment EQ requirements referencing them back to the EQ rule, there was a lot of discussion as to how was this to be accomplished. In other words, was it to be covered under Reg Guide 1.97 submittals, was it to be covered under documentation for 50.49, how was it to be done?

As a part of that discussion, the common base of knowledge at that time that was there in that room agreed for post-accident monitoring that we would modify the ERPs or EOPs, which ever way you want to call them, and use the post-LOCA leakage currents form the Wyle Test Report on the States terminal blocks. That was conclusively agreed with.

I just want to go to the front-end of the transient. On the front-end of the transient, and I believe, as I testified to, and I believe Reg Guide 1.9 gives words that reflect the thinking on the front-end of the transient, but for the very extreme transients that we are talking about here that are used for qualifying EQ equipment, the assumptions that are made here to develop these profiles, and the actions required to mitigate these events, which are all described in Chapter 15 of the accident analysis, I believe, the accident analysis themselves are clear in indicating that the required response to these events is automatic, and that there is no operator action required, and that was the common knowledge of both the staff and the licensee at this point in time.

Q Mr. Jones?

A [Witness Jones] I just basically add about Reg Guide 1.97 -- I mean that was being discussed at that time. That was well known by the NRC and the term "post-accident monitoring equipment" was a term that was developed by the NRC and given to the licensee. I mean that wasn't something that Alabama Power Company made up, recognizing that we're not talking about after a 30-day event. We are talking about after the peak LOCA condition.

So it was a common terminology there between the licensee and the NRC and I don't see any source of confusion.

A [Witness Love.] Okay. Maybe another clarification point is that this same philosophy was used for the instruments themselves, so I mean we've extended this to terminal blocks in this discussion but this was the philosophy and I believe Mr. DiBenedetto can testify to that as well.

This was the understanding for instruments as well in terms of their performance requirement, that they need to function in the portions of the harsh environment where their action is required. That is all that was required to be demonstrated.

I believe you have asked me for the pre-'85 understanding, that is my belief of the pre-'85 understanding.

A [Witness DiBenedetto] I agree with what Mr. Love said and there's probably one other factor, the instruments themselves were tested of course differently than a terminal block. The terminal blocks, as we have discussed, don't exhibit permanent deformation, permanent degradation whereas there is a potential through the dormancy period if you would call it that, the instrument that it could get damaged, so they were tested the full range to demonstrate again they would operate when they had to operate, at the beginning and at the very end.

Q Okay, gentlemen. Just I want to be clear, so the record is clear, Mr. Love, did you testify that you were at the meeting with the NRC?

A [Witness Love.] Yes, I definitely was.

Q And of course, Mr. Jones, you testified that you don't recall these discussions, I believe in your earlier testimony?

A [Witness Jones] I didn't recall a specific statement that you asked me what was made. I remember the general discussion in instrumentation and post-accident monitoring equipment relative to 1.97 requirements was discussed in detail.

Q I see. Let me approach it this way. Certainly you knew during that meeting that you required certain instrumentation at 140 degrees F. after a main steam line break. I just want to make clear -- you knew that at the time of the meeting?

A [Witness Love.] Well, I knew that there was instrumentation that would be required for manual action post-accident for operator action. I knew that. The NRC knew that.

Q Yes, sir. I want to ask you if you knew -- well, you don't know the NRC knew that, though, do you sir? I mean for a particular temperature?

A [Witness Love.] Well, the NRC, these profiles that I have in here are out of the FSAR and they are the licensing basis for the Chapter 15 accident analysis for Farley Nuclear Plant.

Q Okay, well, let me ask it this way. During that one-day meeting where all these things were discussed, you can't testify that the NRC knew you had instrumentation circuits with terminal blocks that needed to function at we'll say 240 degrees, is that fair?

A [Witness Love.] The NRC knew that, yes. They did. That was the purpose of having the discussion, for determining what value of leakage current would we use in the ERPs. That was the purpose of having that discussion, that aspect of the discussion.

Q Okay. I want to be clear on this. Then you are telling me -- well, let me present this as by saying Mr. Shemanski has said he doesn't recall the details of it. Earlier Mr. Jones didn't but now recalls the discussion of 1.97 but you are telling me that you specifically discussed requiring instruments that employ terminal blocks at temperatures to 240 degrees, if you recall, sir?

A [Witness Love.] I am not going to tell you a specific temperature. What I am going to tell you is the fact that we had post-accident monitoring instrumentation that would be required to operate post-peak, to take some manual actions was understood and that the resolution of that issue was to use the values of leakage current from the state's terminal block testing and I recall this because perhaps I was there -- one of the reasons I was at that meeting was for this purpose, to discuss this activity and I was involved in providing that information for Alabama Power Company to Westinghouse so I wanted to make sure that I understood the issue and that I would capture the data that would be required to be given to Westinghouse for the ERPs and that was one of my functions in this meeting.

Q If I understood though, the first part of your testimony is that you will not testify, you can't testify as to specific temperatures?

A I don't recall discussing a specific temperature, no.

Q No, and then my next question to you is though you knew at the time that you required at least some of those instruments at 240 degrees, is that fair?

A [Witness Love.] I'm sorry?

Q You knew at the time of the January meeting, January, 1984, that some of the instrumentation using terminal blocks would be required at temperatures of 240 degrees?

A [Witness Love.] Vis-a-vis they were at post-accident, required for post-accident mitigation. Yes, I understood that. So did the NRC understand that. In fact, these instruments are discussed in the FSAR.

Q Yes, sir, but my question is just if you understood that, you knew the 240 degrees --

A [Witness Love.] Yes. I mean -- I understood the tail of the profile.

A [Witness Jones] And I would just like to add that, I mean we are going back over this again but I think Mr. Shemanski has also agreed that he was in a NRC meeting just a few days before our meeting and this issue was clearly understood by the NRC. I mean we left that meeting on common grounds. They knew as much as we did and we knew as much as they did.

Q Sir, I think the reason we're here is to try to determine just what was known. We have your testimony to go on and you gentlemen were there and we have what is written in your minutes of February 29th, 1984 and that is what I attempting to establish.

Let me go on to the next point. Mr. Love, you have testified then that you knew that. Also directing your attention now -- I'm sorry?

MR. REPKA: Excuse me. You just recaptured his testimony and you said "You testified that you knew 'that'" -- what do you mean by 'that?'

BY MR. HOLLER:

Q Mr. Love has testified and correct me if I am wrong, sir, that you were aware that at least some of the instruments will be required at 240 degrees?

A [Witness Love.] Post-accident, yes.

MR. HOLLER: Not to cut them off, I'll let --

MR. REPKA: No, you can ask your questions. Just when you were recharacterizing a witness's testimony I would like it to be clear what it is you're saying. That's all.

BY MR. HOLLER:

Q Let me refer now to IN 84.47, which is Staff Exhibit 48. I'll ask if you have a copy of that.

A [Witness Jones] What's the Staff Exhibit?

Q Staff Exhibit 48.

I'm going to direct your attention to page three of four, and the third paragraph of the discussion.

A [Witness Love] Yes.

Q If you're with me there, about the middle of that paragraph or -- it's the second full sentence -- begins with: "Although no written response to this notice is required, it is suggested that licensees and construction permit holders..." -- and it lists to items, one of which is "to review facilities to determine if terminal blocks are used in low voltage applications."

And the second is: "To review terminal block qualification documents to ensure that the functional requirements and associated loop accuracies of circuits utilizing terminal block will not degrade to an unacceptable level due to the flow of leakage of currents that might occur during design basis events."

A [Witness Love] Yes, sir.

Q My question to you, sir, is that, one, you were aware of this requirement prior to November -- strike that. You were aware of this notice prior to November 30th, 1985?

A [Witness Love] Yes, we were.

A [Witness Jones] Yes.

Q Is it not fair to say then, if you knew you required a terminal block to function or a circuit with a terminal block to function at 240 degrees, that you would review that to make sure that the flow of leakage currents that might have occurred during design basis accident would not contribute to the inaccuracy of that instrument?

A [Witness Love] I believe we've already testified specifically to this aspect of Reg Guide -- I'm sorry, IEN-84-47, in our previous testimony. And there we indicated that, from our perspective, this is exactly what we had already done. We had identified the instrument circuits, terminal blocks via our master list. We had -- and the fact that they were instrument circuits. And we had the meeting with the NRC to spacifically discuss how we were going to handle this issue.

A [Witness Jones] And we also documented it in our meeting minutes. So, this issue was discussed in the meeting in January of '84. So, as we've testified before, when this notice came out, it was clear to us that this issue had already been addressed and agreed to at the meeting.

A [Witness Love] And we had submitted the values shortly after that meeting. I was involved in the discussions with Westinghouse in preparing the letter to forward the data to Westinghouse, as a result of this meeting, which we did exercise.

I believe Mr. McKinney testified yesterday that the ERPs were revised to include that data.

Q Okay. Just so I am clear on this. Is it fair to say, as an engineer, you found it acceptable to use data taken at temperatures between 70 and 120 degrees to support the functioning of a piece of equipment at 240 degrees?

A [Witness Love] The state of our knowledge at that point in time, we felt that was adequate, and so did the NRC staff.

Q Well, now, sir, you can't testify to the NRC what they thought.

A [Witness Jones] They agreed to it in the SER in December of '84. They referenced our meeting minutes. It is clear, in my mind, that not only do we believe that was the right thing to do at that time, the NRC agreed to it.

Q Let's take that one step at a time. correct me if I am wrong, but you testified that you do not recall temperatures being discussed during that meeting; is that fair?

A [Witness Jones] The --

A [Witness Love] Specific temperatures, no.

A [Witness Jones] The way we were going to resolve the issues was documented in our meeting minutes.

Q We will get to that, sir.

A [Witness Jones] Precisely.

Q Mr. Love has answered the first part of the question. If you want to add to that one, please do. But, let me go to the -- so the answer, I take it is no.

A [Witness Love] I don't recall. I mean, to be honest with you, I don't recall whether we discussed specific temperatures or not.

Q Now, Mr. Jones, in fairness to you, I believe you were referring to what's previously been identified as APCo Exhibit 20. Yes. APCo Exhibit 20; is that correct, sir? This is the letter of January 29th, 1984?

A [Witness Jone , Yes, if that's the January 29th, '84 letter, I agree.

Q I guess it's even easier if we refer to -- and maybe you gentlemen can help me. I think you've included that pertinent part -- people have been digging for that -- in your testimony, haven't you?

A [Witness Jones] We've testified to this a number of times.

Q I direct your attention to page 124 of this surrebuttal testimony.

A [Witness Jones] We're there.

Q This is an important point. I will ask your indulgence and get to it. Fair to say -- and we're referring here to APCo's response to the NRC comment addressed the current leakage of States terminal blocks and its affect on equipment within the scope of 10 CFR 50.49; is that correct?

A [Witness Jones] That's correct.

Q Okay. I'll try paraphrasing and see if you agree with that. You've told the NRC that you were going to take, using the Wyle test data, that you would attach instrumentation of the conclusion of the LOCA test -- strike that. That you would take the leakage current values that were recorded at the conclusion of the LOCA test, and use those in the development of the revised emergency operating procedures; is that correct?

A [Witness Jones] Correct.

Q And this is what we have written. This is what we have to go on. So, it's fair to say you told the NRC we're going to take that post-LOCA data which the NRC, I think you've testified, knew had been taken, and use that to calculate your EOPs?

A [Witness Jones] Right.

Q But there's nothing in here that says that you used those for terminal blocks at any particular temperature, sir; is that fair to say?

A [Witness Jones] No. It's not in there.

Q Okay. Is it anywhere else other than --

A [Witness Jones] No.

Q So, we have -- before I leave this, just so we're clear, this testimony, and we have your testimony that you discussed post-LOCA conditions; is that correct -- during the meeting January 11th, 1984?

A [Witness Love] We discussed Reg Guide 1.97 instrumentation. We discussed the issue of leakage current in terminal blocks, and how should that be handled in light of the post-accident monitoring instrumentation, and this was the resolution of that discussion.

I mean, the NRC was aware, at that time, of the Wyle Test Report, which we used to qualify the States terminal blocks. The words are clear here. Conclusion of the LOCA test, the leakage values were recorded. Familiarity with that report and familiarity with this should answer that part of the qu tion. So, there shouldn't have been any misunderstanding. I do not believe there was any misunderstanding about the data that we were going to submit to Westinghouse upon the staff's concurrence on that approach.

We did get the staff's concurrence on that approach.

Q I think we covered the other things.

MR. HOLLER: Let me turn to the panel, and see if they had any other questions on that?

WITNESS JACOBUS: I think you have covered it.

MR. MILLER: Thank you for that.

JUDGE MORRIS: Let me interject a question because it hasn't been brought up.

Would you turn to 50.49, Paragraph J, and maybe you could read it out-loud.

WITNESS JONES: Yes. "A record of qualification including documentation in Paragraph D of this section must be maintained in an auditable form for the entire period during which the covered item is installed in the nuclear plant, or is stored for future use to permit verification that each item of electrical equipment important to safety is covered by this section: 1) is qualified for its application; and 2) meets its specified performance requirements when it is subjected to the conditions predicted to be present when it must perform its safety related function up to the end of its qualified life."

JUDGE MORRIS: Did you discuss this in this January meeting, was this the basis for saying that the terminal box needed only to perform post-peak sometime later?

WITNESS JONES: Yes, sir. That was clearly understood by both parties that you need to qualify your equipment when they are called upon to perform their safety functions.

JUDGE MORRIS: Thank you.

Excuse the interruption, Mr. Holler.

BY MR. HOLLER:

Q Let me move along in time to November 1987, and the inspection at Farley. Is it fair to say, gentlemen, that in the inspection, the environment qualification file that was presented to the NRC inspectors did not contain reference to the February 29th, 1984, letter?

A [Witness Jones] Would you repeat the question?

Q Sure.

The February 29th, 1984, letter which was identified as APCO Exhibit 20, my question to you is, with reference to that, at the time of the inspection in November of 1987, that the environmental qualification file did not contain reference to that letter?

A [Witness Jones] Maybe I will defer.

MR. REPKA: I will stipulate that Dr. Jacobus has already testified that he never saw it.

WITNESS LOVE: But, again, I don't believe that we felt that it was necessary to keep the EQSER in each package of environmental qualification equipment.

MR. HOLLER: Yes, sir.

BY MR. HOLLER:

Q So that there is no confusion in the record, though, I am not referring to the EQSER.

A [Witness Love] That is what makes the link to this letter from the standpoint of agreement.

Q That may be, sir.

You have testified that the SER wasn't there, and I take that as a no that the letter or reference to the letter was not included in the qualification file?

A [Witness Jones] In the package, I don't know if it was or wasn't. I need to go back and review the package.

JUDGE MORRIS: Doesn't the package have a list of contents, wouldn't that be fairly quick?

WITNESS JONES: Yes, sir. That would be something that we could do. I don't have the index with me.

JUDGE MORRIS: Okay.

MR. REPKA: For the sake of the record, I think it should be clear that by 1987 the world had moved on, and APCO Exhibit 52 was, by then, the basis of qualification.

WITNESS LOVE: Right. At the time frame of the inspection, as was pointed out here, the basis for ERPs and ERP calculations had already evolved, and we have testified to that.

If you will, the base had changed in terms of what was to be included in the ERPs, and what was in the process of being performed at that time. It had already evolved past that. Instrumentation uncertainty calculations had already started to evolve and were evolving in the industry in at least one other version of the ERPs was already in place at the time of the '87 inspection.

The ERPs had changed from their pre-November 30th, '85, conditions based on the next evolution of the instrument uncertainty ERP calculations.

WITNESS JONES: If I may, prior to the inspection in the September '87 time frame, I had a discussion with Mr. DiBenedetto, and based on his knowledge of audits that were being conducted by the NRC at that time frame, the level of documentation needed to be enhanced in our file, and we went about doing that prior to the inspection.

BY MR. HOLLER:

Q Is it fair to say, gentlemen, aren't you telling me then that your basis for qualification at the time of the inspection and what you presented to the inspectors was not what you had before, this is something new, is that correct?

A [Witness Love] May I just address that, from this standpoint, if you were to go to Farley Nuclear Plant today, the EQ qualification documentation that exists in the file does not look like it did November 30th, 1985. It has progressed as the rest of the industry has progressed, and as the expected standard has come up, the level of documentation has come up.

So if you were to look at a file today at Farley Nuclear Plant, it would not look like the files that existed at the time of November 30th, 1985.

Q You agree, sir, though, that you had the requirement to maintain an auditable file, is that correct?

A [Witness Jones] Yes. No question.

Q And you will agree that the file that you presented to the NRC inspectors reflected -- if I can use that term for now -- the way you were approaching terminal blocks as of November 1987, is that a fair statement?

A [Witness Jones] That is correct.

MR. REPKA: And I will remind Mr. Holler that the basis for enforcement was, under the modified enforcement policy, compliance as of November 30th, 1985, plus what the licensee knew or clearly should have known prior to November 30th of 1985.

MR. HOLLER: I thank Mr. Repka for his instruction, and I will go on.

JUDGE BOLLWERK: We are hearing a lot of testifying from counsel. Let's sort of keep it to a minimum. We want to hear from the witnesses. We recognize what the basis of it is.

MR. REPKA: I have a feeling we are going off on a tangent, that is all.

JUDGE BOLLWERK: All right.

BY MR. HOLLER:

Q If I may, to my third question, sir and have you not testified that there was no reference in your file to the previous qualification?

A [Witness Jones] I don't know if that was in the file without looking at the index per se, or whether it was referenced. Obviously, while a file needs to be auditable, not every piece of documentation to answer every question has to be in that qualification package. So, we had that safety evaluation, our meeting minutes, where we could retrieve them. Granted, they may not have been in that package. I don't know. I really don't know what that has to do with.

A [Witness DiBenedetto] Let me add, David, if you recall, during the inspection both Mr. Jones and I spoke to two of the Sandia inspectors, iterating back our position on the use of terminal blocks and how they were being used, and how they were being qualified for application.

The first inspector was only there for a day, and he was going to relay this information to Dr. Jacobus. Again, David Jones and I spoke to Dr. Jacobus about qualification for application of the terminal blocks. He kind of indicated that he understood, he agreed, and then the next thing we knew, at the exit interview, or the exit meeting that day, was that there was a problem with the way we were qualifying our blocks.

This happened during the audit.

A [Witness Jones] And it was brought to their attention during the audit. The NRC inspectors were aware of it, and there was a lot of discussion about our historical position on terminal blocks in our agreement with the staff at the exit meeting. So I don't think there was any misunderstanding when the inspectors left our site in November '87 what our historical position was on terminal blocks.

A [Witness DiBenedetto] Let me add one other thing, because a lot happened during that audit. In our trying to support the position and where we were in 1981, '84, '85 and '87, there was some confusion. Mr. Wilson and Dr. Jacobus both wanted more information, and we requested Westinghouse to come in to further elaborate on the reactor protection system, the EOPs that were being generated, and the accuracy of studies that were going on to put it all together and put it back into perspective.

Q Now, you've testified as to what information was given, related orally to the inspectors.

MR. HOLLER: Let me ask NRC if they have a comment on that.

WITNESS JACOBUS: I guess the first comment that kind of puts it all together is that no temperature was provided to us where the terminal blocks had to function. If anything was presented, it was merely this argument that it functions early, it functions late, therefore, the post-accident data is acceptable.

That argument, to the best of my knowledge, was not in the file itself and there was no temperature anywhere in the file that I know of other than on the skew sheet as a basis for the temperature that these terminal blocks had to function. Therefore, all that I can assume is that the terminal blocks need to function at that temperature barring any additional data.

JUDGE MORRIS: At that temperature meaning the complete profile on the skew sheet?

WITNESS JACOBUS: The skew sheet summarizes the data, gives the peak temperature value. If I see nothing in the rest of the file or nothing is provided to me saying the temperature that we actually need these for, I cannot make a determination that they are needed at 240, 260, 300, 309. All I can assume is that they are in fact needed at the temperature as outlined on the skew sheet.

JUDGE MORRIS: As I recall now, the skew sheet lists only the numerical peak temperature.

WITNESS JACOBUS: That's correct.

JUDGE MORRIS: There is also a plot of the temperature profile during the accident.

WITNESS JACOBUS: That's correct.

JUDGE MORRIS: Was that available?

WITNESS JACOBUS: That's normally -- often it's attached to a skew sheet.

JUDGE MORRIS: Was that available to you during the inspection?

WITNESS JACOBUS: I don't recall whether that -- I suspect that that was probably in there. I think I have one now. But likewise, there is nothing on that profile that says it only has to function above this temperature. That profile is merely the profile, and I have no basis to pick off a value of 240 or 260. It's taken us up until the surrebuttal testimony to finally figure out what temperature the blocks really needed to work at.

JUDGE MORRIS: Thank you.

MR. HOLLER: Let me -- Mr. Love?

WITNESS LOVE: Well, I just have a comment. I mean, we have testified in response to this -- to Mr. Jacobus' viewpoints on this already in our testimony, but I would just like to add, and I don't have the exhibit number here, but EQ Action Item 67 and 18, which has an exhibit number -- Mr. Jacobus did review this document and it does indicate that for the 1987 RPS/SVAS and ERP setpoints, we were using a value of 1E7 ohms and it did provide references to how we developed that number. So that information was available to him.

WITNESS JACOBUS: Okay. Let me comment on that, if I may. I agree that that information was available to me. That was the data that was taken at 150 degrees fahrenheit. Based on that, the only thing I would be able to conclude, using reverse logic, would be saying, therefore they must only need them at 150 degrees fahrenheit and below.

We have finally found out on the surrebuttal testimony that that is in fact not correct. They are needed up as high as 260 at least, perhaps to higher temperatures during the transient.

WITNESS LOVE: But again, I would like to state that the value -- since we are talking about a dynamic process here, a transient process, the way the ERP calculations had evolved, they were not -- the method of using a number in the ERP setpoints in order not to bound the conditions, there was some engineering judgment involved in that, and what we had documented was what we believed our basis and what I believe the basis to be for selecting that value to bound the conditions when the instrumentation would be required to operate post LOCA.

JUDGE CARPENTER: Mr. Love, to be sure I understand, would you identify again for me the instrument circuit that's the most critical here that involves the 280 degrees? Which circuit are we talking about?

WITNESS LOVE: Okay. For the -- I believe it's on Page 181. Let me get there.

[Pause.]

WITNESS LOVE: Okay. The number of 240 degrees and then the post LOCA numbers of 260 I have discussed on Page 181. No manual operator action -- and we're referring to the main steamline break now because this has the higher post peak temperatures, higher than the LOCA profile. For this particular event, the wide range pressure and pressurizer level would be the two signals that would be required for termination of safety injection, and I have described that on Page 181.

JUDGE CARPENTER: Having identified that

particular instrumentation circuit as being associated with these particular temperature values --

WITNESS LOVE: Yes.

JUDGE CARPENTER: -- I think you keep saying there is evolution, and there are a lot of aspects that I see change over time.

WITNESS LOVE: Yes.

JUDGE CARPENTER: But whatever changed that caused any change of view with respect to when that circuit was going to be needed and what was the temperature at that point in time? How was that evolving, or had it just not yet been looked at?

WITNESS LOVE: In terms of the EOPs, the EOPs that APCo would have had in place, pre-'85 deadline, I believe, and, you know, I -- if we were to look at those, they would have had an operator action for termination of safety injection using RCS wide range pressure and pressurizer level. That would have been there pre-'85, so does that answer your question?

[No response.]

WITNESS LOVE: And there would have been some value in those ERPs that would have been determined with an uncertainty band of when that action should take place.

JUDGE CARPENTER: But this is to ask the same question in another way, just to make sure I understand: My real point was, when you had these conversations with the NRC in 1984, was the need for that circuit and the temperature likely to exist when that need occurred, part of that discussion, or is this something that was identified subsequently?

WITNESS LOVE: Yes.

JUDGE CARPENTER: I'm trying to be clear whether it's -- what's evolving specifically.

WITNESS LOVE: Okay, the instrumentation that would be used to terminate safety injection for this event, that was known, and, I believe, understood, by the NRC as well as the client and that action was understood; that that manual action had to take place was understood in the -- by the staff in the '84 meeting.

JUDGE CARPENTER: And the staff, at that point in time took tests at lower temperatures as being adequate for this higher temperature?

WITNESS LOVE: Again, the values for the numbers that were assumed back then, the other aspect of this is the instrument itself. The instrument itself was believed -- and we testified to this before -- it had a very large error band.

JUDGE CARPENTER: Thank you for refreshing my memory.

WITNESS JACOBUS: May I make just one point on that?

JUDGE CARPENTER: Yes.

WITNESS JACOBUS: Mr. DiBenedetto has also previously testified that the testing associated with Information N tice 8447 and 8447 itself, were the first generic information for the licensees that perhaps terminal blocks really were a significant contributor and that's something you better look at.

It's not adequate to treat the sensor all by itself.

WITNESS DiBENEDETTO: We don't disagree that 84-47 put the utilities on notice about the use or application of terminal blocks. What we're saying is that they had an evaluation in place, they had a basis in place. They reevaluated it when 84-47 came out and said, basically the story still remains the same. We have not changed our position, and we feel that the story that was put in place is adequate in that 84-47 is not a concern to us.

JUDGE CARPENTER: I didn't mean to open up a re-plowing of each and every furrow. It was just something that I didn't remember in this context, and it is that there was this guidance, but it was looked at against the preoccupation with the sensor inaccuracy which subsequently turned out not to be a sound position.

That's the way I understand the testimony and however it is, we'll dig it out of the record. Let's don't recreate more.

JUDGE MORRIS: I want to ask a quick question of Dr. Jacobus, and you may not be able to give me a quick answer, and you can think about it and maybe answer later. But in the surrebuttal testimony, the temperature of 240 degrees which en rises to 260 after the cessation of emergency cooling, says that from the temperature profile of the accident, the ambient temperature is that.

From what you've told us, and when temperature is decreasing, there's a thermal lag in the block itself, and I would be interested in whether that's minor or significant at that time, at that temperature.

WITNESS JACOBUS: I think I can probably give you an answer to that right now. Basically, at 240 degrees, because the transient peak is so quick, the block probably would not have heated all the way through.

So, at 240, it's not clear whether it would be the internals of the block would be a heating up mechanism or a cooling down mechanism. Is that addressing your question? I'm not sure.

JUDGE MORRIS: No. I'm interested in the leakage current on the surface, and would there be a lag in the temperature which would affect that during this downward trend after the peak?

WITNESS JACOBUS: I think that's going to be very difficult to say because of the -- as I mentioned earlier, the time to come to equilibrium is on the order of an hour or a little more, perhaps. As we looked at the figure this morning, it may even be up as long as several hours, so you're never really going to attain equilibrium throughout much of this profile, I wouldn't think.

JUDGE MORRIS: What you've told me, I think, is that it's very uncertain because you don't know whether relative parts of the block are heating up or cooling down at this time?

WITNESS JACOBUS: I would have to say that, yes.

JUDGE MORRIS: Okay, thank you.

BY MR. HOLLER:

Q Okay, gentlemen, if I may, let me try something and see if we can get here quickly. Would you agree with me that the data in the Wylie test report 443541 -- this is the test report on which you relied in 1984 -- does not contain data that would give you an indication of insulation resistance at -- of a terminal block at 240 degrees?

I want to be clear that I'm not asking you whether or not you required it; we've been through there. I'm just asking you, you'll agree with me that that data is not in that test report?

A [Witness Love] The data was not recorded at that temperature in the test report; that's correct.

Q And would you agree that you cannot extrapolate or you cannot extract from that report, data that would give you an indication of the insulation resistance at 240 degrees?

A [Witness Love] I'm not -- that was not the method that was used at that time.

Q I understand, sir. I'm just asking you, whatever method you wanted, if that's --

A [Witness Love] I'm not sure. I mean, in terms of trying to develop characteristics for terminal blocks, it appears that there is a characteristic, at least from my perspective, that we can develop and that's what we have been looking at here, is that realistic or not realistic in terms of how it would change with temperature under a harsh environment condition.

Q Okay, sir. Let me try it this way and then we can move on to the next report. Accidents showing a similarity to another terminal block that had been tested in another test report, can you find the data in the Wylie test report that would give you insulation resistance at 240 degrees for a terminal block?

A [Witness Love] If the information had been recorded in that manner, knowing what we all know today, then we would have used that data.

Q Is that a no or a yes, sir?

A [Witness Love] It's not there.

Q It's not there. Okay, and let me move on to the CONAX test report which is a report which, I believe, you indicated that at the time of the inspection, you referred the inspectors to as the basis for the one times ten to the seventh insulation resistance value used to calculate the next set of EOPs; is that correct, sir?

A [Witness Love] This would be IPS-107.

Q Yes, sir.

A [Witness Love] That is correct.

Q I would ask you the same background. Is there data directly from IPS-107 that shows what insulation resistance of a terminal block would be at 240 degrees Fahrenheit?

A [Witness Love] The data is not specifically there at that temperature, however, the data is there during the cooldown period of the transient and it is there during the portion of the simulated post-LOCA testing when the containment sprays are operating and at the portion that would be indicative of what would be the case for when the post-accident monitoring would have to operate.

Q I understand that, but we are putting that aside. The issue here is for this value of 240 degrees without any reference to Farley, I just want to know if you agree with me that the data is not in the CONAX test report that can give you an insulation resistance value for a terminal block excluding --

A [Witness Love] Would you give me just one second?

Q Yes, sir, please.

MR. HOLLER: Perhaps we could take five minutes.

JUDGE BOLLWERK: Mr. Love, is five minutes sufficient?

WITNESS LOVE: Five minutes is fine.

JUDGE BOLLWERK: Why don't we take a five minute break here at this point.

JUDGE CARPENTER: I might comment that you are saving a lot of time, you are asking some of my questions.

[Brief recess.]

JUDGE BOLLWERK: I believe we had a question about the CONAX report that was pending.

MR. HOLLER: Yes, sir.

BY MR. HOLLER:

Q Would you like me to repeat the question, Mr. Love?

A [Witness Love] I believe the question was 260, was that correct, or 240?

Q 260 degrees, or 240, I won't quibble over that.

A [Witness Love] Data was not report at those specific values.

JUDGE BOLLWERK: Just so that it is clear, the exhibit number for that is what?

MR. REPKA: Are we referring to test IPS-107?

MR. HOLLER: Yes.

MR. REPKA: The one page graph is APCO 53, and the full redacted version is APCO 124.

JUDGE BOLLWERK: All right. Very good.

I am sorry, Mr. Holler, I interrupted you.

MR. HOLLER: Thank you, sir.

BY MR. HOLLER:

Q Mr. Love, just to make it clear, I think you have testified those temperatures were not in there, but I think my specific question to you is, can one determine the insulation resistance for a terminal block at 240 degrees from the information in the CONAX report or IPS-107?

A [Witness Love] This gets back to looking at the method that I used for judgment here. The actual value is not here, no. What I did is, I looked at the test data available. I looked at the profile, the environmental conditions that the terminal block was being exposed to, and it was a PWR profile, which enveloped the Farley conditions, was also conservative, in my mind, in that the spray portion of the test was continued for 240 hours, so the actual spray solution in the chamber was continuously operated while the block was at 150 degrees, or approximately 150 degrees fahrenheit at that portion of the test.

Then, in reviewing that information, which is contained on the Graph No. 1 of that report, I selected a value of IR lower than the value recorded for the aged terminal blocks that were in that portion of the test, and that value was 1E7 ohms.

Q I followed along, except for the mechanism of how you got from 150 degrees to 240 degrees?

A [Witness Love] That was based on my engineering judgment that this particular test, the way it was conducted, and the severity of the continuous spray portion of the test on the terminal blocks that using a value lower than the value of resistance that they measured with the sprays continuously on, in my engineering judgment, was conservative.

Q I want to be clear on this, and this is engineering judgment absent an Arrhenius calculation to go from 150 to some higher temperature, just based on those factors you have told us, nothing else, you judged that this block would have that same value at 240 degrees?

A [Witness Love] The block would not have that same --

What I am trying to explain is, the value of block resistance as is evidenced in the SAND report, and also in some of the circuitry that is shown in the summary documentation of the SAND report, that report indicates that there is, at least it indicated to me that the insulation resistance or the leakage current will vary with temperature, that that characteristic exists.

What we are trying to do here is put absolutes on something. It indicated ranges of change, and those ranges of change were consistent within the temperatures that we are dealing with here at Farley post-LOCA.

My judgment on that was partially based on looking at the NUREG for the transmitter circuit. I believe I testified to that in my testimony, and we can find that page, I believe it was page 85.

In looking at the transmitter circuit, where the cooldown occurred from --

Let me find that page.

WITNESS LOVE: It's Page 85 in Staff Exhibit 74. If one observes the transmitter circuit output as it was recorded when the temperature was decreased in the test chamber, this graph depicts a definite following of recovery of that current trace with the decrease in temperature. I had looked at this documentation when I was thinking about this issue.

I believe also in the SAND 83-1617 data on Page 48, it also shows a trace of the insulation resistance versus a thermocouple temperature in the -- and indicates that the insulation resistance will follow the temperature of the block in a linear fashion.

WITNESS JACOBUS: May I comment on that at this point? Are you finished?

JUDGE CARPENTER: Can I interrupt? At a previous gathering, I tried to suggest the fact that if you think the relationship between one variable and another variable, X is equal to A times Y, I think of that as linear. If you think the relationship is something other than that, please don't call it linear because I get confused. If you mean it's exponential, please say exponential. Words here are very confusing. You said it's linear, directly proportionate.

WITNESS LOVE: I'm sorry.

JUDGE CARPENTER: Yes. But I don't know why you flinch from the briefer, more succinct expression that's equally accurate. Just say it's exponential instead of a lot of words --

WITNESS LOVE: It's exponential. I'm sorry. It's exponential.

WITNESS JACOBUS: May I comment?

MR. HOLLER: If Mr. Love is finished, Dr. Jacobus, you had a response to Mr. Love's comment?

WITNESS JACOBUS: Yes.

MR. HOLLER: Or a comment to Mr. Love's response.

WITNESS JACOBUS: I think, Gene, you have a figure that I've plotted using the data on Page 48 that is using a log scale to assess if that in fact does indicate linearity.

MR. HOLLER: If I may so it will be easier for people to follow, let me mark for purposes of identification Staff Exhibit 84, the graph that Dr. Jacobus has referenced here, and I will allow Dr. Jacobus, while I'm passing these out, if he would, to describe what it is, Staff Exhibit 84 is.

JUDGE BOLLWERK: Do we want to give this some kind of title before he describes it? I think the other one, we called it staff IR versus temperature data. I don't know what --

WITNESS JACOBUS. How about if we call it staff IR versus temperature data from Figure 26?

MR. HOLLER: Just so the record's clear, what the staff has marked for identification as Staff Exhibit 84 is staff IR versus temperature data from Figure 26.

JUDGE BOLLWERK: All right. Let the record reflect that Staff Exhibit 84 has been marked for identification.

[Staff Exhibit 84 was marked for identification.]

MR. REPKA: I would also like to ask that the record reflect that we have never seen this document before, and by way of voir dire, I would ask the Board's indulgence to ask Dr. Jacobus when he prepared this exhibit.

JUDGE BOLLWERK: Go ahead.

WITNESS JACOBUS: I prepared this document in response to the Alabama Power Company surrebuttal testimony that claimed Figure 26 demonstrated a linear relationship on a log scale, and I plotted this data to see if that, in fact, appeared to be the case to me.

MR. REPKA: Okay.

MR. HOLLER: So the record is clear, Dr. Jacobus, is the purpose of this document just to illustrate the points that are included in the data source?

WITNESS JACOBUS: It includes the raw data that I chose from Figure 26 in the top left corner. The temperatures go 172, 160 and 150. And I chose IR datapoints as shown on the figure and I plotted them to see if it appeared linear, and it does not really appear very linear to me.

WITNESS LOVE: This is for 170 to 150?

WITNESS JACOBUS: This is for 172 down to 150.

JUDGE MORRIS: To help Dr. Carpenter, we will say for the record this is a semi log plot.

WITNESS LOVE: What I'm trying to explain is my view or looking at this document back in the time frame when it came out. I have plotted also in more detail the EB-25 thermal blocks on my figures IR-1 through IR-3, and I believe I also show that the higher temperatures that the Sandia data indicates, that it is no longer a straight line on a semi log plot, but in the temperatures of interest to Farley, the Sandia data indicates that it is -- it does exhibit linear characteristics on the semi log plot.

WITNESS JACOBUS: I simply made this plot in response to the comment that Figure 26 demonstrated the insulation resistance increased linearly on a semi log scale as temperature came down, and I don't seem to believe that that's the case.

WITNESS LOVE: But I believe I can draw a line through those three plots -- those three points if I consider a best fit. But be that as it may, I -- what I'm trying to explain is my reasoning -- I believe what I was asked was for some insight into why I was considering a value of 1E7 in the time frame when that value was determined, and I was simply referring to items like Page 48 and like Page 85 to indicate a phenomena which was not discussed very clearly in the Sandia documentation or the documentation that was discussed in IEN-84-47.

The positions that seem to be being taken are ones of only concentrating on this data at the worst case peak temperature values that are indicated in this report rather than looking at the relationships that this data indicates when viewing it in terms of the cooldown of the terminal block.

WITNESS JACOBUS: There are two things I'd like to respond to: They have never said or implied that data from the worst case peak tempe ure of the Sandia data is the only data that should b onsidered, or that it should even be used at all.

The second thing is, my understanding from page 172 of the Alabama Power Company surrebuttal testimony is that Figure 26 or page 48 of Staff Exhibit 73 was presented as supporting the question; is there any other information in Sandia 83-1617 which also indicates that IR is linear with respect to temperature?

WITNESS LOVE: All I'm aying is, I believe there is data in the Sandia report th indicates that effect.

WITNESS JACOBUS: Here I've plotted that data, and if you want to use that to say that the insulation resistance is linear on a semi-log scale from 175 down to 95, I just don't believe that.

WITNESS LOVE: We do not need to operate the terminal blocks at that upper extreme.

WITNESS JACOBUS: I agree.

MR. HOLLER: I think, unless Mr. Love has something more, Dr. Jacobus' positions are there for the Board to --

WITNESS LUEHMAN: I have one comment on that.

It's, we define what the -- I guess Alabama Power's position is that they have this -- they'll secure the safety injection at 240 degrees, 260 degrees, somewhere in there. My question is -- I guess my comment is, in their EOPs, operators -- we seem to have somehow limited the discussion just to those instruments that would be involved in that specific function in that specific temperature range.

I guess my comment is, I think that the EOPs that Farley had required operator action, operator monitoring of other parameters during the accident scenario and it -- that they were required to take action, if necessary manually, to mitigate the consequences of an accident.

Those instruments would be things like steam generator level. They'd have to monitor aux feed flow and steam generator level and take whatever manual actions were necessary right after the initiation of an accident, and it's not clear to me, if we've defined what temperatures those potential mitigation issues might take place.

BY MR. HOLLER:

Q Mr. Love?

A [Witness Love] The two profiles that I have used from the accident analysis result in the most severe temperature profiles and in the containment, and they are the basis for the EQ qualification program. The things that you are talking about in terms of the whole realm of events discussed in the EOPs, would not result in temperature and profiles of this severity.

They are -- just for instance, aux feedwater flow is a variable that is measured from instrumentation outside of the containment. The containment pressure response is measured by a remote transmitter that has a sensing line and terminal blocks are located outside of the containment.

What I have tried to address here were the relevant post-accident monitoring actions that would be required for the event that would subject these instrument terminal blocks to the most severe, most limiting containment temperature responses.

The other -- there is a whole myriad of scenarios or events which the ERPs are designed to take care of, however, none of those events will result in temperatures --temperature profiles that are used for this -- are this severe, and that's why these profiles were selected as the basis for environmental qualification.

Q Let me just ask you, Mr. Love, is it fair to say then that your testimony is that you would not need to look at -- the operators would not need to look at instruments, other instruments during the myriad of accidents -- let me rephrase it for you. It looks like you were confused by the question.

Is it your testimony, or you do not disagree that in monitoring an accident, operators would be required to look at instruments that employed these terminal blocks at temperatures greater than 200 degrees?

A [Witness Love] I guess I'll just go back to (b)(i) again, safety related electric equipment. This equipment is not relied upon to remain functional during design basis events to ensure the integrity of the reactor coolant pressure boundaries and the capability to shut down this reactor and maintain a safe shutdown condition and the capability to prevent or mitigate the consequences of accidents that could result and potential offsite exposures.

I'm not sure what you're asking me. What I'm saying is that --

Q Let me try it this way.

A [Witness Love] Okay.

Q Are you suggesting that because there's an automatic function, that the operator then is not required to look at an instrument that is measuring parameters that will be addressed by that automatic function?

A [Witness Love] I'm saying, for these events, there is no operator action prior to peak LOCA that is required, nor would he take to mitigate these events. In other words, he would not by his ERPs, take operator actions for these events, pre-peak temperature.

Q Are you talking about --

A [Witness Love] For the specific events.

Q Yes, sir, you told me there are no automatic actions for those events?

A [Witness Love] No, I did not say that. I said manual operator actions.

Q Understood, sir. My question to you is, would not the operator still be monitoring his instrumentation, notwithstanding the automatic functions?

A [Witness Love] There are many, many -- the answer is yes, but the -- we must put this in context. Reg Guide 1.97 addresses many, many variables for -- that are available in terms of instrumentation, to monitor for these events.

There are diverse -- by the very nature of the way that the instrumentation is developed and designed, there are diverse monitoring points which will be used by the operator, and the intent is that if there is an ambiguity in one device, he will have another device pointed out to him to resolve that ambiguity, and the majority of these transmitters and devices are not located with terminal blocks inside the containment.

For example, things like core exit temperature which is a very important parameter, is -- Alabama Power Company has probably spent very much money as a result of Reg Guide 1.97 to put in a system of cabling which will not be subject to this issue.

WITNESS JONES: I'll just add, I don't feel like the scope of Reg Guide 1.97 equipment is at issue here. I think we know what the scope is, and that's been approved. I think it's a matter of now, these pieces of equipment that is in our scope, will they perform when called upon?

I'm not sure why we're asking --

WITNESS LUEHMAN: I guess the reason I posed what I did is I agree with Mr. Love that if you have a design basis accident, the -- there is not going to be any operator action initially -- that it's going to be automatic functions. However, the EOPs are designed such that if an automatic function does not take place, that certain manual operator actions are going to be required. And if he doesn't know which instruments he can rely on, how are those actions going to be initiated?

WITNESS JONES: I don't think anyone is claiming here that EOPs have a lot of instrumentation, and a lot of instrumentation available to the operator. But that does not necessarily mean that every instrument that's in the EOP procedures is an EQ piece of equipment.

WITNESS LUEHMAN: I agree with that. I am just saying we haven't -- we've seen -- my only point is we seem to have concentrated on the instruments that are necessary to secure from safety injection. My question is then what is Alabama Power's position relative to which instruments do require environmental qualification then?

WITNESS LOVE: It's in our Reg Guide 1.97.

MR. HOLLER: Let me suggest, unless the Board -- I think the positions are out there -- unless the Board has specific question on this point that hasn't been addressed, that we might move on.

[Judges conferring off the record.]

JUDGE BOLLWERK: No.

BY MR. HOLLER:

Q Mr. Love, a slight transgression. I think we had arrived at the point of the original question. And that was deriving from the information in the CONAX test report -- the connectron terminal block -- if you could determine the value of 240 degrees what -- the insulation resistance. That was the question. Do you agree with that sir? And you explained for us the basis for your engineering judgment. It is in the record. I would just ask you is there anything else, in addition to the things you described for us that you used in performing that engineering judgment?

A [Witness Love] I believe that is also -- the remainder or the basis for that judgment, I believe, as documented, was in the EQ Action Items 067 and 0018, as well as -- at the time.

Q Yes, sir. And now response --

A [Witness Love] And that's -- I don't know the exhibit number on there.

MR. REPKA: APCo Exhibit 52.

WITNESS LOVE: APCo Exhibit 52.

MR. HOLLER: Now --

WITNESS LOVE: I believe -- I'm sorry.

MR. HOLLER: Yes, sir?

WITNESS LOVE: I believe also that we expanded on that, due to additional questions which arrived in the -- after the inspection, we expanded on it in the APCo Exhibit 59 at the November 24th, 1987 meeting. There is an additional expansion on the judgments applied, and the basis for those judgments in that document.

BY MR. HOLLER:

Q Okay. Just so I can put this in perspective. At the time of the inspection -- at the time of qualification -- strike that. Let me just put this in perspective. The original question was what do you find in the CONAX test report. And the answer to that is engineering judgment, based on the things that you've described -- that you've looked at?

A [Witness Love] That report, plus these other -- other documents that I have described. Yes.

Q And, of course, that report and these other documents were generated post-inspection; is that correct, sir?

A [Witness Love] The only document that was generated post-the week of the inspection was the JCO -- the additional data that was provided at the November 24th, 1987 meeting.

Q Okay. I can go two ways here. Let me -- let me come back to that, if I may and just to finish going through here. With regard to the General Electric EB-151B terminal blocks --

WITNESS JACOBUS: CR-151B.

MR. HOLLER: CR -- thank you. CR 151B terminal blocks.

BY MR. HOLLER:

Q Is it fair to say the basis for the qualification -- strike that. Let me ask it to you this way. Which report would you look to if I were to ask you for data regard -- or data regarding the insulation resistance of a terminal of a GE CR-151B terminal block of 240 degrees?

A [Witness Love] Well, again, I -- the document that would have been available in the 1987 inspection, to explain the 1E7 value and my application of that to the CR-151B, as well as to the States block, would have been EQ Action item number 6718.

Q Is it fair to say then that you would have gone back to the CONAX test report as the underlying data to look for? You've alreauy explained how you would go through tat process?

A [Witness Love] Yes.

MR. HOLLER: Okay. Let me go back then to the APCo Exhibit 52, the EQ action items 018 and 067, and ask Dr. Jacobus if he has a response to that, as far as providing a basis to reach a temperature of 240 degrees -- or the insulation resistance value of 240 degrees at the terminal block?

WITNESS JACOBUS: If I -- you mean the reason why 240 degrees is the value that should be used, or if there is date in there to support --

MR. HOLLER: No, no, no. Let me make this clear. I think Mr. Love has testified that he would, in his engineering judgment of which he took the CONAX test report data -- some of that is included in what's been identified as APCo Exhibit 52. I would ask if you have any comments on if one can take the CONAX test report data, using the reasoning that is in APCo Exhibit 52 and arrive at an insulation resistance value of a terminal block of 240 degrees?

WITNESS JACOBUS: I think that is clearly a fairly big leap of faith to do that. We have all heard, in testimony how important the temperature is to the insulation resistance of the terminal block. And if the temperature is the most important factor, then it is clear to me that you should use data at a reasonably representative temperature for the actual conditions that will exist. That is without going to the further question of how and why we define a design basis accident.

I think Gene will be covering that later in his cross examination.

BY MR. HOLLER:

Q I'll just ask if he has any comment on that. Then we can move on from here.

A [Witness Love.] The only comment that I have is that I believe that the Sandia data which was also available at this time frame but could not be used I believe as was testified to earlier somewhere in this proceeding was not permitted to be used as an EQ qualification document.

I believe from my review of that data that it supports the judgment that I made for that temperature, that my selection of 1E7 ohms was representative to the point that there would not have been any impact on the ERP values.

We have also established that the ERP values could have had a value as low as 5E5 ohms and not have had any effect on the values that were in there for the operators to use.

Q Okay, sir. So before we leave this, and we are close to leaving it, so as not to confuse things though, whether the value of the one times ten to the seventh or five times ten to the fifth for insulation resistance, that would not change the methodology you described for us of how you would approach that from the data that was in the CONAX test report, is that correct?

A [Witness Love.] What I have described to you is the approach that I took in 1987.

Q Okay. I'm going to leave the CONAX test report then. I think we are focused in on the Sandia information and I'll ask you, in the interest of time I am going to go and ask you having heard the testimony this morning, will you agree with me that the terminal blocks or rather that the insulation resistance values taken at 95 degrees Centigrade in the Sandia tests, and I am referring to Staff Exhibit No. 73, were taken at dry conditions? I am just asking.

A [Witness Love.] Mr. Jacobus has testified to that.

A [Witness Jacobus] Actually I didn't testify exactly to that -- relatively dry conditions. The terminal block was hotter than the environment moisture would have a tendency to evaporate.

Q My point in asking, Mr. Love, is just to -- if in fact you do not agree with that or having heard that data that --

A [Witness Love.] I don't have any additional response on that particular temperature point.

Q And you have agreed -- strike that.

You have testified that of course you did not rely on Staff Exhibit 73, the Sandia report, for the qualification of the blocks. That's a fair statement?

A [Witness Love.] We did not rely on that. That data was available.

Q I understand, and so you looked to that data as if, if I may use the term, a separate source to confirm or to verify the results you had obtained through your analysis, is that correct?

A [Witness Love.] I believe that the data supports the analysis that I made, the judgment that I made on the 1E7 ohms.

Q All right. That leads me to two parts.

The first question would be then if you are looking at it to rely on it then -- strike that.

If you are looking at the Sandia report to verify what you separately have done, is it fair to say then the issue is the validity of the information in the Sandia report or the validity of understanding the information in the Sandia report?

A [Witness Love.] From the verification standpoint, that would see to be what this issue is about, yes.

Q Yes, sir, and you would not disagree with me if I said that, if the validity of the underlying information you used from the Sandia report were shown to be other than you thought, then that would remove the value of that as a comparison document?

A [Witness Love.] If I have made errors in interpreting that particular data as I understood and those errors were significant to my conclusion, then that would be correct.

Q And, sir, lastly then, since you did not rely on that for qualification, then your -- let me strike that and try it this way.

What I am driving at is that you have already testified that you did rely on that so if it turned out in fact not to be what you thought, then you would have to rely on your original analysis that you did, is that correct?

A [Witness Love.] If for some reason it is determined that the Sandia data does not support or refute the data that I have, the analysis that I had used was as documented in EQ Action Item 67 and 18 in 1987, yes, that is correct.

Q Fair enough, all right.

MR. HOLLER: At this point I -- if I could take just three minutes, if the Board wants --

JUDGE BOLLWERK: Should we take a ten minute break? How's that?

MR. HOLLER: Well, sir, if I may, with the Board's permission, there is a minor, a relatively minor issue here in view of the testimony that I do not intend to go into it, however to set the record straight, it is the Staff's position there may be some dimensional miscalculations with regard to the testimony on similarity of blocks.

I do not intend to at this time go into that discussion for a similarity argument but I think we'd set the record straight and during the break if we make Alabama Power Company aware of that, we could perhaps stipulate to the correct figures and save ourself a lot of time.

JUDGE BOLLWERK: How much time do you need?

MR. HOLLER: We'd need a longer break if do that.

JUDGE BOLLWERK: All right. Fifteen minutes is enough?

MR. HOLLER: That should be enough to accomplish that, yes.

JUDGE BOLLWERK: All right, fifteen minutes. Why don't we take a fifteen minute break.

We will come back at five till 4:00.

MR. HOLLER: Thank you, sir.

[Recess.]

JUDGE BOLLWERK: I think there was a question about a possible stipulation or something that you were trying to arrive at an agreement about?

MR. HOLLER: Yes, sir. I think this may help things.

BY MR. HOLLER:

Q Mr. Love, I would like to direct your attention to your surrebuttal testimony at page 199. During the break, we had pointed out that there may be some dimensional -- I don't want to misphrase this -- some of the dimensions may be not as indicated there.

I think you were in agreement, and I will turn the question over to you now, sir, if you want to explain that.

A [Witness Love] Yes. As stated on page 199 of our surrebuttal testimony, we had, in response to Dr. Jacobus' discussion on similarity in the step height, we provided a sketch based on the drawings that we had available in making some assumptions which we discussed in the notes regarding the various terminal-to-terminal ways of determining the distances from terminal point to terminal point.

Since we have received a current block, what we did is, in anticipation that this question may come up, not that we feel it is significant, but we did revise this sketch based on the as-built dimensions of this block. So we would be glad to submit that into evidence as another sketch of this block with measurements made on this block.

MR. REPKA: At this point, I would ask that Mr.

Love and Dr. Jacobus and the Board to be handed what we have marked as APCO Exhibit 135, and ask that that be marked for identification.

I would state that we discussed this at the break, and the parties are prepared to stipulate that this drawing shows dimensions that the parties agree to.

Is that correct, Dr. Jacobus?

WITNESS JACOBUS: Yes, within reasonable tolerance.

JUDGE BOLLWERK: This is a drawing of the block as-built, which is the one that we have as an exhibit?

MR. REPKA: Which is APCO Exhibit 134.

MR. HOLLER: That is correct.

JUDGE BOLLWERK: Let the record reflect that APCO Exhibit 135 has been marked for identification.

[APCO Exhibit No. 135 was marked for identification.]

MR. REPKA: I will go ahead and move that it be admitted into evidence.

JUDGE BOLLWERK: Any objection?

MR. HOLLER: No objection.

JUDGE BOLLWERK: Then APCO Exhibit 135 will be received in evidence.

[APCO Exhibit No. 135 was

received in evidence.]

BY MR. HOLLER:

Q Mr. Love, just a couple of quick questions. Do you remember in your testimony before you had arrived at a value of a characteristic dimension of the block?

Do you recall that, sir?

Do you recall the characteristic dimension of the block?

A [Witness Love] Are we referring now to the similarity analysis?

Q Yes, sir.

A [Witness Love] Which portion of it?

In my testimony, I described this figure which is contained on page 199, is that what you are referring to?

Q Yes, sir.

Let me ask you the question this way, from your calculations, can you come up with what could be called the characteristic dimension of the block?

A [Witness Love] The purpose of the surrebuttal testimony and including this figure was to address the theoretical discussion that Dr. Jacobus had provided about a step height of one foot, and I was simply trying to put that back into perspective to show that the dimensions could be measured in various ways from pole to pole, and all those measurements were significantly less than a foot, and were basically equivalent to the EB-25, the CR-151B, and the States terminal blocks.

I believe in my testimony, I stated that that should not be surprising in that these are all 600 volt terminal blocks, and that, in itself, will dictate a relative terminal spacing in order to have a 600 volt rating.

Q Let me try it this way. Let me refer you to APCO Exhibit 52, which was the response to the EQ Action Items 18 and 67.

A [Witness Love] Yes.

Q On page 3 of 4 of that document, Bates No. 63874, I believe under the Connectron NSS-3 block it lists a center-to-center spacing of poles at .320 inches. Is that correct?

A [Witness Love] Yes. I explained in my testimony, in fact, in this package, there is a drawing of the terminal block that was included in this package, and from that dimension drawing that spacing was obtained. So that was the number that I used here for comparison purposes, but the document package contained the dimensional data for the terminal block as a part of the back up for the package.

Q I am referring to APCO Exhibit 135, which is the drawing of the actual block, is that correct?

A [Witness Love] Yes.

Q And do I read it correct then that center-to-center spacing at the poles would be --

A [Witness Love] It is .4 as opposed to .32.

The dimension that I was referencing from the original drawing in the analysis was the center-to-center spacing. As indicated on this drawing, the measured value we got from the as-built was .4 as opposed to .32

Q Fair enough.

WITNESS JACOBUS: Let me clarify, the number .32 as reflected in the Connectron literature, is the interior dimension, not including the thickness of the barrier, that is why the difference between .4 and .32.

WITNESS LOVE: I will concede .32 versus .4.

WITNESS JACOBUS: Then we had the further concern that there is the difference in height so that the center-to-center spacing for the Connectron block really isn't the relevant parameter.

I think now you have come up with .72 as a roughly comparable parameter on the Connectron block.

WITNESS LOVE: Yes, that is correct, based on the as-built dimension, but I am comparing that to one-foot, which was the [illegible]tical discussion.

MR. HOLLER: Fair enough. I think we are almost there.

BY MR. HOLLER:

Q With Dr. Jacobus' clarification, I will refer you to your statement in APCO Exhibit 52 on page 3 of 4 below the table, and I will read it, "As shown above, all of the installed instrument boot terminal blocks have superior significant characteristics to the NSS-3

A [Witness Love] I was indicating various parameters there, not just the center-to-center spacing, but I also, in discussing this, referred and contained in this package the dimensional data and additional information on all these terminal blocks.

Q Fair enough, sir.

My question to you would be, in view now of having calculated from an actual terminal block, is it still your testimony that all the installed instrument loop terminal blocks have superior significant characteristics to the NSS-3 block?

A [Witness Love] I still believe that is correct for the purpose of instrument accuracy, which is the topic at issue.

MR. HOLLER: Dr. Jacobus, do you have a comment?

WITNESS JACOBUS: I would just note that the relevant dimension on APCO 135 appears to be .72, and the original value used in the similarity analysis was .32.

WITNESS LOVE: The original value used in the similarity analysis was, I was merely --

In this evaluation which consists of more than this page, as I stated earlier, there is data on the terminal blocks as part of this package. I was doing a comparison of the side-to-side values or pole-to-pole values, and the value that I picked of .32 is the dimension off of that block, or .4, if you will.

But the point of significance here is that it is a 600 volt terminal block, and the spacings are all basically equivalent because of that electrical property.

WITNESS JACOBUS: I might just note that I don't see that on this diagram. I see superior significant characteristics.

WITNESS LOVE: Well, you're only looking at this particular section. You need to look at the complete package.

MR. HOLLER: Fair enough. Unless the Board has some other questions on the similarity of the blocks and the dimensions, I have none.

JUDGE CARPENTER: While I can't really believe that a factor two is the biggest uncertainty in trying to qualify these blocks, the Board just, first, had a chance to look at these blocks today.

I've turned this connection NSS-3 upside down and I see the conductors are not spaced as far apart from each other as they appear to be when I view it from the top. Is that a misimpression on my part?

WITNESS LOVE: I do not believe so.

JUDGE CARPENTER: So that, in fact, the difference between the blocks is not as large as one would infer from looking at the top of the block

WITNESS LOVE: That is correct.

JUDGE CARPENTER: But you didn't pay any attention to that in your analysis.

WITNESS LOVE: I used the .32 or the .4 number, that's correct; .4 as-built measurement.

JUDGE CARPENTER: Would it make any difference if you really did look at the bottom of it?

WITNESS LOVE: It's actually a better comparison. I'm not sure -- in other words, that is where all of the points are on the same level.

JUDGE CARPENTER: I withdraw the question as being patently obvious.

MR. HOLLER: Let me move -- draw your attention to Staff Exhibit 83, which was passed out this morning, and, in particular, Page 3 of Staff's Exhibit 83, Staff IR versus temperature data.

BY MR. HOLLER:

Q I'll address this to Mr. Love or I'll let anyone else on the panel who wants to respond answer it. Mr. Love -- I'm sorry, do you have it?

A [Witness Love] Yes.

Q My question to you would be in your engineering judgment, are the exponential plots of insulation resistance versus temperature indicated on Page 3 reasonable in light of the data that I think we all heard Dr. Jacobus explain and that is plotted on Page 3 of Staff Exhibit 83?

A [Witness Love] I'm looking for a page number.

Q It's the third page down, sir. It's the one -- just so there's no question, it has the identification of the various points in the upper lefthand corner.

A [Witness Love] And you're referring to the IB-9, EB-25, Phase II plot. Is that the plot we're referring to?

Q Yes, sir. From the two exponential plots that are indicated.

A [Witness Love] That appears to be the plot that we used in the JCO.

Q Yes, sir. But my question to you is is it still your testimony that, in your engineering judgment, that those plots are reasonable in view of the other data that's on this plot -- pardon me -- on this graph?

A [Witness Love] The other data has not changed my opinion, no.

MR. HOLLER: I would just ask Dr. Jacobus if he has any comment.

WITNESS JACOBUS: Well, I would simply note that it's fairly clear to me that those straight lines are much less conservative than any of the other data from any of the other tests might suggest.

I will also note that, for the record, the points labelled Solomon EB-25, the point at 121 degrees C labelled Wyle ZWM, and the point at 127 degrees labelled GE Test ZWM and GE Test CR-151, that all of those data points were taken prior to those terminal blocks ever having been exposed to temperatures in excess of the temperature that that data is reported at.

Therefore, we have -- we should have no arguments that there was permanent damage to these three particular blocks via exposures to previous cycles of DBAs or whatever you may wish to call that.

WITNESS LOVE: My problem is simply this. In looking at terminal block data as it has been made available and has been available in the industry, I have tried to look at it from the standpoint of one test at a time and I've tried to look at it from the standpoint of trying to determine how the insulation resistance in that test responded to the transient conditions of that test, rather than trying to -- and lock for a correlation of that as opposed to trying to pick discreet points at temperature values from very many different tests and then plotting them on one graph.

That -- from my understanding of this perspective, that tells me nothing. I'm sorry.

MR. HOLLER: If there are no additional comments, I intend to just give the opportunity to Dr. Jacobus to address a point that Dr. Carpenter raised in this morning's discussion, but I have no further questions.

Dr. Jacobus is prepared to do that or if the Board would desire redirect at this time, the Staff has no objection.

JUDGE BOLLWERK: Why don't we allow the redirect first and then we can allow Dr. Jacobus to make his statement and talk to Judge Carpenter.

MR. REPKA: I have just a very few questions.

REDIRECT EXAMINATION

BY MR. REPKA:

Q First, Mr. Love, there was some discussion earlier this afternoon about whether for ERP calculation -- for purposes of ERP, whether you need to include insulation resistance values for 240 degrees or 260 degrees.

First, let me ask how many values of insulation resistance do you use in an ERP calculation?

A [Witness Love] The method that was used in 1987 for doing these calculations used a minimum value of insulation resistance determined for the cable. It used also a minimum or a -- one value for cable, one value for terminal block.

So the calculation was not designed to follow, if you will, the transient. It was one discreet value for cable and one discreet value for the terminal block.

Q Okay. And there was some testimony that to take a value from 150 degrees, recognizing whatever conservatisms were built into that value, that there is a leap of faith to go to 260 degrees. Do you care to comment on that?

A [Witness Love] I think I testified to that before. I do not believe that it's a big leap in faith, but let me try to put it in perspective from the standpoint of the values as they existed in the 1987 timeframe with the cable and the terminal blocks.

I believe we have established that the performance value that would have not resulted in a change to the instruments at issue here was 5E5 ohms. If we were to use any of the graphs that we're talking about here and determine the temperature value at 5E5 ohms, that value would be much higher than 260 degrees.

Q So you're saying if 1E7 was --

A [Witness Love] With the exception of the 1973 test.

WITNESS JACOBUS: Wait a minute.

MR. HOLLER: Is he just about to finish his answer?

BY MR. HOLLER:

Q When you said the 1973 test, you're referring to the 1973 GE --

A [Witness Love] GE test, which Mr. Jacobus indicates is flat at 2E4 ohms, yes.

WITNESS JACOBUS: I want to make sure that I heard that the way I heard it. In looking at any of these plots, I'm not sure what "these" plots are, but looking at any of these plots, using the acceptance criteria in a five-times-ten-to-the-five, we would conclude that that installation resistance happens at a much higher temperature than 260 degrees Fahrenheit.

WITNESS LOVE: For the plots that, in my belief, are representative of the IR versus temperature characteristics of the GE-States terminal blocks, yes.

WITNESS JACOBUS: For example, the Wyle test that Mr. DiBenedetto referred to in his assessment that was submitted shortly after the inspection, where data was taken at 121 degrees C, roughly 250 F, on the way up to the peak temperature, and the value was roughly ten-to-the-fifth, is that non-representative of the DBA profile in plant Farley?

WITNESS LOVE: I am not saying that there may not be some value in some report which perhaps will not support that. I'm saying that I believe the data taken from reports and LOCA testing that simulated one design basis accident and even considering a profile for one design basis accident which was more severe than that which would be experienced in the worst case accident at Farley, using that type of information will support these.

WITNESS JACOBUS: I have to go on record. At this point, I cannot recall any test where data was taken in the vicinity of 250 degrees F where the insulation resistance was anything like ten-to-the-seventh ohms. I will go on record as saying that.

BY MR. REPKA:

Q Mr. Love, are you trying to tell us that the ERP calculation itself will not change unless you have an IR value that drops below 5E5 ohms?

A [Witness Love] That is correct for the 1987 analysis for the instrumentation in discussion in the session, that's correct.

Q Now, the next thing I wanted to ask you was there was some discussion this morning about what has been labelled as your Figure IR-3 in the surrebuttal testimony.

A [Witness Love] Yes.

Q About whether that plotted terminal-to-ground or terminal-to-terminal data from the Sandia report.

A [Witness Love] Yes.

Q Would you just care to, for my benefit as much as anybody, clarify what is wrong, if anything, with that plot

A [Witness Love] I believe what Dr. Jacobus pointed out this morning was that the Page 174 and 175 five-number summaries of data which I used in this figure for the Phase I Plot A and Plot B were mistakenly taken from the terminal-to-ground data as opposed to the terminal-to-terminal data which was used for the JCO.

In looking at this, the JCO data was based on five-number summaries, Pages 158 and 159, and that would effect slightly the plots that I have on Figure IR-3, Plot A and Plot B. However, it will not change the conclusions arrived at from using that data.

Q So the JCO used terminal-to-terminal data and this plot used terminal-to-ground data.

A [Witness Love] That is correct.

Q And we're really only talking about IR-3, is that correct?

A [Witness Love] That is correct.

Q And we're talking specifically about Plot A and B on IR-3.

A [Witness Love] Plot and Plot B, that is correct.

Q And if you were to plot -- replot those using terminal-to-ground data over the same temperature range, the effect would be slightly lower IRs.

A [Witness Love] Terminal-to-terminal data. You said terminal-to-ground data.

Q I'm sorry. Terminal-to-terminal.

A [Witness Love] Terminal-to-terminal data would result in a slightly -- a slight change in the slope and it would be slightly lower than the two curves that are there on a semi-log scale. The curve for the Plot A would look like the curve in the JCO, APCO Exhibit 59.

Q And would those changes in any way effect your surrebuttal testimony?

A [Witness Love] No. I've already said that it will not effect the significance of that. It may change slightly the value indicated in terms of -- I was being very specific to a discreet point of IR values selected at a discreet point of temperature, but the order of magnitude of those numbers will still support the conclusions that I had arrived at in the testimony.

Q Last series of questions. Judge Carpenter asked a question about the spacing on the NSS-3 terminal block, specifically the bottom.

A [Witness Love] Yes.

Q Now, the bottom spacing, I understood you to say, is closer than the above-ground spacing, if that's an accurate --

A [Witness Love] That is correct.

Q Would the closer spacing tend to lead to greater leakage currents?

A [Witness Love] It would -- yes, it would.
Q And, therefore, it would, in fact, result in poorer performance of the block.
A [Witness Love] Yes. In my opinion, yes.
Q And use of data from that block even more conservative.
A [Witness Love] That is correct.

MR. REPKA: Thank you. No further questions.

JUDGE BOLLWERK: No recross? Time for Board questions?

MR. HOLLER: Dr. Jacobus has a comment. He didn't have an opportunity on the responses, but if doesn't --

WITNESS JACOBUS: The only response I would make is with response to the last question that was asked. That would make it more conservative with respect to leakage currents.

I would just go back one more time to note that the major non-conservatism there, which I think we've discussed in some detail, the fact that the data was taken at 150 versus some higher number, 240, 260, 300, whatever number you care to use.

MR. REPKA: There's a disagreement on that point.

MR. HOLLER: The Staff has no more cross examination.

JUDGE BOLLWERK: All right. Board questions.

BOARD EXAMINATION

JUDGE BOLLWERK: I first have a couple questions for Dr. Jacobus. I'm going to ask him a couple questions and then I may defer the rest of what I have until Judge Carpenter is finished.

Can you describe for me the general peer review process that a document like Staff 73 or Staff 74 undergoes with respect to Sandia, what the peer review process is within Sandia National Labs?

WITNESS JACOBUS: Yes. In fact, specifically, I think there's a -- just to give you a reference, I believe there's a somewhat detailed acknowledgement section in Staff 73 and some of that acknowledges the reviewers, I believe.

Normally what goes on is that we are required to have two technical reviewers, which would be peer reviewers. At the time when this was done, there were three levels of management review required, along with a few other completely non-technical reviews.

In addition, this particular report, I know one of the two reports was reviewed by a gentleman from Portland General Electric by the name of Gary Johnson. That was perhaps the second volume. Yes.

On the acknowledgements on Page xii of Staff Exhibit 74, you will see that Gary Johnson of Portland General Electric Company supported the work with input on the circuit analysis. He, along with Dr. Solomon at Temple, and Mark Jacobus, Mert Robertson, Frank Wyatt, Dave Furgal, Larry Bustard and Tim Gilmore here at Sandia carefully sifted through the draft report, making critical and needed comments.

So there are two required. In this case, it appears like perhaps six people did some sort of a review of that.

JUDGE BOLLWERK: This is typical of a Sandia report. Is there any differences between the way this report was handled and Sandia reports are handled generally?

WITNESS JACOBUS: Well, as I mentioned, typically it is required that two technical reviewers review the report. In this case, it appears that the had, at least on this second report, about six reviewers. That is not -- the reviews are normally not that extensive.

JUDGE BOLLWERK: Was there any peer review done of either of these reports by the NRC staff before they were released?

WITNESS JACOBUS: The NRC staff does have to approve the release of the documents. I am not familiar with the extent to which they reviewed them.

JUDGE BOLLWERK: Mr. Luehman, can you shed any light on that in terms of the NRC staff review?

WITNESS LUEHMAN: No, sir, I can't. Not on these reports.

WITNESS JACOBUS: Normally, for example, today, with reports that I'm doing, they would go back to my Research Project Manager. He would review them and they would then go to NRR for NRR's review. They would then go to the industry through EPRI for industry comments and review prior to final publication.

These got some industry review, perhaps not as much as my current reports are getting.

JUDGE BOLLWERK: You mentioned Portland General Electric, but I take it these di[illegible] t go to EPRI, for instance. You did not mention that.

WITNESS JACOBUS: As far as I know, they did not.

JUDGE BOLLWERK: I take it you're familiar with the type of peer review that's done for technical journals and scientific journals.

WITNESS JACOBUS: Yes, I am.

JUDGE BOLLWERK: Can you contrast that with the type of peer review these were given?

WITNESS JACOBUS: I would characterize the main difference being that the reviewers for a technical journal are outside of your own company, whereas our reviewers mostly are within the company. The people that were listed there, with the exception of Gary Johnson, are within Sandia. It's internal technical review versus external.

In terms of the depth of the review, I would tend to believe that it's roughly the same. I have done technical review for journals. I know what level I review them. I've done technical review for peer review on these kinds of reports and my review really doesn't depend on which of those two mechanisms the report came to me by.

JUDGE BOLLWERK: All right. I think I will defer to Judge Carpenter at this point.

JUDGE CARPENTER: With my apologies to the witnesses for the lateness of the hour. The Boards always get to sweep up. We never get fresh witnesses.

I want to begin by asking the indulgence of staff counsel and the licensee's counsel. I want to explore something for just a very few minutes that is not narrowly related to the issue that's before us, but does sit under it or around it or over it.

Mr. Kraft -- and I will say, Dr. Jacobus, I've been very concerned for some weeks about our examining these reports without having Mr Kraft [illegible] to speak for them.

Am I correct in my reading of your involvement is almost to the point of being a coauthor or is that an unfair guess?

WITNESS JACOBUS: That's pushing it a little bit. For a report of this magnitude, my contribution to it was probably -- was not worthy of coauthor.

JUDGE CARPENTER: Given that proviso, the Board acknowledges very clearly that you're not the sponsor of these two documents in the sense of being their author. At any point where you don't know what Mr. Kraft was thinking or what have you or what he meant, that's what we have to live with and we'll have to see whether we have to call Mr. Kraft.

WITNESS JACOBUS: I have talked to him. He has been out of this work now for seven or eight years -- about seven years, and his words were "You are probably much more qualified at this point to talk about that report than I am."

JUDGE CARPENTER: I just wanted that proviso to be in the record. Now turning to the thing that I'd like some help with.

Mr. Kraft writes a very nicely comprehensive discussion of the terminal blocks from a lot of different perspectives. He even goes so far as to have little sections on Page 4 of Staff Exhibit 74 that says, "Why Terminal Blocks," is the heading.

It would be a big help to the Board in having some perspective about this issue to impose on you all, to the extent that you choose to -- and remember, I don't know or I don't have an opinion is a very valid answer.

But Mr. Kraft makes the point that terminal blocks have been widely used for the reason they allow circuit elements to be quickly and efficiently isolated. They are especially convenient for maintenance in areas where anti-contamination clothing encumbers personnel.

I'd like to ask each of you whether you think that's a substantive thing or just a little observation. Is it really true that one of the principal reasons for using terminal blocks is so that people can get in and out of areas which have non-negligible radiation levels in a minimum period of time or not, or is that just sort of coincidental.

WITNESS JONES: I'm in total agreement. It's a very vital, critical component in installation of terminal blocks and instrument circuits.

JUDGE CARPENTER: Well, we can go right to the point. In replacing a terminal block at Farley with permanent splices, is there an appreciable dose increase to the workers year after year or not?

WITNESS JONES: Yes.

JUDGE CARPENTER: What do you mean by appreciable?

WITNESS JONES: I think you've probably seen the procedures that you go through in installation of a Raychem kit. Just by the mere nature of having to do that installation takes much longer than just taking a screwdriver in there and loosening screw determination and re-termination.

So I think that's my logic for saying there is an appreciable amount of time that it takes for a maintenance worker to install a Raychem splice, cut one out, reinstall it, vice, determination, re-termination of the terminal block.

JUDGE CARPENTER: And you think, hypothetical, one minute with a terminal block, ten minutes with a splice, that there would be a measurable change in the radiation dose for the locations inside containment.

WITNESS JONES: Yes, sir. Obviously depending on the specific location, but there is an appreciable difference.

JUDGE CARPENTER: Mr. Luehman, do you have any views? Do you agree with Mr. Kraft or not or don't want to?

WITNESS LUEHMAN: I think that as only having been an inspector of these things, I think Mr. Jones and Alabama Power, from a larger perspective, are in a better position to tell you what the time involved and the amount of radiation involved is.

JUDGE CARPENTER: My only question was if, by chance, in some prior experience, you had some knowledge, but apparently no. Thank you.

WITNESS JONES: [illegible] another twist to that. Plant operations personnel and maintenance personnel at the plant protested violently to us having to put splices in these circuits of terminations for that very reason.

JUDGE CARPENTER: Well, I'm for, from understanding the record that's been developed to date -- but it certainly seems reasonable to wonder whether or not the industry movement away from terminal blocks for the reason that they couldn't identify a qualified block is not entirely compatible with ALARA, and that's not in an enforcement context. It's in an NRR context and a health and safety context.

I can't make up my mind whether it's big enough to worry somebody about or not. But Mr. Kraft's statement couldn't help but make me think that way.

WITNESS JACOBUS: I might just make one note here, Judge Carpenter. Since the time of this report, in the last five years or so, there have been a number of different types of quick disconnects developed. As a matter of fact, at Sandia right now we are testing a number of those. They are all purported to be environmentally qualified, made by CONAX, EGS, and a number of other vendors.

So there has been some response in the industry to the loss of the use of terminal blocks, using these other types of fairly easily disconnected connections.

JUDGE CARPENTER: Thank you. Just in passing, on the next page, Page 5, under this paragraph "Why Terminal

Blocks," Mr. Kraft tells us that the arguments against the use of terminal blocks are generally the dynamic regulatory environment and a desire to avoid qualification problems.

Is that an invalid observation ala 1984?

WITNESS JACOBUS: I think that it's not totally invalid. I think it's a pretty good statement. The fact that a number of people, even back as early as 1981 and 1982, per Mr. Kraft's survey, were pulling out terminal blocks, taking them out and replacing them with splices, because they felt that the regulatory environment at that time, with the new qualification rule coming up, was such that they would have difficulty qualifying their terminal blocks and they replaced them even prior to this terminal block work in Information Notice 84-47.

JUDGE CARPENTER: Thank you. Judge Bollwerk asked about review of Mr. Kraft's work and you mentioned several names. Were any of those in the Chemistry Section at Sandia?

WITNESS JACOBUS: I don't know about Mert Robertson who was at Sandia. With the exception of him, none of the other gentlemen in there at Sandia that are identified worked in Chemistry.

However, I believed Dr. Solomon at Temple University who also reviewed the report is in the Chemistry Department at Temple University. I'll see if I can find reference to that quickly.

JUDGE CARPENTER: The report identifies Dr. Solomon. There's no question about that.

WITNESS JACOBUS: Excuse me?

JUDGE CARPENTER: The report identifies Dr. Solomon. There's no question about that.

WITNESS JACOBUS: I believe it identifies he's associated with the Chemistry Department at Temple, and he did review this report. I would presume that he's a chemist, but that's not absolutely necessarily the case.

JUDGE CARPENTER: Well, the reason I ask -- turn to Page 58 in Staff Exhibit No. 73.

WITNESS JACOBUS: Staff Exhibit 73 you said?

JUDGE CARPENTER: In Staff 73, Page 58.

WITNESS JACOBUS: I am there.

JUDGE CARPENTER: This Section 4.3.6 describes condensate sample conductivity analyses.

WITNESS JACOBUS: Okay.

JUDGE CARPENTER: It isn't real clear why the samples were collected and conductivity was measured. But at any rate, Mr. Kraft says that the measurements might vary from the film conductivity because of the temperature difference between the film and the condensate sample.

I just can't imagine anybody measuring the conductance of a liquid solution and not measuring the temperature. But at any rate --

WITNESS JACOBUS: They did measure the temperature and it tells you -- I believe it tells you the temperature when it was measured, does it not?

JUDGE CARPENTER: I'm just looking on Page 58.

WITNESS JACOBUS: It says in the footnote "Temperature of chamber at time sample was taken. Sample temperature at measurement time was not recorded, but was at least ten to 20 degrees C cooler."

JUDGE CARPENTER: For five of the data points, there are two temperature measurements.

WITNESS JACOBUS: I'm not with you at this point.

JUDGE CARPENTER: The first line gives the time of the observation. It says after first steam ramp, 250 -- 215 micromhos per centimeter. I don't see any temperature.

WITNESS JACOBUS: Okay. That would essentially be in the vicinity of 95 degrees C after the first steam ramp, I would assume.

JUDGE CARPENTER: Well, I accept his statement that there's a temperature difference. So they wouldn't be identical. He says the thrust here is the measurements may vary considerably from the film conductivity, A, because of the temperature difference, and, B, the presence of contaminants from the chamber, the steam system, and the piping that accumulated in the bottom of the chamber and are not present on the terminal blocks.

How does he know that?

WITNESS JACOBUS: How does he know that it might vary because of those factors?

JUDGE CARPENTER: It says they're not present on the terminal blocks.

WITNESS JACOBUS: Because the terminal blocks are located within enclosures and the steam comes in from the top. It's, in effect, distilled water when it gets into the junction box. If you look in the bottom of a test chamber after the test, you see pieces of rust and sediment and dirt accumulation, but you don't see comparable things inside the junction box.

JUDGE CARPENTER: So you're saying the steam -- does the steam flow through the box?

WITNESS JACOBUS: The steam would enter the box through several sources. One would be the unsealed conduit openings and one would be the weep hole that is drilled in the bottom of the box. So in the bottom of the box, the steam is coming down and up.

You wouldn't expect it to pick up things sitting -- sediment and things like that. You wouldn't expect it to really sweep into that box.

JUDGE CARPENTER: And to just finish this, C is the presence of contaminants in the terminal blocks from [illegible]ts that are either not present or extremely dilute [illegible] the condensate sample.

I get the feeling that the steam is flowing over the blocks; not the bulk of the flow, but some of the flow over the box and it's appearing in the condensate sample.

WITNESS JACOBUS: Yes.

JUDGE CARPENTER: Did you have a chance to look at the experimental setup?

WITNESS JACOBUS: Yes. I was there when that particular test was done.

JUDGE CARPENTER: What was the feedwater to the steam generator?

WITNESS JACOBUS: The feedwater consists of demineralized water which is then treated with a conductivity enhancer for the purpose of the steam generators. The steam generators are electrode-type boilers and those electrode-type boilers require a certain amount of conductivity.

So from there, steam is generated. The steam is essentially distilled water. That steam then goes through the steam system piping. The energy is stored within an accumulator and eventually the steam gets into the test chamber. A fairly typical setup used in qualification testing.

JUDGE CARPENTER: Thank you. It would have been nice if there had been a description of that in the report. Turning to Page 114, Mr. Kraft made mention of the fact that there might be fingerprints on the block and there might not be. You've told me that the steam supply was deionized water.

In your conversations with Mr. Kraft or other reviewers, have you been able to account for the occurrence of substantial quantities of calcium carbonate on the surface of the block?

WITNESS JACOBUS: We have not discussed that point. I have not discussed that point. I am not sure what the source of calcium carbonate would be. I do not purport to be a chemist and I'm not -- I would be doing the worst of speculation were I to do that.

JUDGE CARPENTER: I realize that the purpose of the test was not to qualify blocks, but to study blocks. But it isn't clear to me that the typical nuclear power plant is going to end up with a block that looks like this under LOCA conditions. That's all.

My question is is this an aberration? Mr. Kraft makes reference to the substantial quantities of cadmium sulfide on the surface of the block.

WITNESS JACOBUS: That's correct.

JUDGE CARPENTER: I have a little handout that relates to the conductivity of water, the conductivity of sodium chloride, but I couldn't find conductivity of cadmium sulfide anywhere, but I'm sure it exists somewhere.

International critical tables does give some insight into the conductivity of solid ionic solids. So my bottom line question is why don't you view Table 17 as documenting, at minimum, what's an aberration, an unresolved issue?

WITNESS JACOBUS: I guess the bottom line with respect to that is comparing the data with other similar tests that have been done by a number of different people, the resulting data is quite consistent with other people's data. In fact, in a number of cases, it's slightly higher.

Therefore, the impact on the results of the test, I do not believe, would be significant, unless we're going to believe that this same aberration may have effected virtually every industry test that's been done.

JUDGE CARPENTER: Well, there's some notion that these blocks were exposed to steam flow and the temperature went up. The steam flow was reduced and the temperature went down. And then the temperature went up because the steam flow went up and it came down and went up and came down.

And the condition of the block at the end of each cycle, speaking loosely, wasn't the same. There was an observable difference in the electrical resistance of the block. And given the film theory and the sodium chloride from the fingerprint theory, I wouldn't expect there to be a whole lot of difference just from cycling the temperature.

But if things are accumulating on the surface of the block to produce some change, say a factor of a hundred in resistance, that might explain it.

WITNESS JACOBUS: A factor of a hundred?

JUDGE CARPENTER: I think that's the extreme of the Phase II, Page 210, ambient at beginning and end.

WITNESS JACOBUS: Right. At ambient temperature.

JUDGE CARPENTER: Not a factor of two, but a factor of a hundred.

WITNESS JACOBUS: The differences are much less significant at elevated temperatures.

JUDGE CARPENTER: We're not going to resolve this today. Just in passing, I wanted to know whether you all had talked about it; whether the source of this contamination could have been identified, maybe clean the system up. You certainly could have gotten rid of the cadmium-plated nuts and done it over again.

WITNESS JACOBUS: We could have if the NRC wanted to spend the money to redo the test based on a factor that nobody really considered to be very important.

JUDGE CARPENTER: I accept that.

WITNESS JACOBUS: That's pretty much --

JUDGE CARPENTER: I've been on your side of the table. But you dismiss it -- I don't quite see the basis. I agree with you that you have to live with it.

WITNESS JACOBUS: I don't disagree that that may have been what accounted for what Mr. Kraft termed some permanent degradation of the block after the test was over.

JUDGE CARPENTER: At least changed the block, not necessarily degradation.

WITNESS JACOBUS: Okay, change. Whether that was due to something deposited on the surface, physical changes to the surface which resulted in a change in surface conductivity as a result of the exposure to the higher temperature, I don't know exactly what the cause of that was.

JUDGE CARPENTER: On the other hand, I correct myself. Mr. Kraft reports that there was carbonaceous residues, graphite-like, on the surface of the block. I think that's reasonably called degradation of the block. That's not water evaporating or being deposited or fingerprints. It's a real change in the body of the block, right?

WITNESS JACOBUS: That would appear to be so, definitely. I think the carbonaceous residue probably came from the base phenolic material. In some sense, the surface was degraded. Whether that accounted for the decrease in insulation resistance at the end of the test is a separate question.

JUDGE CARPENTER: I understand that the test was over. The test was over. There was no more money to pursue this. But my real question is whether it raised some cautionary feeling about how broadly applicable the data might be, and you said you compared it with other data and it wasn't really different.

So apparently there wasn't any sense of cautionary --

WITNESS JACOBUS: Keep in mind the other thing is that just about everybody in the industry was going out and replacing all the terminal blocks. So it was becoming no longer an issue.

You don't -- once you've identified that there's a problem with something, people get rid of it. The NRC does not continue to want to spend research dollars investigating something that is no longer used in the applications where it would be relevant.

JUDGE BOLLWERK: At this point, why don't we take a five-minute break. I have to use the restroom and we'll come back.

JUDGE CARPENTER: And be of good cheer. This may eliminate a hundred questions and it may not.

JUDGE BOLLWERK: We'll come back about 5:00.

Thank you.

[Recess.]

JUDGE BOLLWERK: I think Judge Carpenter had a few more questions.

JUDGE CARPENTER: Before I -- yes, Mr. Holler. I was going to ask you.

MR. HOLLER: If I may, sir, before we begin, I would just remind the Board that Dr. Jacobus still had that information with regard to your questions. I don't know what part you would want --

JUDGE CARPENTER: Why don't we do it right now, please.

WITNESS JACOBUS: Will you pass that out?

MR. HOLLER: Yes, sir. If it's going to that, there is a document that may be helpful to it. If I may, for identification purposes, document called "Plastics in Engineering," with extracted pages, and "Handbook of Plastics and Elastomers," for identification purposes labelled Staff Exhibit 85.

JUDGE BOLLWERK: These are excerpts from a book called "Plastics in Engineering." Is that basically what we're talking about?

MR. HOLLER: That's correct, sir. And then one, two, three, four pages down, on the fifth page, are some extracts from "Handbook of Plastics and Elastomers." We've included th se as one. For these purposes, we'd be happy to identify them as two, but I think it's just as easy to deal with it this way.

JUDGE BOLLWERK: We'll just identify them both as being -- they're attached together as Staff Exhibit 85, which the record should reflect has been identified.

[Staff Exhibit No. 85 was marked for identification.]

WITNESS JACOBUS: I'm only providing this to try to help address Judge Carpenter's questions regarding the moisture films and some of the questions of bulk resistivity. I called back my office and somebody ran over to the library and quickly dug up this information and sent it back to us.

What I would do is particularly call to Judge Carpenter's attention to the second page of the exhibit, the last paragraph of that page. I'll just read that very quickly.

"Surface insulation resistance of most insulators is extremely good under dry conditions, but becomes poor when exposed to damp conditions. Resistance is lowered considerably if the moisture is absorbed into a continuous film which would occur if salts from the material itself or from dirt on the surface aids the absorption."

And then it goes on to talk about some other things. There is also some data in here that may help Judge Carpenter in terms of bulk resistivity of phenolic material at various temperatures. I'm not sure if that would be helpful or not.

We simply provided it for his consideration to the extent that he'd like to use it. I have not had time to review it in detail, so I don't know in detail what it says.

JUDGE CARPENTER: I thank you for your efforts. I note on the third page there's a table, Roman XXXVI, which is a micro-filled phenolic, but, unfortunately, I can't read the exponent of the resistance.

WITNESS JACOBUS: Which page are you on?

JUDGE CARPENTER: I can tell it's not two digits, but I can't tell what digit it is.

JUDGE CARPENTER: Do we have the original of this? Who received it? I guess we certainly could provide a better copy of this if the Board wishes to see a better copy. We're providing it primarily for your benefit.

JUDGE BOLLWERK: Is it something you want to see?

JUDGE CARPENTER: Thank you for providing me with a copy. If it turns out to be of real interest, I'm sure a local library has an original.

WITNESS JACOBUS: That's true. It has been around since about 1949.

JUDGE CARPENTER: The hour grows late and I don't want to belabor, from strictly an intellectual point of view, an engineering report. But in trying to understand the underlying phenomenon that are represented by the Sandia report, from my background as an electrochemist, I have considerable problems, all the way to the most primitive one of the formulation of the model doesn't even tell me what reaction is going on at the anode or what reaction is going on at the cathode, and there is no recognition that this is a transport of current by ions, and there have to be reactions at the electrodes.

WITNESS JACOBUS: This was an attempt to roughly come up with some generic things. It is recognized that this model is not a highly accurate model. It was intended as a very first order attempt to come up with some theoretical considerations.

JUDGE CARPENTER: I'll accept that. I've got a little handout, and it won't be too mysterious because most of the material comes out of International Critical Tables, which I'm sure you've looked at.

But the only reason I went that direction, there was an issue as to what the functional dependence of the resistance, electrical resistance of water is as a function of temperature or the electrical resistance of sodium chloride as a function of temperature, and I thought I'd see what endless number of researchers over the years had concluded as a basis for trying to make a finding of fact of the two exhibits that are before the Board.

So I don't want to belabor this now. I just want to run through it very quickly and let you see why I have a little -- it doesn't dispose of the issue, but I just wanted you to see the results of that exploration.

Mr. Holler, if you could help me.

JUDGE BOLLWERK: I'm going to identify for the record what has been marked as Board Exhibit 2, entitled "Board Examination Papers-Farley on the Issue of Terminal Blocks." It consists of ten numbered pages, which are excerpts from the International Critical Tables, as well as some charts prepared by Judge Carpenter, and a portion from the Physical Chemistry of Electrolytic Solutions Handbook, as well as a Handbook of Aqueous Electrolyte Solutions.

Let the record reflect that Board Exhibit 2 has been marked for identification.

[Board Exhibit No. 2 was marked for identification.]

JUDGE CARPENTER: If we could just walk through these very quickly. Turning to Page 2, this is a copy of the page -- International Critical Tables Page 233, which includes the data for sodium chloride that Dr. Jacobus and Dr. Solomon, as I understand it, used in evaluating the conductivity of sodium chloride solutions.

WITNESS JACOBUS: Dr. Solomon actually did that part, I believe.

JUDGE CARPENTER: Fine. My only point is I didn't find this page by accident. I found it because it was referenced.

So given that and given the thought that the surface of the block might have sodium chloride on it from fingerprints, I ask the question if that were true, how would the resistance of the block vary with temperature. And that's Page 3. And as you can see from the reference line there, it really isn't exponential. So I make the point that those data points have an uncertainty of probably a tenth of a percent.

These are not block data. These are real solutions being carefully measured. Clearly, the theoretical function or the fundamental function isn't logarithmic, but it isn't wildly different from logarithmic.

I also note over the temperature interval they were interested in, the variation of sodium chloride conductivity is only about a factor of two. The solubility doesn't change much with temperature and the conductivities -- to a laboratory person, two percent per degree is a headache. But as far as these blocks are concerned in a LOCA, it's a very small change compared to the five or six orders of magnitude that were observed at Sandia.

And staying in International Critical Tables, turning back from Page 233 to Page 230 International Critical Tables, there is information about how you make solutions for determining the cell constants of conductance devices.

Are you familiar with Parker solutions, Dr. Jacobus?

WITNESS JACOBUS: No, I'm not.

JUDGE CARPENTER: They are the standards for calibrating any cell constants for conductivity. Therefore, as you can see, they're very careful to show not more than four significant figures, but they do estimate out to six.

And these people think that the dependence is a quadratic. Why I would think differently, I don't know. So I would expect, if I was looking at data that were being caused by the conductance of ions in a solution, they'll be different depending upon what ion it is, but I think the temperature dependence would be very different from this over a modest temperature range, and we'll come to a larger temperature range.

And just in passing, looking at the impact that different ions might have on such a conducting system. As you can see, except for hydrogen ion, the temperature coefficients are not wildly different. The electrochemist's seat-of-the-pants two percent per degree.

Turning to Page 5, I read in Staff Exhibit 74 on Page 68, I quote, "It's known that lambda follows an Arrhenius relationship of the form lambda equals U exponential minus E-sub-A over RT."

And so I test that proposition just by making the plot of the data from the International Critical Tables. And it doesn't look like it really is an Arrhenius relationship.

WITNESS JACOBUS: It does not look like there's a --

JUDGE CARPENTER: No. It's a very poor fit.

WITNESS JACOBUS: I'm not --

JUDGE CARPENTER: I'm not talking about casual data now. I'm talking about a tenth of a percent.

WITNESS JACOBUS: You're on Page 5 and you're comparing --

JUDGE CARPENTER: Yes, right.

WITNESS JACOBUS: -- the thing labelled "Arbitrary Visual Aid." Is that --

JUDGE CARPENTER: Right.

WITNESS JACOBUS: -- to the X's?

JUDGE CARPENTER: Right. They don't seem to be exactly linear on this plot.

WITNESS JACOBUS: I'm not sure I'm with you. The straight line that's labelled "Arbitrary Visual Aid" is derived from something or is that just an aid to see if it's linear?

JUDGE CARPENTER: It says arbitrary visual aid, looking at -- I simply connected the points with a straight line and then I put a straight line the length of the graph paper just to look and see.

WITNESS JACOBUS: Just to identify whether that --

JUDGE CARPENTER: I didn't want to clutter up the data by drawing a straight line through it.

WITNESS JACOBUS: I understand.

JUDGE CARPENTER: But be that as it may, I will say, Dr. Jacobus, when I read "It is known" without a reference, I begin to wonder where the burning bush is that the voice from heavens came down and said this is so, because as I continue to try to find out what the people who make a living making these kind of measurements are of the opinion, and I look at Harned & Owen, Physical Chemistry of Electrolytic Solutions, it happens to be 1964, which I think I can observe is probably considered one of the more robust references that there is in terms of being critical of the data.

Harned & Owen very carefully throw data that they have some question away. And Harned & Owen says, no, no. It's not just parabolic. But if you're really going to do it to .02 percent, it's got to have a little cubic term in it.

But they didn't talk about an Arrhenius relationship. And so I looked at another more recent, 1964, Harned & Owen, Handbook of Aqueous Electrolytes, not of the stature of Harned & Owen, but they're still talking about cubics and I still can't find any jump from the kinetics section of most textbooks to the conductance section in these handbooks.

I know what Glasstone says and I'm very frustrated trying to find what the water that might be on the surface of the block might be doing.

The Atomic Energy Commission supported some research and I just copied a couple pages of this report in the Journal of Chemical Physics, Volume 50, May of 1969, which summarizes the author's own research and other research in a very convenient way.

And if you look at Page 9 of my handout, which is 4425, you'll see that for the dissociation of water, which is a chemical reaction, the field generally agrees. It depends on reciprocal absolute temperature for the dissociation. But then given the dissociation, you then have the variation of the conductance of the hydrogen ion and the hydroxyl ion as a function of temperature, and water is a fascinatingly complicated liquid.

But with certain temperature intervals, the hydrogen ion actually has extra conductivity and -- I'm quoting -- I'm paraphrasing what the gentleman tells me.

So that the functionality is not simple and we end up with this delightfully irregular result, for the reason that these people are -- they do all kinds of funny things, putting water in a sapphire anvil and compressing it to 98 kilobars.

But the only pertinent part of this is as a convenient way to look at or find a graph of the conductivity of water as a function of temperature at pressures smaller than .4 kilobar. In this plot, the pressure effect is essentially negligible.

The interesting thing to my eye is that there really is a factor of a hundred variation in the conductivity of water over the temperature interval that we're thinking about, and there's only a factor of eight in sodium chloride.

And I just get charmed with what can be causing the conductance, changes that you've observed. And I agree wholeheartedly that if it were pure water and the pure water comes and the pure water goes as the temperature goes up and down, you would see large changes in resistance as a percentage of the resistance.

Are you with me?

WITNESS JACOBUS: Partially.

JUDGE CARPENTER: The trouble I have -- expose a block to steam and the block is the temperature lag. The water condenses on it and makes a film and perhaps some droplets run off, either carrying the sodium chloride off as they did in the Sandia experiments, because you couldn't find it on the surface of the block at the end of the experiment.

There was only one little trace of sodium and that could easily -- you're losing the conductor as the water comes and goes. As the water goes, I should say. Then turning to whether or not the sodium chloride can account for this, then I have the problem, well, yes, so the water evaporates and the solution becomes more complicated, but I've got the same number of sodium ions, the same number of chloride ions, and the equivalent conductance does depend on concentration, but not factors of ten.

So I can't put the pieces together. I'm not testifying now. I'm just telling you my desk and my work table have been an intellectual swamp for some weeks, trying to develop a rational analysis of what I see.

I chased quite a bit to find this conductivity of water at high temperatures. Do you understand this hole that I have? If I accept that it's an electrolyte in a film on the surface of the water at the peak LOCA temperature, for example, and then cool it, if I can't get rid of the electrolyte in my think experiment, I can't get the resistance to change by ten-to-the-third or ten-to-the-fourth.

Can you help me?

WITNESS JACOBUS: If the film entirely evaporates, you may get large changes. You're going across mechanisms, where, in one case, you have the solution on the block and, in another case, it's dry.

JUDGE CARPENTER: But the chamber doesn't suddenly get flushed with dry air, does it?

WITNESS JACOBUS: No, no. When the terminal block is at a higher temperature than the environment, that causes the moisture to evaporate off of the block because the temperature in the chamber is coming down.

JUDGE CARPENTER: Without belaboring this, remember the results of your model calculation. Down to a film thickness of how thin and you were still getting a milliamp?

WITNESS JACOBUS: Right. But beyond that, if that evaporates, there's only a tiny. tiny bit of water on there at that point because it's so thin and it can evaporate off at that point if the temperature is changing.

So the terminal block is being hotter. As you reduce the temperature, that film may evaporate. There would be no film at all at that point, and now you're governed by the surfa⁻⁻ characteristics of essentially a dry block.

To give you perhaps --

JUDGE CARPENTER: I don't really want to pursue this issue because what you're invoking here is it depends very much on the dynamics of the system, on how you do the experiment, how fast you change the temperature, and so on.

I'm not sure that there's been any careful attention to that correspondence, as I wander there, and I won't wander much further.

I wanted to ask perhaps both the staff witnesses and then the applicant. There's been a lot of reference to this IEEE Standard 323-1974.

WITNESS JACOBUS: 1974 or 1971?

JUDGE CARPENTER: I'm sorry. I'm looking at the revision of 1971. I'm looking at APCO Exhibit 36. My only question is the bulk of the standard goes along and then there's an appendix. Within the standard, there is only Figure 1, a simulated service condition profile which shows an additional peak to assure margin and a specified period of operating capability to function during and following a design basis event.

The authors of this standard refrained from putting any numerical values in Figure 1, but simply say there are a number of temperatures, etcetera. But no specifications, as I read it.

WITNESS JACOBUS: Are you talking about Figure A-1?

JUDGE CARPENTER: No. Figure 1 on Page --

JUDGE BOLLWERK: What's the Bates number up in the corner?

JUDGE CARPENTER. The Bates number is 61953 and it's also Page 16. Do you see what I'm referring to now?

WITNESS JACOBUS: Yes.

JUDGE CARPENTER: And then there's an appendix, Bates No. 95955, which actually specifies the time and the temperatures. And then it says these appendices are not part of IEEE Standard 323-1974.

I guess I'll start with Mr. Luehman. What significance -- do you know if NRC has ever sanctioned in any way, with a reg guide of what have you, the use of this appendix?

WITNESS LUEHMAN: I don't know.

WITNESS JACOBUS: I believe I can perhaps give you some insight that may go to the heart of what you're trying to get at. The idea is that Figure A-1 was added to the standard as a "generic suggested profile" that people could use to qualify equipment on a generic basis.

And in using that, it was expected that most conditions at most plants would be within that envelope. So if a manufacturer did attest to that environment, they would very likely be able to envelope a plant condition and that plant would be able to use that as a qualification document.

JUDGE CARPENTER: Fine. That helps me. There is no implication that this is the legitimate profile.

WITNESS JACOBUS: No, absolutely not.

JUDGE CARPENTER: It's only the envelope. Thank you very much. I think I'll pause.

JUDGE BOLLWERK: All right. Judge Morris?

JUDGE MORRIS: You can now shift gears about through five speeds. I have been confused about what the groundrules were for this game and whether there's been differences of opinion or differences of understanding or differences in communication over periods of time on what the criteria were for qualification of these terminal blocks.

Maybe I could start by asking you, Dr. Jacobus, when you arrived on the scene for the first inspection in the fall of 1987, what your understanding was of what the criteria were for acceptable performance of the terminal blocks as a result of a design basis accident.

WITNESS JACOBUS: I'm not real sure how to answer that question. As I testified previously, I can only look at the skew sheet value as a basis for the temperature at which the terminal blocks have to perform, unless I find something else somewhere that says that is not the case.

JUDGF MORRIS: So to begin with, that was the basis on which you were inspecting. ꞁ that correct?

WITNESS JACOBUS: That's correct.

JUDGE MORRIS: And did that basis change during the course of the inspection?

WITNESS JACOBUS: As I recall, I was never presented any documentation to say that any other value was correct. I was not -- for example, the February letter that has been referred to of 1984, I'm not sure what the exhibit is, that was not given to me during the inspection.

JUDGE MORRIS: So that your whole reasoning process during the course of the inspection and whatever you contributed to the inspection report was based on your understanding that the blocks should be qualified for peak LOCA and main steam line break accident temperatures. Is that correct?

WITNESS JACOBUS: When you get to the inspection report, we ad also had the meeting in Atlanta on -- I'm not sure what date it was -- November 29, and Alabama Power had presented some information that said they did not need the terminal blocks except at temperatures below 296 degrees Fahrenheit.

So I also had that and some documentation that said that. So with that clarification, that's very close to the peak LOCA conditions. With that clarification, the answer is basically yes to your question.

WITNESS JACOBUS: Since that time, has your understanding of the performance criteria necessary to qualify these blocks changed?

WITNESS JACOBUS: Well, we've heard Alabama Power Company's testimony that up to this point, they have agreed that they have to be qualified to at least 260 degrees Fahrenhei

From a technical standpoint, I would still maintain that they have to be qualified through peak LOCA conditions unless there was evidence that that were not the case for every possible accident; not for just the design basis accident, because the design basis accident, if you can show it performs in a design basis accident, you also cannot show it performs in every lesser accident.

JUDGE MORRIS: So that you don't accept the argument that it's needed only during the initial upward transient and then again sometime later during the downward transient. You think it may --

WITNESS JACOBUS: At this point, I do not accept it because the complete information for all the various accidents has not been addressed. If we say we're only looking at the design basis accident and we cannot show performance throughout the design basis accident, then, to me, it no longer is a design basis accident.

A design basis accident says you show it works here; therefore, we can extrapolate and say it will work for anything less severe. And I have not -- I never did see an analysis that said that for every different potential accident, that that would be the case, what they had claimed.

JUDGE MORRIS: I understand.

WITNESS JONES: May I respond?

JUDGE MORRIS: Mr. Jones, you were about to be called upon.

WITNESS JONES: My response to that is during the inspection, when Mr. Jacobus or Dr. Jacobus, excuse me, and Mr. Wilson raised the concern about how the profile was developed and raised questions regarding our post-accident monitoring equipment.

Not only did we have several discussions with them trying to explain our philosophy of instruments performing their function early in the event and then equipment or monitoring instruments needed after the peak condition, after some discussion with them about that, still lacking their concurrence, Westinghouse was flown down from Pittsburgh.

We had a specific meeting on the philosophy that was being used. And it was my understanding when we left that meeting there was no concern about the philosophy that was adopted by Alabama Power Company. It was just a matter of the contribution of leakage currents due to the terminal block contribution of the whole instrument loop.

WITNESS JACOBUS: I would agree that there was no -- we had no differences with the methodology. In coming to, in effect, the Westinghouse setpoint methodology and their EOP methodology, and I would agree that it was the question of what data should be input for insulation resistance for the terminal blocks.

What I have not seen is any complete and thorough justification that says those terminal blocks will not be needed above a certain temperature in any possible accident. In effect, you are coming up with a new design basis accident for which the terminal block needs to function.

In the original direct testimony, we saw that, for LOCA conditions, it only had to function at 170. In the surrebuttal testimony, we see in a higher energy line break it has to function at 240 to 260 and we're looking at after the peak conditions.

Are there other accidents where it has to function at 270 or 280 or 265? I haven't seen -- I simply have never seen that analysis.

WITNESS JONES: I'll just respond to that. In 1984 when terminal block contributions came on the scene and

NRC raised the concern, we got an agreement by adding a conservatism, as you well know, and that was documented in our letter.

In 1987, after additional concerns were raised and what we heard that the NRC was requiring additional documents, wanted additional conservatisms, we went and did a similarity analysis, added additional conservatisms.

They were still concerned during the meeting. We brought Westinghouse down to the site. We even took their data and wrote a JCO on it and then they still weren't satisfied.

There was no way to satisfy them. So we took the terminal blocks out.

WITNESS JACOBUS: I would submit that all these conservatisms that were added still did not account for the major issue, and I think the record will speak for itself on that.

WITNESS JONES: It was clear that Dr. Jacobus would not be satisfied with anything less than us taking out the terminal blocks, so we did.

JUDGE MORRIS: In your qualification, did you limit yourself to the LOCA and main steam line break accidents?

WITNESS JONES: Yes, sir. We limited it to the design base bounding curve, which is consistent with qualification of all of our equipment. We use the bounding curve.

WITNESS LOVE: But that is not to say that that does not envelope other conditions. To get into the types -- I would just like to state that there was a whole separate issue and regulation called Reg Guide 1.97. If we had realized or had known at the time that there was still confusion, we could have gone into Reg Guide 1.97, which is a complete regulatory document of its own, with documentation indicating what instruments are required to function when for what scenarios.

And these are the enveloping EQ conditions and these are the only instruments required at these temperatures for these events.

WITNESS JONES: Now, if we want to get into Reg Guide 1.97 in which instruments have to function at what time, we can go into that. I just did not realize that was part of this hearing.

JUDGE MORRIS: I was going to ask if that question has been discussed prior to today.

WITNESS JONES: It has not, to my knowledge.

WITNESS JACOBUS: I believe that my rebuttal testimony outlined all of these factors that would need to be considered. I believe my direct testimony even outlined those factors. In the surrebuttal testimony, those factors were all dismissed because it says the terminal blocks would have worked at 309 degrees.

WITNESS LOVE: We dismissed those in our testimony because they weren't pertinent to the applications that we were talking about.

WITNESS JACOBUS: I think we have another point of disagreement that's fairly clear.

JUDGE MORRIS: On the record, so we don't need to pursue it here.

WITNESS JACOBUS: If you wish, I can point it out in my -- any of my testimony. It's been talked about several times. That's on Page 33 of my rebuttal testimony. In response to that, the Alabama Power surrebuttal testimony -- I will see if I can find the reference to --

JUDGE MORRIS: While you're looking, let me ask Mr. Jones if you're looking at Page 33 of the rebuttal testimony of Mr. Jacobus and Mr. Luehman.

WITNESS JONES: Okay. I'm on Page 33.

JUDGE MORRIS: In preparing your surrebuttal testimony, did you consider each one of these points?

WITNESS LOVE: We addressed this issue. I'm looking for --

WITNESS JACOBUS: Page 193 of the surrebuttal testimony.

WITNESS LOVE: We considered those points in addressing -- making our response, yes.

JUDGE MORRIS: I guess the record will speak for itself. Thank you very much.

JUDGE BOLLWERK: Anything else, Judge Carpenter?

JUDGE CARPENTER: Dr. Jacobus, we have this on the record, but it's almost off the record. I just need to understand. If you look at that last graph on Page 10 of my handout and look at the conductivity of a cube of water at 200 degrees, in just very round numbers, reading it off the graph, it's five-times-ten-to-the-minus-six.

So if you had a nickel-plated screw a centimeter away from a nickel-plated screw and you had a cross-sectional area -- I mean, a deep film, a whole centimeter thick, what resistance would you expect?

WITNESS JACOBUS: Say that one more time.

JUDGE CARPENTER: Look at the graph. The number is five-times-ten-to-the-minus-six for the conductivity.

WITNESS JACOBUS: Okay.

JUDGE CARPENTER: Take the reciprocal of that and what have you got?

WITNESS JACOBUS: Two-times-ten-to-the-five, I believe, if I've got my exponents right.

JUDGE CARPENTER: I guess I better stop. The day goes late. Because that's not the exponent that I get with a pencil and paper.

WITNESS JACOBUS: Five-times-ten-to-the-minus-six times two-times-ten-to-the-minus-five is one. One of us needs to --

JUDGE CARPENTER: I'm dividing one by five and getting .2. I'm taking the reciprocal of ten-to-the-minus-six and getting ten-to-the-sixth.

WITNESS JACOBUS: Which is the same as two-times-ten-to-the-five. Point two times ten-to-the-sixth. Wait a minute.

JUDGE MORRIS: No, you're right.

JUDGE BOLLWERK: Nobody has a calculator.

JUDGE CARPENTER: The point I wanted to make just in passing is I just can't get down to these ten-to-the-fourth numbers any way I try.

WITNESS JACOBUS: All I can do there is go to the test data.

JUDGE CARPENTER: But what I didn't realize until today is this is a dead issue. The reason I was interested, Mr. Kraft tells us that in Europe, they've tried to qualify blocks and are concluding that they only should use porcelain or ceramic blocks inside containment.

If this film business were the cat's pajamas, it wouldn't make any difference what the block was. And if that's not entirely true, then it might make a difference what the block was and that's something the NRC might spend money on.

WITNESS JACOBUS: Except for the fact that in the relevant applications, at this point, I think everybody has removed the terminal blocks from the applications that would be sensitive to those affects.

JUDGE CARPENTER: I'm aware of that, but I'm not too comfortable with real people, not hypothetical actors, but real people getting real radiation as a result of this.

WITNESS JONES: We didn't replace them by choice, I might add.

JUDGE CARPENTER: I understand. I'm just trying to explain why I've taken some interest in this, because these are real people that I hope everybody in this room feels some responsibility for.

WITNESS JACOBUS: Yes, I agree. I mentioned before that there have been other types of connectors developed. There also -- we got very late in this test program and never got a chance to test it. I think it was a European company developed a terminal block of a very unique design that gave you an effective distance of inches, on the order of something like four or five inches between the terminals.

JUDGE CARPENTER: Be that as it may, we are where we are today. As I say, I just wanted to explain why I just find this -- I first look at the Sandia data. This is a wonderful thermometric substance. I don't expect to go in a hospital and find people with one in their mouth, but it's a remarkable resistance change, to me.

And I'm still not comfortable that I understand it, but it's not necessary for me to understand it for this case. But it's irresistibly intellectual, and that's enough out of me.

JUDGE BOLLWERK: All right. I just have two brief questions, two more general issues I want to talk to Mr. Luehman about for a second.

At one point in this proceeding, there was a question about terminal blocks with regard to Limitorque operators. Can you tell me the status of that in terms of the notice of violation?

I just want to tie up a loose end here. I have some recollection.

WITNESS LUEHMAN: Specifically --

JUDGE BOLLWERK: Maybe I'll just have to check the record myself if you have no recollection of it.

WITNESS LUEHMAN: I think that -- I'm drawing a blank as to --

JUDGE BOLLWERK: Maybe Mr. Holler can help me out.

MR. HOLLER: The question is is that still an alleged violation from the staff?

JUDGE BOLLWERK: Yes.

MR. HOLLER: Yes, sir, for the terminal blocks and the Limitorque valve operators.

WITNESS LUEHMAN: It's under the heading of the general violation, but I thought you were asking something more specific. There was a number of discrepancies with some of the Limitorque operators.

MR. HOLLER: Testimony was offered on direct and --

JUDGE BOLLWERK: Right. We haven't heard anything about it in a while, and that's why I wanted to make sure I hadn't -- something hadn't fallen between the cracks that I had missed.

But there has been testimony and the record will speak for itself.

WITNESS LUEHMAN: Yes. It's under the Limitorque -- the general heading of Limitorque with the T-drains and --

JUDGE BOLLWERK: Right. I guess we saw nothing on rebuttal or surrebuttal except T-drains, and I wanted to make sure that I hadn't missed something. It sounds like the record is going to speak for itself on that matter, then.

All right. I want to ask you another general question. This goes back, frankly, to something Mr. Wilson had mentioned yesterday, but I think it's something that you can address in the general context of the enforcement policy.

I would like to get some understanding from you as to the time deadline, as you see it, in this case that controlled APCO's ability to develop new information and give it to the staff and have it considered as part of their qualification process in terms of the inspection.

I know there were a number of different steps here. There was an inspection itself. There was a meeting in November of 1988. There was then some submissions, at least I remember with respect, for instance, to the Chico/Raychem. There was a submission in January of 1988.

There was an inspection report in February of 1988, another enforcement conference in April of 1988. Can you give me some idea of where in terms of the policy statement the ability of APCO to develop new information and submit it to the staff and have it considered at that time came to end in this proceeding.

WITNESS LUEHMAN: Are we talking specifically to Chico A/Raychem?

JUDGE BOLLWERK: Well, let me ask you two questions. Can you give me a generic answer or does it depend on the particular item of equipment?

WITNESS LUEHMAN: Well, I think the generic answer is obviously that if -- it's easier to -- there's two issues here. One is if a licensee was able to provide -- ultimately provide information, and I would guess I would classify that short of testing, because I think the staff's position on additional testing is that it's inconsistent to allow licensees to do additional testing simply for violations.

JUDGE BOLLWERK: For the purpose of this, we'll assume that whatever definition of developing you're going to use is the one we would accept. What I'm interested in is where, assuming that --

WITNESS LUEHMAN: I think that the answer to that is that in the case where the licensee continued to develop -- there was ongoing discussions with the staff and, at some point, the licensee was able to convince the staff that there was adequate documentation, then I think that we would probably have -- I guess what I'm saying is if the licensee could conclusively show that their position was maintained by analysis or whatever, then I think that we would accept that.

That would be on a case-by-case basis, weeks. Depending upon what we're talking about, how difficult the information was to retrieve. I think in the case -- to get more specific to the case at hand, I think that on most of the issues that we're talking about, that we have looked at all the information that the licensee has provided on these various issues in this case.

And I think that we've looked at it -- the staff has looked at it all. And the question is on some issues, I think as Mr. Wilson testified yesterday and I think maybe even in the course of the testimony today on this issue, on a few of the issues, the licensee may have closed the gap, so to speak.

But I think that in -- it's the staff's judgment that in the case of the things we're talking about here, that there is still significant gaps no matter if we continue -- if we consider the information up to this point excluding any testing that we would consider additional.

So in a generic sense, what I'm saying is we would probably give flexibility, because obviously if a licensee showed conclusively or closed the gaps considerably in what the staff alleged were problems, we would probably give a lot of leeway in that.

In those cases where the gaps were significant and they were never closed, I don't think that it really then makes any difference whether the licensee provided that during the inspection, the day after or there weeks after.

Obviously we would run into some consistency problems if, for one licensee, we were accepting things -- I mean, a year after the inspection, a licensee came back and said, oh, by the way, we've just developed this and this solves all our problems.

I'm not saying that's the case here, but I think that we did usually have a cutoff of days or weeks, but shortly after the inspection.

JUDGE BOLLWERK: Did you define the cutoff here? I guess that's the -- is there anything on the record that indicates what the cutoff was in this particular -- with respect to this particular inspection?

WITNESS LUEHMAN: I think that the answer is that we've considered all the -- I mean, clearly we've considered the information that was provided in the notice of violation and everything that led up to the notice of violation. We tried to address all of that in the order imposing the civil penalty which was not issued till 1990.

Obviously, if we felt Alabama Power came through with information that made rational arguments and closed the gap, and, in fact, in some of the things that were originally in the notice of violation, we concluded that and some items that were originally in the notice of violation were dropped from consideration at a later date.

So the staff's consideration was ongoing. But it reaches the point where the staff has to make a decision that the gaps between what the licensee considered adequate and what the staff considered adequate can't be bridged.

I guess what I'm saying is it's a more difficult situation where you actually have a case where a licensee ultimately brings forward information and now you -- and it determines that there isn't a violation, how fair is it to another licensee who might have gotten a violation who wasn't -- where that wasn't -- where the information wasn't brought forward by that first licensee, inasmuch as it matters.

I guess the dilemma that we're in is we have to cut if off at some point. In this case, since this case went all the way to hearing, we've obviously considered all the information the licensee has brought up through their surrebuttal testimony.

If we felt that -- I think the staff's position was that if the licensee made convincing arguments on these things in their surrebuttal -- all the way up through their surrebuttal testimony, I don't think that the staff is just in this to win. I think that -- I think it's to do the right thing, in our opinion.

JUDGE BOLLWERK: So when Mr. Wilson yesterday was telling us that he continues to evaluate this information in terms of the environmental qualification of the Chico/Raychem seals, he was, in fact, stating what the staff's position is and he's continuing to evaluate it.

WITNESS LUEHMAN: He continued to -- as he was provided more information, he was clearly asked to look at it and see if the licensee was making new arguments that he might have overlooked. Obviously -- and then based on what he saw and what was reviewed by the team.

I think that's a fair statement.

JUDGE BOLLWERK: All right. Thank you very much for clarifying that for me. I think that's all I have. Anyone else?

[No response.]

JUDGE BOLLWERK: All right. Mr. Jacobus, we thank you -- if you have something to say, certainly.

WITNESS JACOBUS: One very quick thing. I made a couple of statements. I said they were in the Sandia report. I didn't reference them. I have that reference now. They're both on Page 3 of Staff Exhibit 73. One is in the first paragraph -- the second paragraph, excuse me, where I mentioned that there were -- I'll just read the sentence of the record -- "sporadic breakdowns to very low values of insulation resistance, a few to several hundred ohms, lasting from less than a second to several minutes, were observed."

And then there's somewhere else in the report where it explains that these were not captured by the data logger which was sampling at discreet periods of time, but were captured on the strip chart recorders.

Also, at the bottom of Page 3 is where it talks about the difference between a serpentine and terminal-to-terminal insulation resistance measurements. It says the values were predominantly one-third to one-tenth. The insulation resistance values in Phase I were predominantly one-third to one-tenth of the insulation resistance values measured in Phase II.

JUDGE BOLLWERK: All right. Thank you, sir. I also forgot to offer to the parties. Does anyone want to ask any redirect questions about any of the matters the Board addressed?

MR. HOLLER: The staff has no redirect, sir.

MR. REPKA: I have no redirect.

JUDGE BOLLWERK: Then at this point, we'll go ahead and dismiss the panels on terminal blocks. We thank Mr. Jacobus, who I think has provided all the testimony he is going to in this proceeding. We appreciate your service to the Board.

I believe also, Mr. Love, I think you are now finished. We thank you, sir, for your service to the Board and your testimony.

[Witnesses Jacobus and Love excused.]

JUDGE BOLLWERK: At this point --

MR. HOLLER: If I may remind the Board, sir, we have some exhibits.

JUDGE BOLLWERK: That's correct, and I think we need to assess where we're at in terms of finishing up. So why don't we go ahead and take care of the exhibits first, and then we'll do that.

MR. HOLLER: If I may, sir. Staff moves to move into evidence Staff Exhibit -- what have been identified as Staff Exhibit 83, 84 and 85.

JUDGE BOLLWERK: Mr. Repka.

MR. REPKA: With respect to Staff Exhibit 83, we have no objection. With respect to Staff Exhibit 84, we object to its admission into evidence on two bases. First, this is a document that only became available today to us and we didn't feel like we had sufficient time to review it. Second, this document was offered to rebut Mr. Love's testimony in Q&A 103 on Page 172 of his surrebuttal testimony.

That temperature -- that testimony relates to the temperature, the shape of the curve, and ranges of significance to the Farley instrumentation. In that context, we don't believe that either the relevance or probativity of the exhibit has been established.

It has not been established that the curve, number one, or the data clearly establishes that the curve is not linear on the logarithmic scale. And, number two, it has not been established that the curve has any relevance to the temperature ranges of significance to Farley nuclear plant.

MR. HOLLER: Staff would just respond by saying the Staff Exhibit 84 plotted the temperatures that were available and for purposes of illustration. The staff has no further comment, sir.

JUDGE BOLLWERK: I am less concerned about the relevance argument and more concerned about the lack of notice to you all to be able to respond to it in any way you saw fit.

It is not my intention at this point to close the record. I'm going to leave it open for a while to allow the parties to go through and make sure they've got everything they want into evidence.

If we provided you with an opportunity to respond to the exhibit, would that address that concern?

MR. REPKA: That would address that concern. I don't think it would address relevance and probativity, but it would address the first concern.

JUDGE BOLLWERK: All right. Why don't we handle it that way. We're going to go ahead -- well. We have also Exhibit 85. Do you have any objection to that?

MR. REPKA: Yes. I hate to be ornery at this late hour, but given the context in which Staff Exhibit 85 was raised, that is the staff was not relying on it in any way, only offering it to Judge Carpenter, I, frankly, am -- I would not like the prospect of either party combing this document to find a basis to support their positions in the proceeding. I don't believe it should be part of the record.

MR. HOLLER: The staff has no objection to the withdrawal of Staff Exhibit 85, but merely included it for continuity. I might suggest that if the Board cares to make it a Board exhibit, the staff would not object to that.

JUDGE CARPENTER: I think Mr. Repka's description is very much the spirit. It was a courtesy to me. I don't look at it as an exhibit from which findings of fact relative to this case are going to be drawn.

It was more my expression of some intellectual curiosity and I haven't had a chance to look at it, but I don't think these plastics people really think about peak LOCA environments when they characterize the materials.

But at any rate, I will take a look at it. But it was a courtesy to me and I considered it personally and not part of this record.

MR. HOLLER: We withdraw -- if I may amend my motion, I withdraw my motion to include Staff Exhibit 85 into evidence and would renew my motion at this point to include Staff Exhibit 83 into evidence and reserve moving Staff 84 into evidence till a later time.

JUDGE BOLLWERK: We're going to go ahead. We'll withdraw Staff Exhibit 85 and the record can reflect that.

We'll mark it as withdrawn.

[Staff Exhibit No. 85
was withdrawn.]

JUDGE BOLLWERK: Staff Exhibit 83 will be admitted into evidence.

[Staff Exhibit No. 83 was
received into evidence.]

JUDGE BOLLWERK: Staff 84 we will also admit into evidence with the caveat that you all will be provided an opportunity -- and I'll set a date, not right now, but in the next -- before we finish this evening, in which you all can respond to it in whatever way you want to, to contest the validity of the exhibit.

If you wish to raise relevance questions again, you can certainly do that and that will go to the weight the Board might give it.

[Staff Exhibit No. 84 was
received into evidence.]

JUDGE BOLLWERK: Then I think we have several APCO exhibits, I think, that need to be receiv d. No. I guess we got them all. We do.

MR. REPKA: I think we're up to date.

JUDGE BOLLWERK: At this point, why don't we go off the record. Let's talk with counsel for a couple minutes and see where we're at.

[Whereupon, at 6:00 p.m., the hearing adjourned for a brief recess.]

EVENING SESSION

[6:15 p.m.]

JUDGE BOLLWERK: Let me do one thing before we move to the witness panels. We need to let the record reflect that Board Exhibit 2 -- it has already been marked for identification. Is there any objection from the parties to our receiving that in evidence?

MR. HOLLER: No objection from the NRC Staff, sir.

MR. REPKA: I have no objection.

JUDGE BOLLWERK: All right. Then Board Exhibit 2 will be received in evidence.

[Board Exhibit 2 was received in evidence.]

JUDGE BOLLWERK: I think the next panel is on T-drains.

MR. HOLLER: Yes, sir, or, more generally, the Limitorque operator switch. T-drains is the issue.

I remind Mr. Levis that he is under oath.

Whereupon,

WILLIAM LEVIS

was called as a rebuttal witness for the NRC Staff on T-drains in Limitorque operators and, having been previously duly sworn, was examined and did testify as follows:

DIRECT EXAMINATION

BY MR. HOLLER:

Q I'll ask him if he would again, for the record, state his name and current position.

A [Witness Levis] My name is William Levis. I'm a senior resident inspector at the Davis-Besse nuclear station.

Q I would ask you, sir, if you have before you a document entitled rebuttal testimony of William Levis on behalf of the NRC Staff concerning Limitorque operators.

A [Witness Levis] Yes, I do.

Q Did you participate in the preparation of this document, sir?

A [Witness Levis] Yes, I did.

Q I'll ask you at this time, do you have any corrections?

A [Witness Levis] I do not.

Q Is the document before you true and correct to the best of your knowledge and belief?

A [Witness Levis] Yes, it is.

MR. HOLLER: At this time I move that the rebuttal testimony of William Levis on behalf of the NRC Staff concerning Limitorque operators be bound into the record as if read.

MR. HANCOCK: No objection.

JUDGE BOLLWERK: All right. Then the rebuttal testimony of William Levis on behalf of the NRC Staff concerning Limitorque operators will be received and bound into the record.

[The rebuttal testimony of William Levis on behalf of the NRC Staff concerning Limitorque operators follows.]

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	Docket Nos. 50-348-CivP
	)	50-364-CivP
ALABAMA POWER COMPANY	)	
	)	
(Joseph M. Farley Nuclear Plant,	)	
Units 1 and 2)	)	
	)	(ASLBP NO. 91-626-02-CivP)

REBUTTAL TESTIMONY OF WILLIAM LEVIS ON BEHALF
OF THE NRC STAFF CONCERNING LIMITORQUE OPERATORS

Q1. State your full name and current position with the NRC.

A. William Levis, Senior Resident Inspector, Davis Besse Nuclear Power Station.

Q2. Have you prepared a copy of your Professional Qualifications?

A. A copy of my Professional Qualifications has been admitted previously into evidence as Staff Exh. 1.

Q3. What is the purpose of your testimony?

A. The purpose of my testimony is to rebut portions of the Alabama Power Company (APCo) Testimony regarding violations of the environmental qualification (EQ) requirements for the Limitorque Motor Operated Valves (MOVs) at the Farley nuclear plant which led to the civil penalty that is the subject of this hearing. The APCo testimony which is the subject of this rebuttal testimony is contained in

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Direct Testimony of Jesse E. Love, James E. Sundergill and David H. Jones on Behalf of Alabama Power Company (ff. Tr. 978) (hereafter L/S/J) and Direct Testimony of Philip A. DiBenedetto on Behalf of Alabama Power Company (ff. Tr. 1227) (hereafter DiBenedetto).

Q4. Are you aware of any 30 day tests of Limitorque motor valve operators in which a motor operator without a T-Drain installed failed the test? (L/S/J Q&A 162, pp.183-85; DiBenedetto Q&A 160, pp.125-26)

A. No. I am not aware of any test to either support use of Limitorque motor valve operators without T-drains in a long term post LOCA environment or that shows failures of Limitorques without T-drains in that environment. The point is that there have not been opportunities in industry in which a MOV had to operate for 30 days in post LOCA environment. Absent testing to simulate those harsh conditions for that period of time, we just do not know how the motors will respond. Mr. DiBenedetto's testimony answering APCo Q160 is misleading in that he states that he is unaware of any failures without stating basis for his conclusion.

Q5. Would not the information in NUGEQ Report "Clarification of Information Related to the Environmental Qualification of Limitorque Motorized Valve

Operator," April 1966, and the absence of information regarding the installation of T-drains in test reports 600456 or B0058 lead a reasonable engineer to conclude though Arrhenius techniques and reasonable engineering judgment that T-drains were not required for the environmental qualification of Limitorque motor valve operators? (L/S/J/ Q&A 162 & 163, pp.183-85; Q&A167 & 168, pp. 187-90)

A. To begin with, in his answer to question APCo Q162 at pp.184-85, Mr. Sundergill states that "[i]nstallation of T-drains is not revealed anywhere in Test report 600456 or Test Report B0058." I do not agree with that statement. Paragraph 6.0 on page 30 of Test Report B0058 (Staff Exh. 54) describes the design and construction of Limitorque MOVs for use inside containment and states that T drains were one of the features added to permit the actuator to withstand the more severe containment chamber DBE conditions. The paragraph specifically uses the term "chamber," which any reasonable engineer would take to mean the test chamber used in qualifying the MOVs.

Mr. Sundergill's argument that all Limitorque motor valve operators at Farley are covered by test report 600198, the test without T-drains installed, in answer to Q168 is flawed. During the inspection the inspectors acknowledged the existence of the NUGEQ document which discussed the Limitorque issues. Some equipment items perform their safety function prior to 7 days and are not required after that time. For that very reason the inspectors stated that the use of the 600198 test report (Staff Exh. 52) could be used for those Limitorque MOV's with short operating times, less that 7 days. However for those valves which have a greater than 7 day operating requirement, the report was not acceptable because the long term effects of moisture were not evaluated. I can not understand how Mr. Sundergill can assume that NUGEQ is endorsing the principle of extending the test. In fact, Mr. Sundergill acknowledges in his testimony that the test can be used if conditions in the test report envelope the plant specific conditions. In the case of valves with a greater than 7 day operating requirement, the test simply does not envelope plant required conditions. As Mr. Sundergill stated in answer to APCo Q167, the Arrhenius technique shows that the conditions of high temperature for short durations can be equated to a condition of lower temperature for a longer period of time. This demonstrates the ability to withstand these temperatures for a given period, not necessarily the effects of moisture.

Q6. Was the issue of T-drains in Limitorque motor valve operators an issue in industry prior to November 30, 1985? (L/S/J/ Q&A 160, p. 181; DiBenedetto Q&A 161, pp. 126-27)

A. Yes it was. In his answer to APCo Q160, Mr. Sundergill states that the T-drain issue "clearly evolved after the EQ deadline" of November 30, 1985. I can state that I know of several sites where this configuration attribute was checked prior to the deadline. For example, on page 13 of the inspec on report for a March 1985 inspection of Crystal River, (Staff Exh. 65) the NRC Staff notes that the licensee planned to verify the presence of T-drains and other details of their Limitorque MOVs during a March 1985 outage. Prior to my employment with the NRC, the company for whom I worked prior to November 30, 1985, had developed a series of checklists for EQ equipment that detailed qualification requirements. The checklist for MOVs indicated that T-drains were required for those MOVs in harsh (high energy line break) environments.

On page 127 of Mr. DiBenedetto's Direct Testimony, he states that the fact that the T-drain issue was cited at 21 different utilities demonstrates that issue was not a concern of many reasonable and prudent engineers. I do not draw the same conclusion from those facts. I see the NRC consistently applying the same criteria to all licensees inspected. The fact that more facilities were not cited shows that many reasonable and prudent licensee personnel knew that T-drains were required and properly installed them.

Q7. Is Mr. ' indergill correct when he says that he suspects that the Limitorque recommendation regarding the installation of T-drains was offered to you more as a maintenance matter than a qualification matter? (L/S/J Q&A 161, pp.182-83)

A. No. In his answer to APCo Q161 at p.183, Mr. Sundergill is misusing the wording I used to describe my conversation with Limitorque. The fact of the matter is that Limitorque would not state to me that it was acceptable not to use T-drains for those MOV's which experience LOCA environmental conditions. In fact, T-drains are shipped with the actuators with accompanying instructions stating to install the T-drains for EQ purposes.

Q9. Does this complete your testimony regarding this matter?

A. Yes.

JUDGE BOLLWERK: It's my understanding that neither of the parties have any cross examination with respect -- Oh. I'm sorry. Why don't you go ahead and do the APCo panel.

MR. HANCOCK: Okay.

Whereupon,

PHILIP A. DiBENEDETTO,

DAVID H. JONES,

and

JAMES E. SUNDERGILL

were called as surrebuttal witnesses for Alabama Power Company on T-drains in Limitorque operators and, having been previously duly sworn, were examined and did testify as follows:

DIRECT EXAMINATION

BY MR. HANCOCK:

Q If we can start with Mr. DiBenedetto, could you please state your name for the record?

A [Witness DiBenedetto] Philip A. DiBenedetto.

A [Witness Sundergill] James E. Sundergill.

A [Witness Jones] David Huber Jones.

Q Do each of you all have before you a copy of Alabama Power Company's surrebuttal testimony on the issue of Limitorque operators?

A [Witness DiBenedetto] Yes, I do.

A [Witness Sundergill] I do.

A [Witness Jones] Yes.

Q Did you assist in the preparation of this testimony?

A [Witness DiBenedetto] Yes, I did.

A [Witness Sundergill] I did.

A [Witness Jones] I did.

Q Do you have any corrections that need to be made at this time?

A [Witness DiBenedetto] I have one minor correction. On page 216 of the prepared testimony, the first full paragraph, there's a parenthetical expression stating "September, 1990." It should be September, 1980.

That's the only correction I have.

Q Mr. Sundergill?

A [Witness Sundergill] I have none.

Q Mr. Jones?

A [Witness Jones] I have one correction. On page 221, the first full paragraph, seventh line down, delete the word "no." "There was no reasonable" should be "There was reasonable assurance."

Q Any further corrections?

A [Witness Jones] That's all.

Q Is this testimony true and accurate to the best of your knowledge?

A [Witness DiBenedetto] Yes, it is.

A [Witness Sundergill] It is.

A [Witness Jones] Yes.

Q And you adopt it as such today.

A [Witness DiBenedetto] Yes, I do.

A [Witness Sundergill] I do.

A [Witness Jones] Yes.

MR. HANCOCK: At this time I'd move that the testimony regarding Limitorque be bound into the record.

MR. HOLLER: No objection from the Staff.

JUDGE BOLLWERK: All right. The testimony reflects these corrections, correct?

MR. HANCOCK: We're going to check on that as soon as Julie gets back.

JUDGE BOLLWERK: All right.

MR. HANCOCK: She's got all the answer.

JUDGE BOLLWERK: All right. We should make sure, though, that it has been made before it goes to the court reporter, back to their main office.

MR. HANCOCK: All right.

JUDGE BOLLWERK: Then the APCo surrebuttal testimony on Limitorque motor operators, T-drains, of Mr. Sundergill, Jones, and DiBenedetto will be received and bound into the record.

[The surrebuttal testimony of James E. Sundergill, David H. Jones, and Philip A. DiBenedetto on behalf of Alabama Power Company concerning Limitorque operators follows.]

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket Nos. 50-348-CivP
ALABAMA POWER COMPANY	)	50-364-CivP
	)	
(Joseph M. Farley Nuclear	)	
Plant, Units 1 and 2)	)	ASLBP No. 91-626-02-CivP

SURREBUTTAL TESTIMONY OF JAMES E. SUNDERGILL,
DAVID H. JONES, AND PHILIP A. DIBENEDETTO
ON BEHALF OF ALABAMA POWER COMPANY
CONCERNING LIMITORQUE MOTOR OPERATORS: T-DRAINS

Q. State your full name.

A. (Sundergill) My name is James E. Sundergill. I am employed by Bechtel Corporation as the Engineering Supervisor of the Electrical and Control Systems Group of the Farley Project.

(Jones) My name is David Huber Jones. I am currently Manager of Engineering Support, Farley Nuclear Plant, for Southern Nuclear Operating Company, Inc.

(DiBenedetto) My name is Philip A. DiBenedetto. I am president of DiBenedetto Associates, Inc., which is an engineering and management services company that provides services to utility clients related to equipment qualification, quality assurance, and nuclear regulatory licensing. I am responsible for the technical and administrative management of the company, including participation in, and supervision of, the extensive environmental qualification (EQ) services that DiBenedetto Associates offers.

Q. Have you previously testified in this proceeding?

A. (Sundergill, Jones, DiBenedetto) Yes. We have previously testified on various technical issues raised by this enforcement proceeding.

Q. What is the purpose of your present testimony?

A. (Sundergill, Jones, DiBenedetto) Our present surrebuttal testimony is offered to address the rebuttal testimony of the various NRC Staff panels on the technical issues in this proceeding.

VI. LIMITORQUE MOTOR OPERATORS: T-Drains

Q133. Mr. William Levis has prepared Rebuttal Testimony on behalf of the NRC Staff concerning T-drains in Limitorque motor operated valves (MOVs). Are you familiar with it?

A. (Sundergill, Jones, DiBenedetto) Yes.

Q134. What is the purpose of your Surrebuttal Testimony on this issue?

A. (Sundergill, Jones, DiBenedetto) Our testimony responds to the concerns and issues raised by the Staff in its Rebuttal Testimony regarding T-drains. We disagree with Mr. Levis' conclusions on this issue regarding violations of environmental qualification requirements. We believe, as before, that the MOVs at the Farley Nuclear Plant were qualified even if T-drains were not installed.

Q135. In general, why do you disagree with the Staff's conclusions concerning the environmental qualification of Limitorque MOVs at Farley without T-drains?

A. (Sundergill) The Staff's conclusions primarily are based on their assertion that Limitorque Test Report 600198 (Staff Exhibit 52), which tested actuators without T-drains for a seven day accident duration, cannot be extended to encompass the Farley accident duration. As more fully explained below, it is my opinion that this test can be extended to cover the Farley accident duration.

Q136. According to Mr. Levis, Test Report 600198 is not acceptable for MOVs with an operating requirement that exceeds seven days. (Rebuttal Testimony, at page 4). Is he correct?

A. (Sundergill) I do not believe that Mr. Levis is correct in his assessment. This disagreement is, in my opinion, the heart of the matter. If it is demonstrated that Test Report 600198 envelopes the Farley parameters, the three MOVs per unit in question were qualified. I contend that Test Report 600198 has sufficient temperature margin to demonstrate that it would cause the equivalent degradation to the actuators as would a lower temperature exposure for a longer period of time.

Q137. Let's begin with Test Reports 600456 (Staff Exhibit 53) and B0058. (Staff Exhibit 54). Mr. Sundergill, in your prior testimony, you state that "[i]nstallation of T-drains" is not evident in either report. (Direct Testimony, at pages 184-85). Mr. Levis disagrees with that statement. (Rebuttal Testimony, at page 3). How do you respond?

A. (Sundergill) My statement may have been imprecise but it was not wrong. I meant to explain that there was no indication in Test Report 600456 (Staff Exhibit 53) that T-drains were installed in that test, and that there was no indication in B0058 (Staff Exhibit 54) that T-drains were installed in the 600456 test. Even though B0058 is often referred to as a test report, it is a summary document providing overall guidance for the Limitorque test program. Test Report 600456 is the actual test in question, not B0058 - and Test Report 600456 includes no indication that T-drains were installed.

Mr. Levis is correct that there is a mention of T-drains in B0058. However, he is perhaps being equally imprecise in his language since he apparently reads more into the T-drain reference in paragraph 6.0 of B0058 than I do. That paragraph states:

> 6.0 <u>DESIGN LIFE</u>
>
> The inside containment and outside containment actuators are of the same basic design and construction with some differences in material to permit the actuator to withstand the more severe containment chamber DBE conditions. These differences consist of use of different phenolic insulating material for the switches, a special motor insulation system, Viton seals instead of Buna N, elimination of all external aluminum parts and the use of 'T' drains and grease relief valve to accommodate the extreme temperatures and pressures of containment DBE environments.

(Staff Exhibit 54, at page 30). Mr. Levis may believe that the simple listing of component differences implies that T-drains were included in the 600456 test, but I do not.

Mr. Levis further states on page 3 of his Rebuttal Testimony that the language in paragraph 6.0 of B0058 "specifically uses the term 'chamber,' which any reasonable engineer would take to mean the test chamber used in qualifying the MOVs." I believe that a reasonable engineer would not interpret that one word out of context. The phrase Limitorque used is "containment chamber," not simply "chamber." In my opinion, the phrase "containment chamber" refers to the containment of a nuclear power plant -- not an autoclave in some test lab. I also base my opinion on a review of the entire context of the statement by Limitorque. The referenced discussion centers on design differences between actuators used inside containment and those used outside containment. The differences exist because the inside containment actuators are exposed to more severe conditions than would be actuators installed outside containment. It is unreasonable to assume that Limitorque meant that it was building actuators strictly for test purposes or strictly for installation inside a test chamber.

Therefore, I reiterate that B0058 does not implicitly or explicitly state that testing was conducted with or without T-drains.

Q138. What about Test Report 600198? (Staff Exhibit 52). As Mr. Levis recognizes on page 3 of his Rebuttal Testimony, it was conducted without the installation of T-drains. Did Test Report 600198 address all Limitorque MOVs at Farley?

A. (Sundergill) In my opinion it did, as explained in response to A162 on pages 183-85 of my Direct Testimony.

Q139. But in reaching your conclusion, aren't you relying on Arrhenius techniques to extrapolate the results of Test Report 600198 for a thirty day, post-LOCA period?

A. (Sundergill) Yes, in part, but also on engineering judgment. The Arrhenius methodology is a means of accelerating the chemical and physical reactions which are part of the aging process. By using this methodology, it can be shown that testing a piece of equipment for a short time at a high temperature is equivalent to it experiencing a lower temperature for a longer period of time. The question raised by Mr. Levis is based on his concern about extending the Arrhenius methodology to accelerate the effects of moisture degradation.

In the 600198 testing of the Limitorque actuators without T-drains, presumably moisture accumulated inside the motor housing. The report did not include any indication of whether or not moisture had accumulated in the motor housing during the test. If there was none, the need for a T-drain is precluded altogether. However, the presence of moisture was presumed in order to be conservative in the analysis.

Any moisture that was present in the motor housing during the test would have been at or about the temperature and pressure recorded for the actuator. The actuator was tested for the initial transient conditions which envelope the Farley LOCA profile for the first 24 hours. For the remaining six days of the test, the actuator was maintained at approximately 250°F and 15 PSIG. (See APCo Exhibit 121, the pages showing the relevant test data for the 600198 testing; these pages from the test report were inadvertently missing from the full 600198 report admitted into evidence as Staff Exhibit 52.) By comparison, over the same period of time, the Farley LOCA profile is ramping down from approximately 140°F to approximately 120°F and the pressure is constant at approximately 5 PSIG. Therefore, the test conditions envelope the Farley profile for the first day and are significantly more severe than the postulated conditions for the next six days.

Based on my engineering judgment, moisture at 250'F and 15 PSIG for 6 days would have at least as significant an impact on the actuator components as would the same amount of moisture at 120'F for 32 days. The 32 days is based on the overall duration of 33 days minus the initial day which contained the transient and peak conditions. My judgment is further bolstered by noting that the electrical insulation used in the actuator exposed to the 600198 testing is not as good as that used at Farley. So, in summary, I believe that the 600198 testing at elevated levels using inferior electrical insulation is sufficient to encompass the postulated accident at Farley.

I note in passing that it is likely that this same reasoning has been employed by the Staff for Limitorque Test Report 600456. (Staff Exhibit 53). This report documents a 30-day accident test on a Limitorque actuator with T-drains installed. In paragraph 4.7.1 (page 26), it states that the "stator and rotor showed little evidence of corrosive build-up and no evidence of physical damage. The end bell was particularly clean with little evidence of water." Note that "little" evidence of water suggests that at least some evidence of water was present. Thus, for the period of the 30 day test, there was some moisture in the Limitorque actuator. Nevertheless, this test has been accepted by Staff for other plants with postulated accident durations in excess of 30 days. Thus, the Staff has tacitly acknowledged that moisture degradation effects may be extrapolated. If one test can be extrapolated, so can another.

(DiBenedetto) Let me add that extrapolation of data has routinely been used in aging studies to extend a test duration to encompass a required test duration (as discussed in the testimony on V-type splices). Additionally, EPRI NP-1558, "A Review of Equipment Aging Theory and Technology" (September 1990) -- an industry-accepted aging document -- suggests that extrapolation to extend life beyond that to which it was tested is permitted and justifiable provided that excess margin is available and the magnitude of extrapolation is reasonable. Reasonable, however, is not quantified. In my opinion, in the present context, the use of excess margin from the 7-day test is reasonable to extend the qualification by a factor of a little more than four times.

Q140. It is Mr. Davis' testimony that "certainly moisture is going to affect the performance of an electrical piece of equipment." (Tr. 595). Is this absolute assertion correct?

A. (Sundergill) No. There are certainly items of electrical equipment which are properly constructed to withstand the effects of moisture. Electrical cable is one example which immediately springs to mind. Another more immediate example is in the case of the Limitorque 600456 test where it states, in paragraph 4.7.1 (page 26), that there was "little" evidence of moisture intrusion. Even though the actuator had been sprayed with water during the test, and some (albeit "little") had gotten in, the performance of the actuator was not affected.

Q141. Before leaving the issue of moisture effects, Mr. Levis alleges that Mr. DiBenedetto's testimony is "misleading in that he states that he is unaware of any [MOV] failures without stating basis [sic] for his conclusion." Rebuttal Testimony, at page 2. How do you respond, Mr. DiBenedetto?

A. (DiBenedetto) Mr. Levis is referring to my Direct Testimony in response to Q160 which asked, in total, "[a]re you aware of any failures that can be attributed to mo :ture in the Limitorque?" I responded that "I am unaware of any failure reported in the industry where the Limitorque motor operator failed because of moisture intrusion." (Direct Testimony, at page 160). Quite frankly, I do not know what kind of basis Mr. Levis wants in support of my response. His own Rebuttal Testimony, page 2, supports my response and is similarly devoid of basis: "I am not aware of any test to either support use of Limitorque motor valve operators without T-drains in a long term post LOCA environment or that shows failures of Limitorques without T-drains in that environment."

Q142. On page 181 of your Direct Testimony, Mr. Sundergill, you testify that the T-drain issue "clearly evolved after the EQ deadline" of November 30, 1985. Mr. Levis disagrees, however, and purports that he is "aware of several sites where this configuration attribute was checked prior to the deadline." (Rebuttal Testimony, at page 5). How do you respond?

A. (Sundergill) In support of his disagreement with my statement, Mr. Levis identifies only one utility that, prior to the deadline, planned to verify the presence of T-drains. He also states that the unnamed company which previously employed him looked at them. The first fact is hardly an indication that the NRC Staff considered the absence of T-drains a violation. In fact, as we discuss below, prior to the deadline, the NRC was inconclusive on the issue. Also, I have no way of knowing what environmental conditions were involved in that plant application.

Mr. Levis' latter example is not even an NRC action. Again, I cannot speculate on the rationale underlying the company's position. I believe that Mr. Levis' examples serve only to bear out my contention -- the issue of T-drains evolved after the EQ deadline. The genesis of the issue may pre-date the deadline, but its evolution (e.g., the Staff taking a position on the issue) transpired after November 30, 1985.

Q143. Mr. Levis also rejects the statement on page 127 of Mr. DiBenedetto's Direct Testimony that "the fact that the T-drain issue was cited at 21 different utilities demonstrates that issue was not a concern of many reasonable and prudent engineers." (As paraphrased by Mr. Levis, Rebuttal Testimony, at page 5.) How do you respond?

A. (DiBenedetto) The 21 utilities I cite in my Direct Testimony represent approximately half of all operating nuclear units in the United States. This is most certainly indicative of what was known or clearly should have been known regarding this issue prior to the deadline. On this basis, and in accordance with the testimony of Mr. Luehman and Mr. Potapovs at the February hearing (Tr. 306-316), Alabama Power Company is not an outlier. One of the primary reasons why so many utilities were not concerned about the issue is because the NRC Staff, in IN 83-72 (Staff Exhibit 55), declined to identify the issue as a safety concern.

Q144. But Mr. Levis has testified that the industry was first notified of the T-drain issue in IN 83-72. (Tr. 606). Are you familiar with that document?

A. (Sundergill, Jones, DiBenedetto) Yes.

Q145. Could you please summarize the portion(s) of IN 83-72 relevant to T-drains?

A. (DiBenedetto) On page 126 of my Direct Testimony, I explained that, although IN 83-72 (Staff Exhibit 55) contained a brief discussion pertinent to T-drains, it did not conclude that a potential problem existed.

(Sundergill, Jones, DiBenedetto) IN 83-72 only stated that, at the time, it was unknown whether the existence of drain plugs or the orientation of the drain hole was essential to proper MOV operation or was in conformance with the qualification tests. Clearly, the NRC was unable to determine the impact, if any, on the operation or qualification of a motor operator without T-drains installed.

Q146. How did Alabama Power Company respond to IN 83-72?

A. (Jones) In response to the Notice, Alabama Power Company reviewed the qualification information provided by Limitorque, as well as its own maintenance practices, in order to determine whether the identified concern was applicable at Farley. During Alabama Power Company's January 11, 1984, meeting with the NRC Staff, we indicated that we would be reviewing IN 83-72 to determine its applicability at Farley, and concomitantly, whether any corrective action was necessary. (See APCo Exhibit 20, Attachment 2, at page 6).

This information notice again needs to be viewed in context. In response to Alabama Power Company's request, Limitorque had earlier, by letter dated October 13, 1980 (APCo Exhibit 122), documented qualification of the Farley MOVs to their qualification reports. Because Alabama Power Company had purchased the MOVs directly from Limitorque, and no modifications were performed by us, there was ~~no~~ a reasonable assurance that the MOVs remained qualified after review of IN 83-72. Keep in mind that IN 83-72 -- as discussed in my Direct Testimony at page 197 -- addressed a concern regarding Limitorque MOVs not procured from Limitorque directly. Based on Limitorque's assurances of qualification, the lack of third-party involvement after original installation of the MOVs, and the fact that Alabama Power Company did not perform modifications without designer approval, Alabama Power Company had reasonable assurance that the Farley Limitorque MOVs were not impacted by IN 83-72.

Furthermore, as Mr. Sundergill has explained, we ultimately concluded that the Farley motor operators provided by Limitorque had been qualified to Limitorque Test Report 600198 (Staff Exhibit 52), which supported qualification of the actuators without T-drains.

Q147. Was IN 83-72 (Staff Exhibit 55) cited by the Staff in either the August 15, 1988, NOV (Staff Exhibit 2) or August 21, 1991, Order (Staff Exhibit 3) as a basis for the T-drain violation at issue?

A. (Sundergill, Jones) No, not explicitly. It was not discussed in the Staff's Direct Testimony on the T-drain issue or in the NOV. Although IN 83-72 is mentioned on page 12 of the Order, it is not expressly correlated to T-drains. The first direct correlation was provided by Mr. Levis in the hearing. (Tr. 606). This fact seems to belie the current argument that IN 83-72 provided such clear notification of a problem prior to the deadline. The Staff did not expressly rely on it before the oral testimony as a basis for a "clearly should have known" finding.

Q148. Based on your testimony regarding the content of IN 83-72, should Alabama Power Company clearly have known of the alleged T-drain EQ deficiencies at issue prior to November 30, 1985?

A. (Sundergill, Jones, DiBenedetto) We don't see how Alabama Power Company, prior to the EQ deadline, could have interpreted IN 83-72 to mean that there were EQ deficiencies at Farley Nuclear Plant due to the lack of T-drains in Limitorque Motor Operated Valves. (Keep in mind that the Modified Enforcement Policy test is whether Alabama Power

Company clearly should have known of <u>the lack of</u> qualification.) The issue did not seem important to Limitorque, in that they did not highlight it in their test reports. As we discussed in Direct Testimony, the industry position was that T-drains were not crucial to qualification.

Evidence was presented to the NRC inspectors at the time of the audit which verified that Test Report 600198 (Staff Exhibit 52) was applicable to Farley. Moreover, in late-1985 and early-1986, the Nuclear Utility Group on Equipment Qualification (NUGEQ) explored the T-drain issue as a generic industry matter. NUGEQ determined from Limitorque that Test Report 600198 involved MOVs without T-drains and Test Report 600456 (Staff Exhibit 53) involved MOVs with T-drains. Based on that information, NUGEQ concluded in an April 1986 report (APCo Exhibit 109, at page 7, footnote 3) that "[t]he omission of T-drains in other situations will not necessarily prevent proper actuator operation or violate environmental qualification." The report further stated that the lack of T-drains is acceptable provided "[t]he required environmental parameters are bounded by other reports (e.g., 600198 . . .) which did not utilize T-drains." (Id.) During the Farley inspection, Alabama Power Company provided proof to the NRC inspectors that Test Report 600198 bounds the accident conditions at Farley. (<u>See</u> Direct Testimony, at page 185).

Therefore, it is our professional opinion that the Limitorque MOVs installed at Farley were qualified as of November 30, 1985.

JUDGE BOLLWERK: My understanding now is that neither of the parties have any cross examination for these witnesses.

MR. HANCOCK: The Licensee does not.

MR. HOLLER: The NRC Staff has no cross examination.

JUDGE BOLLWERK: All right. Then Board questions. Judge Carpenter, none?

JUDGE CARPENTER: No.

JUDGE BOLLWERK: All right. I just have one or two quick ones.

Mr. Sundergill, on page 223 of your testimony you describe the conclusion of the Nuclear Utility Group on Environmental Qualification, NUGEQ, with respect to t t report 600456 and what it provides on whether T-dra. were used as part of that test. Could you state for me again what the NUGEQ -- is that how it's pronounced?

WITNESS SUNDERGILL: NUGEQ, yes.

JUDGE BOLLWERK: -- their position is with respect to the use of T-drains in that te report?

WITNESS SUNDERGILL: In respect to test report 600456?

JUDGE BOLLWERK: Right. As I understand it, as it's reported in paragraph 6.0 of B-0058. This is page 223 of your testimony.

WITNESS SUNDERGILL: Right. I'm confused as to your reference to B-0058 in paragraph 6.

JUDGE BOLLWERK: Maybe I can clarify it. On page 211 and 212 you read paragraph 6.0 of B-0058 as failing to establish that the T-drains were part of the test report. Is that correct?

WITNESS SUNDERGILL: Yes. That's correct.

JUDGE BOLLWERK: I just want to make sure I'm clear on what the NUGEQ position is with respect to that test.

WITNESS SUNDERGILL: Well, basically what NUGEQ is saying is that test report 600456 had T-drains in it during the testing and that test report 600198 did not.

JUDGE BOLLWERK: I understand that's contrary to your position, then. Am I correct or not?

WITNESS SUNDERGILL: No. Our position is in accordance with what NUGEQ is saying. We contend, also, that 600198 did not have T-drains, and 600456 did. What NUGEQ is saying is that, if you can demonstrate that 600198 envelopes your plant-specific conditions, then that is sufficient justification for not having T-drains in your plant. That's what we're saying that we have done.

JUDGE BOLLWERK: All right. Let me ask you, then, on page 218 of your testimony you draw the distinction between the genesis of the T-drain issue and its evolution.

Could you explain to me a little more what the difference is between the genesis and the evolution?

WITNESS SUNDERGILL: Well, the T-drain issue was originally brought to light in the industry, to my knowledge -- I'd have to go back and look at the exact references -- in information notice 83-72, I believe, which, of course, was a 1983 document, which is prior to the EQ deadline. that notice, it just contained the reference that there was some concern on the part of the NRC about T-drains. No further statements as to what that concern was or if that was going to have a negative impact on qualification.

The documents since that time -- none that I am aware of have talked specifically to the absence of T-drains, other than some of the NRC inspection reports. The ones that we have heard of and have been talked about here occurred after the EQ deadline.

My statement here is that, while the issue may have started prior to the EQ deadline, and while there may have been activity in some quarters about it, it did not become fully developed until after the deadline.

JUDGE BOLLWERK: How does that effect "clearly knew or should have known," in your opinion, in any way?

WITNESS SUNDERGILL: Well, if the issue were not fully developed until after the EQ deadline, then we could not have known about it prior to the deadline.

JUDGE BOLLWERK: Do you have any response to that? I guess, Mr. Levis, this is your testimony, correct, sir?

WITNESS LEVIS: Yes, sir, it is.

I'm not sure I understand the distinction between genesis and evolution, here, but I will say that there were two NRC inspections that were done prior to the EQ deadline, and one of those inspections noted that the Licensee identified T-drains as an issue to be verified during their walkdown portion of the inspection. There is reference in there about, we didn't make an issue of it at that time, or there was no enforcement taken, because we were not issuing violations for these types of items prior to the deadline.

There hasn't been an additional information notice that came out since 83-72 to address the T-drain issue, but, when the inspections in the EQ area started, it was a [illegible] that NRC had taken early on.

JUDGE BOLLWERK: One of the things that APCo says in its testimony is that 83-72 was only referenced for the first time with regard to T-drains in your testimony. Do you agree to that? Is that an accurate statement? I think that would be somewhere between pages 219 and 223. I'd have to look up the exact reference.

WITNESS LEVIS: The issue of 83-72 wasn't addressed in the inspection report at all as it related to T-drains. During the first-round hearings, I was asked the question, when did the industry first -- when should they have first become aware of the issue. That's the response that I provided at that time.

JUDGE BOLLWERK: Do you find the failure to talk about it in the notice of violation to be significant, in terms of this enforcement action?

WITNESS LEVIS: I can offer my opinion there. I wasn't involved in the panel that reviewed, nor the preparation of the notice of violation. I don't consider that significant, is my personal opinion, no.

JUDGE BOLLWERK: I don't think I have any other questions, if no other member of the Board does.

[No response.]

JUDGE BOLLWERK: Let's see. There aren't any exhibits with respect to this testimony, so I guess we are ready to move to the next panel. Let me check one thing, first.

I think this is it for Mr. DiBenedetto. Is that correct, sir?

WITNESS DiBENEDETTO: Yes, sir.

JUDGE BOLLWERK: You look very happy.

Thank you, sir, for your testimony and your service to the Board. We very much appreciate it.

WITNESS DiBENEDETTO: You're very much welcome. Thank you.

[Witness DiBenedetto excused.]

JUDGE BOLLWERK: At this point I guess we're ready to move on to the next panel, on the GEMS level transmitters.

MR. HOLLER: Yes, sir.

Whereupon,

WILLIAM LEVIS

was called as a rebuttal witness for the NRC Staff on GEMS level transmitters and, having been previously duly sworn, was examined and did testify as follows:

DIRECT EXAMINATION

BY MR. HOLLER:

Q Since we're starting a new one, I'll just ask Mr. Levis, for the record, if he would again state his name and current position at NRC.

A [Witness Levis] My name is William Levis. I'm the senior resident inspector at Davis-Besse nuclear station.

Q I'll ask you, sir, if you have before you a document entitled "Rebuttal testimony of William Levis on behalf f the NRC Staff concerning GEMS level transmitters."

A [Witness Levis] Yes, I do.

Q Did you participate in the preparation of this document?

A [Witness Levis] Yes, I did.

Q Do you have any corrections to make to this document, sir?

A [Witness Levis] I do no.

Q Is this document true and correct to the best of your knowledge and belief?

A [Witness Levis] Yes, it is.

MR. HOLLER: The Staff moves that the rebuttal testimony of William Levis on behalf of the NRC Staff concerning GEMS level transmitters be bound into the record as if read.

JUDGE BOLLWERK: Any objection?

MR. HANCOCK: No objection.

JUDGE BOLLWERK: Then the rebuttal testimony of William Levis on behalf of the NRC Staff concerning GEMS level transmitters will be received and bound into the record.

[The rebuttal testimony of William Levis on behalf of the NRC Staff concerning GEMS level transmitters follows.]

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket Nos. 50-348-CivP
ALABAMA POWER COMPANY	)	50-364-CivP
	)	
(Joseph M. Farley Nuclear Plant,	)	
Units 1 and 2)	)	
	)	(ASLBP NO. 91-626-02-CivP)

REBUTTAL TESTIMONY OF WILLIAM LEVIS ON BEHALF OF THE NRC STAFF CONCERNING GEMS LEVEL TRANSMITTERS

Q1. State your full name and current position with the NRC.

A. William Levis, Senior Resident Inspector, Davis Besse Nuclear Power Station.

Q2. Have you prepared a copy of your Professional Qualifications?

A. A copy of my Professional Qualifications has been admitted previously into evidence as Staff Exh. 1.

Q3. What is the purpose of your testimony?

A. The purpose of my testimony is to rebut portions of the Alabama Power Company (APCo) Testimony regarding violations of the environmental qualification (EQ) requirements for the GEMS level transmitters at the Farley nuclear plant which led to the civil penalty that is the subject of this hearing. The APCo testimony which is the subject of this rebuttal testimony is contained in Direct Testimony of Jesse E.

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Love, James E. Sundergill and David H. Jones on Behalf of Alabama Power Company (ff. Tr. 978) and Direct Testimony of Philip A. DiBenedetto on Behalf of Alabama Power Company (ff. Tr. 1227).

Testimony of Love, Sundergill and Jones

Q4. Who first discovered the low or missing silicone oil levels in the GEMS level transmitters? (p.201, Q&A 183)

A. The first GEMS transmitter without any silicone oil was found by NRC inspectors in the company of licensee representatives. Subsequent to that, APCo found three more GEMS transmitters in an environmentally unqualified condition, because of silicone oil at a level not supported by the qualification documentation.

Q5. Is APCo correct in its assertion that the low silicone oil level in the GEMS level transmitters was an installation/maintenance problem and not an environmental qualification problem? (p.202, Q&A 185)

A. No. In answer to APCo Q185 Mr. Sundergill states that the lack of oil in the GEMS transmitters does not indicate a weakness in the environmental qualification process. In his testimony, Mr. Sundergill initially testified that "the four specific examples of installation deficiencies in the GEMS containment sump transmitters do not properly reflect on APCo's EQ program." When cross examined on this point, Mr. Sundergill changed his testimony to "the four specific examples of installation or maintenance." (Tr. 1170). Mr. Woodard in his testimony, however, testifies that Alabama Power Company did not create a separate organization whose job was EQ management. Mr. Woodard testified that APCo "integrated these requirements into our plant organization." (Tr. 1301). The point is that the environmental qualification regulation requires licensees to establish a program for qualifying the electric equipment important to safety as that equipment is installed in their plants. The GEMS transmitters were identified by APCo on their master list as requiring qualification. Four of the transmitters were in a configuration for which APCo had not established environmental qualification. If the equipment is not properly installed and maintained, it may not work when required, notwithstanding how many test reports say the piece of equipment is qualified.

Alabama Power Company had no idea or record of the condition of the GEMS level transmitters as of the environmental qualification compliance deadline of November 30, 1985. The APCo technical panel of Messrs. Love, Sundergill, and Jones that testified on the GEMS transmitters stated they had no knowledge of the silicone oil level in the transmitters as of November 30, 1985 in response to questioning on this point by Judge Carpenter. (Tr. 1171). The nonconforming silicone oil level condition went unnoticed by APCo until the NRC discovered the condition on a transmitter during the November 1987 inspection. The NRC inspectors were offered no records that would indicate that the GEMS transmitters had not been in that condition since before the compliance deadline of November 30, 1985. In his deposition during discovery in this proceeding, Mr. Berryhill, who was APCo's Manager of System Performance, an organization which included the quality control group, testified that APCo did not know how or why the nonconforming silicone oil condition occurred.

> Q. All right. Would you say that that was a maintenance problem if you're familiar with the particular situation?
>
> A. Well, you know, if I speculated on it I can't say why what we found existed. We couldn't go back and establish -- to my knowledge it was never -- generally when something like that happens we -- and as I recall in this case too you do a very thorough research of your documentation, and you go back and interview a lot of people, and in most cases the interview turns up who did what in the past.
> I don't recall that we found an individual, but from my viewpoint I believe that it was probably some mistake or whatever you want -- you know, that during that maintenance process maybe the fluid was not put back in, but again I have no documented evidence either way how it got there.
> I do know that for one of those that I believe it was almost all the fluid gone as I recall.

Deposition of Robert Berryhill, June 26, 1991, p. 43-44.

This example of four of the eight GEMs transmitters having low silicone oil levels, combined with the lack of discipline APCo displayed in the installation of the V-type terminations leads me to conclude that EQ program requirements were not understood or implemented at the craft level at the Farley plant. This demonstrated lack of assurance of EQ requirements and the apparent insensitivity to the importance of EQ equipment and its corresponding special requirements on the part of craftsmen and their management at Farley indicates to me a weakness in the environmental qualification process and not just an installation or maintenance problem as Mr. Sundergill would have the Board believe.

Testimony of DiBenedetto

Q6. Has the NRC Staff suggested that "component disassembly" be included as part of walkdowns? (pp.47-43, Q&A 47)

A. Mr. DiBenedetto's response to APCo Q47 leaves you with the impression that complete disassembly was required to perform walkdowns to get the level of detail that the NRC inspectors were looking for during NRC inspections or that would have been expected of a licensee during licensee verification of proper installation. This is not true. The only "disassembly," if you want to call it that, that was required for the NRC inspectors to do their inspections during the NRC walkdowns was the removal of switch covers, conduit covers, junction box covers and actuator covers. This is also the level of detail that other licensees required of me when I was an engineering consultant on EQ matters, prior to my employment with the NRC.

Q7. Does this complete your testimony regarding this matter?

A. Yes.

JUDGE BOLLWERK: I guess the APCo panel will be next.

Whereupon,

DAVID H. JONES

and

JAMES E. SUNDERGILL

were called as surrebuttal witnesses for Alabama Power Company on GEMS level transmitters and, having been previously duly sworn, were examined and did testify as follows:

DIRECT EXAMINATION

BY MR. HANCOCK:

Q The same thing. Once again, for the record, please state your name.

A [Witness Sundergill] My name is James E. Sundergill.

A [Witness Jones] David Huber Jones.

Q Do you gentlemen have before you a document that is the Alabama Power Company's surrebuttal testimony regarding GEMS level transmitters?

A [Witness Sundergill] I do.

A [Witness Jones] I do.

Q Did you each assist in the preparation of this document?

A [Witness Sundergill] I did.

A [Witness Jones] Yes.

Q Do either one of you have any corrections that need to be made?

A [Witness Sundergill] I have none.

A [Witness Jones] None.

Q Is this surrebuttal testimony true and accurate to the best of your knowledge?

A [Witness Sundergill] It is.

A [Witness Jones] Yes.

MR. HANCOCK: At this time I'd move that Alabama Power Company's surrebuttal testimony regarding GEMS level transmitters be accepted and bound into the record.

MR. HOLLER: The Staff has no objections.

JUDGE BOLLWERK: Then the Alabama Power Company surrebuttal testimony on GEMS level transmitters will be received and bound into the record.

[The surrebuttal testimony of James E. Sundergill and David H. Jones on behalf of Alabama Power Company concerning GEMS level transmitters follows.]

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket Nos. 50-348-CivP
ALABAMA POWER COMPANY	)	50-364-CivP
(Joseph M. Farley Nuclear Plant, Units 1 and 2)	)	ASLBP No. 91-626-02-CivP

SURREBUTTAL TESTIMONY OF JAMES E. SUNDERGILL
AND DAVID H. JONES ON
BEHALF OF ALABAMA POWER COMPANY
CONCERNING GEMS LEVEL TRANSMITTERS

Q. State your full name.

A. (Sundergill) My name is James E. Sundergill. I am employed by Bechtel Corporation as the Engineering Supervisor of the Electrical and Control Systems Group of the Farley Project.

(Jones) My name is David Huber Jones. I am currently Manager of Engineering Support, Farley Nuclear Plant, for Southern Nuclear Operating Company, Inc.

Q. Have you previously testified in this proceeding?

A. (Sundergill, Jones) Yes. We have previously testified on various technical issues raised by this enforcement proceeding.

Q. What is the purpose of your present testimony?

A. (Sundergill, Jones) Our present surrebuttal testimony is offered to address the rebuttal testimony of the various NRC Staff panels on the technical issues in this proceeding.

VII. GEMS LEVEL TRANSMITTERS

Q149. Having read the Staff's Rebuttal Testimony, will you please give the Board your perspective of the issues presented by this alleged EQ deficiency?

A. (Jones) In my judgment, the issues are whether the GEMS level transmitters were filled with silicon oil on November 30, 1985 and, if not, whether such a failure is an EQ problem or a maintenance one. Alabama Power Company has previously filed with the Board its report "on the level of silicone oil in the GEMS level transmitters on November 30, 1985." That letter says:

> Despite an extensive review of the GEMS Level Transmitters maintenance records, APCo has been unable to determine definitively the levels of the silicone oil in the transmitters on November 30, 1985. The GEMS installation manual, however, expressly identified the appropriate level of silicone oil for the eight transmitters. APCo believes that this installation manual was followed at the time of installation because had the appropriate level of silicone oil not been applied when the transmitters were originally installed, then APCo's quality assurance program or quality control program should have discovered any deficiencies. No evidence of any such deficiency has been found. Between the date of installation and November 30, 1985, there are no records that would indicate that the level of oil had fallen below the appropriate levels, with one exception. APCo has discovered a May 16, 1985 Maintenance Work Request (MWR), which indicated that one of the eight transmitters did not have the appropriate level of oil. The MWR says that the transmitter was filled at that time to the appropriate level. Other than the one transmitter reference in the MWR, APCo cannot determine conclusively the level

of silicone oil in the transmitters at the deadline.

Regardless of when the transmitter lost the oil, it appears to be a maintenance problem, not an EQ one, for the reasons stated in the Direct Testimony.

(Sundergill) Let me add here that Mr. Levis provides a very general definition to the EQ program that simply is not contained in the applicable regulations: 10 CFR 50.49 or IEEE 323-1974. The requirements do not explicitly state anywhere within their contents that maintenance of equipment is part of an EQ program. While it is necessary to perform proper maintenance in order for the qualification of the equipment to remain valid, this necessity is not a regulatory requirement.

Q150. In the Staff's rebuttal testimony concerning GEMS level transmitters, it claims that Mr. Sundergill has "changed his testimony." (Rebuttal Testimony Concerning GEMS Level Transmitters, at page 3). It says that in Mr. Sundergill's written testimony he states that the low levels of silicone oil are attributable to "the four specific examples of installation deficiencies;" (Rebuttal Testimony Concerns Gems Level Transmitters, at page 2) however, at the enforcement hearing, he provided for the possibility of installation or maintenance deficiencies as being potential sources of the problem. Please respond to this.

A. (Sundergill) The full question and answer presented to me in the written Direct Testimony must be read and not taken out of context. The question, Q185 on page 202 of my Direct Testimony, states in relevant part: "With respect to the four suspect transmitters, you stated that the deficiency is more properly characterized as an installation/maintenance issue rather than an EQ issue." (Emphasis added.) This underlined portion of the question refers to my response to Q182 on page 201, in which I stated: "The first issue is an installation/maintenance issue; not an EQ issue." The Staff is not clear in its explanation of how I have "changed" my testimony. Nevertheless, Staff Counsel's questioning of me found in the hearing transcript on pages 1170-71 makes clear that I do not know whether the low level of silicone oil is due to a deficiency in the original application of the oil to the transmitters or to a deficiency in the subsequent maintenance of those four transmitters. My response is also clear that I recognize the possibility that either installation or maintenance could have caused the low levels of oil. As a result, any allegation that I have "changed" my testimony is not supported.

Q151. Based on the GEMS deficiency, the Staff draws some sweeping conclusions about the overall EQ program at Farley. In particular, Mr. Levis concludes that the "EQ program requirements were not understood or implemented at the craft level at the Farley plant." (Rebuttal Testimony, at page 4). How do you respond?

A. (Jones) This is both untrue and unfair. Bob Berryhill and I previously testified about the many hours, days, weeks, and months which many people, including highly competent, skilled craftsmen at Farley Nuclear Plant, devoted to complying with EQ requirements. To impugn the reputation of Alabama Power Company's craft labor on such thin and unrepresentative evidence as four transmitters found in 1987, in low-oil conditions, is over-reaching at best and, at worst, insulting. Besides, Alabama Power Company's training program and QA/QC program were NRC-approved. Moreover, the numerous, very favorable inspection reports, SERs, TERs, and other correspondence received by Alabama Power Company during this period belie the credibility of the Staff's current position on Alabama Power Company's EQ program.

Q152. Were the low oil levels in the GEMS safety significant?

A. (Sundergill) As explained in detail on page 203 of my direct written testimony, I do not believe that the low oil levels in the transmitters have any safety significance. The GEMS level transmitters provide only a redundant indication for transfer from the injection to the recirculation phase. Primary indication for this transfer is provided from the Reactor

Water Storage Tank level indication. The devices that provide the primary indication are Class 1E items of equipment and are located in a mild environment. Therefore, even under the postulation that the GEMS level transmitters would fail in a design basis accident, the primary indication system would be unaffected.

Q153. What is your conclusion on this issue?

A. (Jones, Sundergill) We continue to maintain that this issue does not represent a violation of 10 CFR 50.49. Even if it were, it is not a violation which Alabama Power Company clearly knew or should have known of prior to the EQ deadline.

JUDGE BOLLWERK: It's my understanding again that there's no cross examination on the part of either party.

MR. HANCOCK: None by the Licensee.

MR. HOLLER: None by the Staff, sir.

JUDGE BOLLWERK: All right.

Any Board questions?

[No response.]

JUDGE BOLLWERK: Again, let me ask just one question.

Mr. Levis, the last time that you testified on this matter, I guess subsequent to that the Board raised a question about the status of the oil levels in the GEMS transmitters as of November 30 of 1985. I wish for my purposes you could state what the Staff's position is as to that oil level on November 30, '85, and what support you have for that position.

WITNESS LEVIS: Basically, I have no direct knowledge of what the level was of the oil in the transmitters at that period of time. During the course of the inspection I did not look at installation or maintenance records to see if I could make that determination.

I'd be guessing if I were to say that it was original installation or maintenance. I just don't know.

JUDGE BOLLWERK: All right. You've read, I take it -- certainly the APCo surrebuttal quotes the letter that they addressed to the Board with their report. I take it you have no quarrel with what's in that letter.

WITNESS LEVIS: No, sir. I have no knowledge that anything there is not correct.

JUDGE BOLLWERK: All right.

Any response from APCo? Is there anything you'd like to add on this issue?

WITNESS JONES: No, I have none.

JUDGE BOLLWERK: All right. That was the only question I had.

Mr. Levis, I believe that completes your testimony before the Board, and we thank you very much, sir.

WITNESS LEVIS: Thank you.

[Witness Levis excused.]

JUDGE BOLLWERK: I believe we have one more to go. We're in the home stretch now.

MR. BACHMANN: Mr. Paulk and Mr. Luehman have been previously sworn.

Whereupon,

CHARLES J. PAULK, JR.,

and

JAMES G. LUEHMAN

were called as rebuttal witnesses for the NRC Staff on premium RB grease and, having been previously duly sworn, were examined and did testify as follows:

DIRECT EXAMINATION

BY MR. BACHMANN:

Q Will you gentlemen state your name and current position with the NRC for the record?

A [Witness Luehman] James G. Luehman. I'm a senior enforcement specialist, Office of Enforcement.

A [Witness Paulk] Charles J. Paulk, Jr. I'm a reactor inspection, Region IV, plant systems section.

Q Do you have before you a document entitled "Rebuttal testimony of Charles J. Paulk, Jr., and James G. Luehman on behalf of the NRC Staff concerning premium RB grease in fan motors and room coolers"?

A [Witness Luehman] Yes, I do.

A [Witness Paulk] Yes, I do.

Q Did you participate in the preparation of this testimony?

A [Witness Luehman] Yes, I did.

A [Witness Paulk] Yes, I did.

Q Do you have any corrections to make to this testimony?

A [Witness Luehman] I do not.

A [Witness Paulk] I do not.

Q Is this testimony true and correct to the best of your knowledge and belief?

A [Witness Luehman] Yes, it is.

A [Witness Paulk] Yes, it is.

MR. BACHMANN: At this point I move that the rebuttal testimony of Charles J. Paulk, Jr., and James G. Luehman on behalf of the NRC Staff concerning premium RB grease in fan motors and room coolers be admitted into the evidence and bound into the record as if read.

JUDGE BOLLWERK: Any objection?

MR. HANCOCK: Alabama Power has no objection.

JUDGE BOLLWERK: Then the rebuttal testimony of Charles Paulk and James Luehman on behalf of the NRC Staff concerning premium RB grease in fan motors and room coolers will be received and bound into the record.

[The rebuttal testimony of Charles J. Paulk, Jr., and James G. Luehman on behalf of the NRC Staff concerning premium RB grease follows.]

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket Nos. 50-348-CivP
ALABAMA POWER COMPANY	)	50-364-CivP
	)	
(Joseph M. Farley Nuclear Plant,	)	
Units 1 and 2)	)	
	)	(ASLBP NO. 91-626-02-CivP)

REBUTTAL TESTIMONY OF CHARLES J. PAULK, JR., AND JAMES G. LUEHMAN ON BEHALF OF THE NRC STAFF CONCERNING PREMIUM RB GREASE IN FAN MOTORS AND ROOM COOLERS

Q1. State your full name and current position with the NRC.

A1. Charles Jasper Paulk, Jr., Reactor Inspector, Plant Systems Section Division of Reactor Safety, Region IV.

James G. Luehman, Senior Enforcement Specialist, Office of Enforcement.

Q2. Have you prepared a copy of your Professional Qualifications?

A2. (All) A copy of each of our Professional Qualifications has been previously admitted into evidence as Staff Exh. 1.

Q3. What is the purpose of your testimony?

A3. (All) The purpose of our testimony is to rebut the portions of the Alabama Power Company (APCo) testimony regarding the violations of the environmental qualification (EQ) requirements for fan motors inside containment and room

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coolers outside containment lubricated with Premium RB grease, as set forth in the Notice of Violation (NO" ,, dated August 15, 1988 (Staff Exh. 2), and the Order Imposing a Civil Penalty, dated August 21, 1990 (Staff Exh. 3). The APCo testimony which is the subject of this rebuttal testimony is contained in Direct Testimony of Jesse E. Love, James E. Sundergill and David H. Jones on Behalf of Alabama Power Company (ff. Tr. 978)(hereafter Sundergill), Dir . Testimony of Dr. Robert O. Bolt on Behalf of Alabama Power Company (ff. Tr. 1196)(hereafter Bolt), Direct Testimony of Philip A. DiBenedetto on Behalf of Alabama Power Company (ff. Tr. 1227)(hereafter DiBenedetto), and Direct Testimony of Vincent S. Noonan on Behalf of Alabama Power Company (ff. Tr. 1225)(hereafter Noonan).

Q4. In Mr. Sundergill's comments on your testimony regarding the vendor's instructions for replacing grease in the containment fan motors and the outside containment room coolers, he states that you did not identify the source of the instructions (Sundergill Q&A 195, pp. 210-11); how do you respond?

A4. (Paulk) Mr. Sundergill is correct that I did not identify the source of the instructions; I did not have a copy of the document I saw at Farley. Identical or similar instructions are in the Joy Manufacturing "Installation and Maintenance Manual: Series 800/1000/2000/3000 Axivane Fans Adjustable Pitch Direct Connected Single and Two Stage Axial Flow Fans" (NP 408) (Staff Exh. 78), which is dated 1980, well before the November 30, 1985, deadline. Staff Exhibit 78 contains the warning that I have discussed previously in my testimony and during cross-examination. On page 6 of Staff Exhibit 78 under "Lubrication of Motors," the vendor (Joy Manufacturing Co.) states that "[m]otors with Class H, Type RN or Class H, Type RH insulation systems, nuclear applications, must be lubricated with Chevron SRI #2 with no substitutions permitted." (Emphasis in original) On the last page of Staff Exhibit 78 there is a section entitled "WARNING:" which states:

> The recommended lubricants have been selected for use with JOY Series 800, 1000, 2000, and 3000 Series AXIVANE Fans. JOY does not recommend mixing lubricants due to possible incompatibility. Motors with . . . nuclear applications MUST be lubricated with Chevron SRI #2 with no substitutions permitted. DO NOT substitute other manufacturing brands without first consulting our factory. If it is desired to change lubricant, follow instructions for lubrication and repeat lubrication a second time after 100 hours of service. Care must be taken to look for signs of lubricant incompatibility, such as extreme soupiness visible from the grease relief area. (Emphasis in original)

At the Farley inspection, I examined documents relating to the lubrication of the motors under discussion here. The language in one of the documents I saw at Farley was either identical to or very similar to the above language in Staff Exhibit 78, and is the basis for my direct testimony concerning the vendor's instructions and their significance. I remember this because the first time I saw that language was at Farley.

Q5. How did you obtain Staff Exhibit 78?

A5. (Paulk) I obtained Staff Exhibit 78 in December 1991. I was performing an inspection at the Wolf Creek Nuclear Generating Station when the question came up concerning which manual contained the information I saw at Farley, as stated in my direct testimony. I went to the Wolf Creek library and obtained Staff Exhibit 78. I note that the date of Staff Exhibit 78 is 1980 and that it was available prior to the deadline; as stated above, I saw a document at least very similar to Staff Exhibit 78 at Farley.

Q6. What is the difference between Staff Exhibit 78 and the instruction manuals the Licensee relies on (APCo Exh. 97, 98, 99, 100, and 101), about which you were questioned on cross-examination (ff. Tr. 541)?

A6. (Paulk) APCo Exhibits 97 and 98 are instruction manuals for *standard* motors, not for motors used in nuclear applications and qualified for a harsh environment. APCo Exhibit 97, a Reliance Electric instruction manual, is dated June, 1976, and was "the prior version of the Instruction Manual immediately available to [APCo]." (Sundergill, Q&A 195 at 211) As stated in APCo Exhibit 97, "[t]he following instructions are for standard units only[.] [F]or special units and applications requiring different greases and regreasing schedules - contact the closest Reliance District Office." (APCo Exh. 97 at Bates No. 0034216) A nuclear application is a special application so that this manual would not apply.

APCo Exhibit 98, dated March 1989, does not contain this statement, but does give information similar to part of the warning in Staff Exhibit 78. (APCo Exh. 98 at FAX page no. 9) APCo Exhibit 99, which is a Joy Manufacturing manual, is an instruction manual for fan motors. Staff Exhibit 78 is also an instruction manual that addresses the same series fans (Joy Series 1000) as APCo Exhibit 99. However, APCo Exhibit 99 does not mention nuclear or other special applications, which Staff Exhibit 78 does, therefore, APCo Exhibit 99 is not appropriate to use in analyzing qualification. APCo Exhibits 100 and 101 are maintenance sections from some manuals, but they do not indicate that they are for motors used in nuclear applications and qualified for a harsh environment. APCo Exhibits 97-101 do not appear to be a basis for concluding that Premium RB grease may be substituted for Chevron SRI #2 to lubricate the motors based solely on analysis of whether they are equivalent greases.

Q7. How do you respond to the assertion that the installation practice or the mixed grease issue is raised for the first time? (Sundergill Q&A 195, pg. 210)

A7. (Paulk) To the best of my knowledge, members of the inspection team discussed greases and mixed greases with Mr. Shipman and others during the inspection at Farley. While I realize that fact is not specifically documented in the inspection report, given that a manual identical or similar to Staff Exhibit 78 was available at the Farley site, the issue clearly should have been considered by APCo even earlier than the inspection.

Q8. What is your analysis of grease as a maintenance issue, and not subject to EQ? (DiBenedetto Q&A 152, 155, pp. 120-123)

A8. (Paulk) Environmental qualification is more than just performing a test on equipment and documenting that test. It involves all aspects of an organization. The maintenance department has the responsibility of maintaining equipment in a condition similar to that tested to ensure that the qualification is not voided.

This licensee argues that once a component is type tested and qualified, then whatever happens is of no consequence for qualification. This argument is flawed, as follows. In order to satisfy 10 C.F.R. § 50.49, a licensee documents tests and analysis of electrical equipment important to safety to demonstrate that the equipment will function during accident conditions. If parts of the equipment are subject to age related degradation and are not replaced periodically, then the assurance that the equipment will function in a harsh environment is lost. Accordingly, maintenance personnel are vital to the EQ program.

I do not recall being shown "bookcases" full of lubricant maintenance documents. I was told that the Licensee had a substantial amount of information regarding what lubricants were used on what components and when the lubrication had taken place. Even with all of the information, APCo did not provide data and analysis adequate to demonstrate qualification of the subject motors with the Premium RB or mixed grease.

(Luehman) As stated on Page 14 of Appendix A to the Order Imposing Civil Penalty, EQ is not solely an engineering function. While the staff agrees that in this case other requirements besides 10 C.F.R. § 50.49 could have been cited, errors in design, procurement, installation, and maintenance that can adversely affect the qualification of equipment can be considered violations of EQ requirements. In addition, in response to a question from Judge Morris, Mr. W...ard testified that APCo did not create a separate organization whose job was EQ management. (Tr. 1301) He testified that APCo "integrated these requirements into our plant organization." (*Id.*) In contradiction to this testimony, however, APCo, through Mr. DiBenedetto's testimony, attempts to draw a clear distinction between EQ and maintenance.

Q9. How do you analyze APCo's use of engineering judgement in this context? (DiBenedetto Q&A 153, 155, pp. 121-23)

A9. (Paulk) Engineering judgement is nothing more than analysis of available data when the actual conditions do not meet the tested conditions. The DOR Guidelines identifies what was expected for documentation:

> Complete and auditable records must be available for qualification by any of the methods described in Section 5.0 above to be

> considered valid. These records should describe the qualification method in sufficient detail to verify that all of the guidelines have been satisfied. A simple vendor certification of compliance with a design specification should not be considered adequate. (Staff Exh. 24, Encl. 4 at 15)

In Supplement 2 to Bulletin 79-01B, the staff informed the licensees in A.8 that "[d]etails for the information and documentation required for type tests, operating experience, analysis, and extrapolation of test data from operating experience are provided in Section 5 of NUREG-0588 . . ." (Staff Exh. 24, at 6) NUREG-0588, Rev. 1, states:

> (1) The staff endorses the requirements stated in IEEE Std. 323-1974 that, "The qualification documentation shall verify that each type of electrical equipment is qualified for its application and meets its specified performance requirements. The basis of qualification shall be explained to show the relationship of all facets of proof to support adequacy of the complete equipment. Data used to demonstrate the qualification of the equipment shall be pertinent to the application and organized in an auditable form."
>
> (2) The guidelines for documentation in IEEE 323-1974 [1971 may be used for Category II] when fully implemented are acceptable. The documentation should include sufficient information to address the required information identified in Appendix E. A certificate of conformance by itself is not acceptable unless it is accompanied by test data and information on the qualification program. (Staff Exh. 23, at 16-17)

NUREG-0588, Rev. 1, Appendix E, provides further guidance to licensees regarding documentation necessary "[i]f any method other than type testing was used for qualification (operating experience, analysis, . . .), describe the method in sufficient detail to permit evaluation of its adequacy." (Staff Exh. 24, at E-2)

APCo's position that the NRC did not consider engineering judgement is not justified. As described above, the NRC recognized that analysis (judgement) may be necessary in some instances, and when this method is utilized, it must be documented "in sufficient detail to permit evaluation of its adequacy." An auditor, whether NRC or licensee, cannot audit information that is in someone's head.

(Luehman) Mr. DiBenedetto states that it is his opinion "that because APCo evaluated the substitute grease in accordance with principles of sound engineering judgement (which included documentation in its maintenance files), it had reasonable assurance that the substitute grease would not impact the qualification or operation of the associated motors." (DiBenedetto Q&A 155, pg. 123) However, a sound engineering judgement could not be made without radiation and compatibility data in the file. Neither the qualification file nor the maintenance file apparently contained any evaluation, no matter how limited, of the effect of APCo's failure to change out the grease as required by the manufacturer on the qualification of the subject motors.

Q10. How do you analyze the assertion that Premium RB grease "could function in accident conditions?" (Sundergill Q&A 194, pg. 209)

A10. (Paulk) The ability of the Premium RB grease to function in accident conditions was not analyzed by the Licensee at the time of the inspection. According to Dr. Bolt's deposition testimony on June 25, 1991, his analysis was performed ". . . just a few months ago." (ff. Tr. 1199, pg. 113) In other words, the analysis was not performed until three and one half years had passed from the inspection date.

In addition, at the time of the inspection, APCo did not provide any information to indicate that the Premium RB grease had not been mixed with the Chevron SRI #2 grease. The Chevron SRI #2 uses a polyurea base and the Premium RB uses a lithium soap. According to the EPRI Lubrication Guide, EPRI NP-4916, dated January 1987, (Staff Exhibit 79)(prepared by Dr. Bolt), polyurea and lithium soap bases are not compatible. Therefore, there was no analysis to qualify Premium RB grease on the motors in question in the Farley accident environment.

Finally, Mr. Sundergill's answer refers to the Texaco documentation (APCo Exh. 74), however, this documentation contains no radiation data, nor does it address compatibility. Therefore, it is not a sufficient basis for demonstrating qualification.

Q11. How do you respond to the APCo analysis of the list of recommended lubricants (in APCo Exh. 97-101) that concludes that Premium RB is an "equivalent lubricant," so that substitution is allowed? (Bolt Q&A 10, pp. 7-8)

A11. (Paulk) APCo Exhibits 97-101 identify the Premium RB grease as a replacement grease, however, these exhibits do not address compatibility of greases. As explained above, Staff Exhibit 78 states that, for nuclear applications, there are "no substitutions permitted." (Staff Exh. 78 at 6 and 12) In addition, Staff Exhibit 78 included the statement that mixing greases is not recommended. (Staff Exh. at 12) If the purchaser wanted to change greases, then certain steps were necessary, as I have previously testified. Further, none of the manuals indicated whether the Chevron SRI #2 and the Premium RB greases were compatible. (*See also* Q&A 6, pp. 4-5, *supra*.)

Q12. The Licensee's witnesses refer to Justifications for Continued Operation (JCOs) for Premium RB grease used on the containment fan motors and room coolers; did the JCOs qualify the fan motors and room coolers? (Sundergill Q&A 196, 197, pg. 212)

A12. (Paulk) We discussed with Mr. Shipman the fact that APCo was preparing a JCO for greases and developing a qualification program for greases. I do not remember reviewing any JCO for lubricants. Because JCOs were required only to show operability, the Licensee was not required to provide them to us. The JCO (APCo Exh. 45) analyzes how a deficiency would affect the operability of the equipment, but does not show that the equipment was qualified. In particular, the JCO does not address compatibility.

(Luehman) A JCO allows a licensee to make an argument that a piece of equipment continues to be operable even though it is not qualified. Specifically, a licensee may argue that the equipment will function under normal conditions, for example, at 100 percent power, that other equipment is available to perform the same function, and that the interval until qualification is established would represent a low risk. The Staff may accept that position and allow a plant to continue to operate, but this does not indicate that the Staff accepted the licensee's analysis as qualifying the equipment. As Mr. Paulk states, the JCO did not address compatibility. Accordingly, the JCO did not demonstrate qualification of the motors.

Q13. The Licensee's witnesses also refer to Texaco documentation. (APCo Exh. 75) Is that documentation sufficient to qualify the fan motors and room coolers? (Sundergill Q&A 198, pg. 213; Bolt Q&A 10, pg. 7)

A13. (Paulk) No. The documentation was not in the qualification file for the motors or in a separate qualification file for lubricants. Additionally, the documentation gives the data for Premium RB grease to show equivalence in lubricating qualities to Chevron SRI #2, but did not address compatibility of these two greases. For these reasons, the Texaco documentation did not demonstrate qualification. (*See also* Q&A 10, pp. 9-10, *supra.*)

Q14. The Licensee's witnesses refer to Wyle test report 40196-1 (APCo Exhibit 76) as documenting "the environmental testing of various greases and oils for use at Farley, including Premium RB grease." (Sundergill Q&A 199, pp. 213-14) What is the significance of this document?

A14. (Paulk) Mr. Sundergill stated on page 213 of his direct testimony that the "test was performed in an expeditious manner . . ." The inspection was in 1987, but the test was not completed until December 1988. APCo Exhibit 76 was not available to qualify the motors as installed at the time of the inspection in 1987.

Q15. What is the significance of Dr. Bolt's analysis? (Bolt Q&A 9, 11, pp. 6, 8)

A15. (Paulk) Notwithstanding that Dr. Bolt did not provide his analysis at the time of the inspection, it would not have demonstrated the qualification of the motors as installed at Farley. Although Dr. Bolt concluded that mixing will have an "inconsequential effect" (Bolt Q&A 11, pg. 8), he does not acknowledge that the Premium RB grease is incompatible with Chevron SRI #2 grease. (*See* Q&A 10, pp. 9-10, *supra.*)

Q16. How do you respond to the assertion that grease is not an electrical component? (Sundergill Q&A 188-192, pp. 204-207; Bolt Q&A 5, 6, and 8, pp. 3-6; DiBenedetto Q&A 148-151, pp. 117-120; Noonan Q&A 30, 31, pp. 23, 24)

A16. (Paulk) I agree that grease is not an electrical component, however, it is an integral part of components such as motors. The issue in this case relates to what was tested and what was installed in the plant. APCo had a document to demonstrate the qualification of the subject motors utilizing a particular lubricant. If APCo had installed and maintained the motors in a configuration that was tested and had documented the testing, then there would have been no further issue. The Licensee, however, elected to change the lubricant from the one used in the test to another lubricant without demonstrating the qualification of the motors with the new lubricant.

Enclosure 2 to Bulletin 79-01B provided a typical master list. (Staff Exh. 24) This typical list includes a lubricating oil, as well as an O-ring and epoxy sealant. These items are also not electrical equipment, however, Bulletin 79-01B identifies them because the NRC was concerned about any equipment that was susceptible to age degradation that could prevent an electrical component from performing its intended function when subject to a harsh environment.

(Luehman) The Licensee witnesses have alleged that the Staff considers greases or lubricants to be an item of electrical equipment. However, this is not an issue in this proceeding. What is stated in Appendix A to the Order Imposing Civil Penalty is "10 C.F.R. § 50.49(f) requires that each item of electrical equipment important to safety shall be qualified by testing of, or experience with identical or similar equipment...." With a different lubricant in an item of electrical equipment (in this case motors), absent a similarity analysis, the item of equipment is not identical or similar to that which was qualified.

In asserting that the grease at issue performs no electrical function and therefore is outside the scope of equipment required to be qualified pursuant to 10 C.F.R. § 50.49 Licensee witnesses attempt to draw a narrow and misleading distinction that differs from accepted industry practice existing before the November 30, 1985, deadline. Mr. DiBenedetto correctly points out that IEEE 323-1974 (APCo Exh. 36) identifies lubricants as needing to be addressed should they be modified after the affected equipment is qualified. (DiBenedetto Q&A 152, pg. 120) That information is taken from Subsection 6.8 of the standard which comes from Section 6, titled "Qualification Procedures and Method." Further, Mr. DiBenedetto neglected to mention that in Subsection 6.2 of that same standard, "Equipment Performance Specifications," item (4) specifically mentions lubricant in outlining preventative maintenance issues of concern in maintaining qualification. Additionally, another standard that existed well before the deadline, IEEE 382-1980 (Staff Exh. 80), which is the standard for valve operator qualification states in Subsection 5.6:

> Examples of modifications which may require requalification by type test are:

> (1) Change in materials of construction which may have an effect on qualified life, for example seals, lubricants, etc. (Staff Exh. 80 at 22)

While this standard does not apply to the equipment at issue here, it illustrates that consideration of lubricants was encompassed in the qualification of electrical equipment important to safety.

In a pre-deadline inspection report dated July 26, 1985, documenting an inspection at Ft. Calhoun conducted April 29 to May 3, 1985 (Inspection Report No. 50-285/85-09, Staff Exh. 64) the Staff raises the issue of the need to maintain proper lubrication of certain pumps in order to assure qualification. (Staff Exh. 64 at 12) This information was readily available to persons like Mr. DiBenedetto, who, according to his testimony (DiBenedetto Q&A 10, pg. 9), stayed current on technical and regulatory developments in the EQ area. The information was available through the NRC public document room or should have been available through the Nuclear Utility Group on Environmental Qualification (NUGEQ) which had a representative at the Ft. Calhoun inspection.

Though the standards state that lubricants be accounted for, they are silent as to the reasons why. In my opinion, the nature of equipment testing answers that question, as follows. In order to qualify a given piece of electrical equipment, that equipment must be demonstrated to function as designed in an accident environment. Therefore, during the course of the qualification the equipment is operated as it would be in the plant. Now assume that during the test the equipment fails to continue to operate. There could be many reasons for the equipment's failure to operate, including those that are strictly electrical or mechanical. However, whether or not the reasons could be definitely determined, the test, in accordance with guidance such as Section 5.2.5 of the DOR Guidelines (Staff Exh. 24, Encl. 4 at 12), would have to be considered unsatisfactory because the equipment could not demonstrate proper performance for the specified duration. Recognizing the integral link such a situation creates between some of the equipment's electrical and mechanical functions, qualification necessarily encompasses both functions where they can not be easily separated.

Q17. How do you respond to the assertion that the Staff "stretches of the concept of EQ?" (Sundergill Q&A 193, pg. 207-8)

A17. (Paulk) The DOR Guidelines state that "[t]he type test should be considered valid for equipment identical in design and material construction to the test specimen." 10 C.F.R. § 50.49 requires, in part, that each item of electric equipment important to safety shall be qualified by testing of, or experience with, identical or similar equipment, and the qualification shall include a supporting analysis to show the equipment to be qualified is acceptable. It is on this basis that the lubricant was considered to be important for rotating equipment. Without additional analysis or testing, it would not be possible to determine if a lubrica... would be capable of performing its function under design basis accident environments and, therefore, prevent the motor from performing its safety function (i.e. turning a fan or a pump). Since grease is an integral part of the motor and is susceptible to degradation as a result of environmental conditions, we do not consider our position as "stretch[ing] the concept of EQ." (Sundergill, pg. 208)

Q18. How do you respond to the Licensee's witnesses assertions that there was no reason that APCo clearly should have known of the qualification deficiencies pertaining to APCO's use of Premium RB grease? (Sundergill and Jones Q&A 201, pp. 214-15; DiBenedetto Q&A 156, pg. 123)

A18. (Paulk) Even though I was not personally aware of the requirements of the manufacturer until I reviewed the documentation at the Farley site, if I was able to identify this just from reading the Joy manual, APCo clearly should have known of the requirements for the exclusive use of Chevron SRI #2 and for changing greases.

(All) The Licensee's reliance on the 1980 inspection report (APCo Exh. 11) and TERs is not adequate to justify its position. The TERs were based on information provided by APCo. The documentation APCo relied on for qualification indicated the motors were tested and qualified with Chevron SRI #2 grease. However, the Licensee knew that it had actually used a different grease and clearly should have known that the grease was different from that tested. With regard to the 1980 inspection, it is true the inspector looked at the fans. However, the report states the scope of the inspection, and it clearly did not include review of qualification file data or maintenance history.

(Luehman) In addition to the specific vendor documents discussed by Mr. Paulk, the industry standards discussed in my response to question #16 at pp. 14-17, *supra*, clearly should have alerted a knowledgeable engineer to the general concerns with lubricants. Further, qualification reports such as Limitorque's B0058 (APCo Exh. 67) discuss the need to account for proper lubrication by adhering to Limitorque's approved lubrication schedule. Again, while such a document does not relate directly to the equipment in question, it does highlight, as do the earlier IEEE standards, the need for the use of proper lubricants to maintain qualification. Finally, Information Notice 79-03, dated February 9, 1979 (Staff Exh. 81), discusses a lubricant issue and specifically mentions the qualification parameters of the grease at issue. Therefore, at least as early as 1979, lubricants as a qualification issue was a concern the NRC discussed with the industry.

Q19. How do you respond to the assertion that this violation lacked safety significance? (Sundergill Q&A 203, pp. 215-16; DiBenedetto Q&A 157, pg. 124)

A19. (All) It is the Staff's position, as stated in the Order Imposing and direct testimony, that the Licensee's lack of a basis to show the substitute grease was equivalent to, and compatible with, the grease specified by the manufacturer and used for original qualification is significant. This remains true notwithstanding a showing after the fact that the substitute grease was equivalent. Furthermore, the Licensee apparently never evaluated whether replacing the grease in a manner other than specified by the manufacturer could have affected qualification and it was not until an outside expert answered that question for this hearing that the Licensee had the expertise to do so.

Q20. How do you respond to the assertion that the containment fans are not needed? (Sundergill Q&A 204, pp. 216-17)

A20. (Luehman) The staff maintains that since the equipment was specified on the Master List, its lack of qualification is a safety significant concern. Mr. Paulk's description of the equipment's function is taken from the Final Safety Analysis Report as he stated in his testimony. (Paulk Direct Testimony, ff Tr. 553, Q&A 10, pg. 6) Mr. Sundergill states in his testimony that Bechtel analysis shows that the conclusions Mr. Paulk reached about the effect the failure of the equipment would have on the plant cannot be supported. At this time, I am unaware of any evaluation APCo has done under 10 C.F.R. § 50.59 to change the Final Safety Analysis Report or any license amendment APCo has submitted to modify the plant licensing basis. Hence, it was reasonable for Mr. Paulk to state that an assumed failure of the equipment could result in adverse consequences to the plant.

Q21. Does this conclude your testimony regarding this matter?

A21. (All) Yes.

JUDGE BOLLWERK: The APCo panel, I believe, is next.

MR. HANCOCK: All right.

Whereupon,

DAVID H. JONES

and

JAMES E. SUNDERGILL

were called as surrebuttal witnesses for Alabama Power Company on premium RB grease and, having been previously duly sworn, were examined and did testify as follows:

DIRECT EXAMINATION

BY MR. HANCOCK:

Q Let's say our names again.

A [Witness Sundergill] My name is James E. Sundergill.

A [Witness Jones] David Huber Jones.

Q Do you gentlemen have before you a document that is Alabama Power Company's surrebuttal testimony on premium RB grease?

A [Witness Sundergill] I do.

A [Witness Jones] Yes.

Q Did you each help in preparing this testimony?

A [Witness Sundergill] I did.

A [Witness Jones] Yes, I did.

Q Do either one of you have any corrections that need tc be made at this time?

A [Witness Sundergill] I have none.

A [Witness Jones] No.

Q Is this surrebuttal testimony true and accurate to the best of your knowledge?

A [Witness Sundergill] It is.

A [Witness Jones] Yes.

Q Do you adopt this testimony as your surrebuttal testimony on this issue for purposes of this proceeding?

A [Witness Sundergill] I do.

A [Witness Jones] Yes, I do.

MR. HANCOCK: At this time I would move that this testimony, the surrebuttal testimony on premium RB grease, be admitted and bound into the record.

JUDGE BOLLWERK: Any objection?

MR. BACHMANN: No objection.

MR. BACHMANN: Then the APCo surrebuttal testimony on premium RB grease will be received and bound into the record.

[The surrebuttal testimony of James E. Sundergill and David H. Jones on behalf of Alabama Power Company concerning premium RB grease follows.]

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket Nos. 50-348-CivP
ALABAMA POWER COMPANY	)	50-364-CivP
	)	
(Joseph M. Farley Nuclear	)	
Plant, Units 1 and 2)	)	ASLBP No. 91-626-02-CivP

SURREBUTTAL TESTIMONY OF JAMES E. SUNDERGILL
AND DAVID H. JONES ON BEHALF OF ALABAMA POWER COMPANY
CONCERNING PREMIUM RB GREASE

Q State your full name.

A. (Sundergill) My name is James E. Sundergill. I am employed by Bechtel Corporation as the Engineering Supervisor of the Electrical and Control Systems Group of the Farley Project.

(Jones) My name is David Huber Jones. I am currently Manager of Engineering Support, Farley Nuclear Plant, for Southern Nuclear Operating Company, Inc.

Q. Have you previously testified in this proceeding?

A. (Sundergill, Jones) Yes. We have previously testified on various technical issues raised by this enforcement proceeding.

Q. What is the purpose of your present testimony?

A. (Sundergill, Jones) Our present surrebuttal testimony is offered to address the buttal testimony of the various NRC Staff panels on the technical issues in this proceeding.

VIII. PREMIUM RB GREASE

Q154. In the Rebuttal Testimony concerning Premium RB Grease in room cooler and containment fan motors, Mr. Paulk identifies Staff Exhibit 78, which is a Joy Manufacturing document entitled "Installation and Maintenance Manual: Series 800/1000/2000/3000 Axivane Fans Adjustable Pitch Direct Connected Single and Two-Stage Axial Flow Fans -- NP 408." Mr. Paulk claims that this document was "identical or similar" to the manual he reviewed during the 1987 inspection. Was NP 408 (Staff Exhibit 78) in the Farley Nuclear Plant files during the 1987 EQ inspection?

A: (Sundergill, Jones) No. Alabama Power Company had the Joy Installation and Maintenance Manual NP 403 (APCo Exhibit 99) at the time of the inspection, and not NP 408. Joy sent the NP 403 manual to Alabama Power Company in 1975 for Unit 1 and 1976 for Unit 2 when the fan motors were initially shipped. This NP 403 manual still remains in the Farley Nuclear Plant files today. As a result, NP 403 is the manual that was available for Mr. Paulk's review during the 1987 inspection.

Q155. On Page 3 of his Rebuttal Testimony, Mr. Paulk identifies a "warning" contained in Staff Exhibit 78, which he claims should have notified Alabama Power Company that Chevron SRI #2 was the only lubricant to be used in the fan motors. Could

Mr. Paulk have seen such a warning on a Joy manual at Farley Nuclear Plant?

A: (Sundergill, Jones) Absolutely not. Since Joy never sent to Alabama Power Company a copy of Staff Exhibit 78, there is no copy of the NP 408 manual in the Farley Nuclear Plant files. The Joy manual that is in the files, NP 403, does not contain any warning that only Chevron SRI #2 may be used. Therefore, Mr. Paulk's claim that he saw a Joy document at Farley Nuclear Plant that warned against the use of any grease except Chevron SRI #2 is simply in error.

Q156. On page 5 of his rebuttal testimony, Mr. Paulk states: "APCo Exhibit 99 does not mention nuclear or other special applications, which Staff Exhibit 78 does, therefore, APCo Exhibit 99 is not appropriate to use in analyzing qualification." How do you respond to this conclusion?

A: (Sundergill) This is the first time Mr. Paulk has asserted that APCo Exhibit 99 (Joy manual NP 403) is not intended to provide instructions for nuclear applications of the fan motors. Because of Mr. Paulk's statement, I telephoned Joy to determine the applicability of NP 403 to Alabama Power Company's nuclear application of the fan motors. Joy confirmed that NP 403 was meant to be used in a nuclear application and that it still applied to the motors used in

Farley Nuclear Plant notwithstanding the fact that a different manual (Staff Exhibit 78) had been prepared. Joy also confirmed that they had no record of NP 408 having been sent to Alabama Power Company. Furthermore, Joy confirmed that it knew in 1974, when it sold the fan motors to Alabama Power Company, that the motors would bo used in a nuclear application. Joy's awareness that Alabama Power Company would use the fan motors in nuclear applications is also readily apparent from the Joy Nuclear Containment Axivane Fan Operator's Handbook, which was sent to Alabama Power Company in 1974 when the fan motors were initially sent. (APCo Exhibit 123) Enclosed with this Operator's Handbook is a copy of NP 403.

Q157. On page 10 of his Rebuttal Testimony, Mr. Paulk complains that Alabama Power Company provided no documentation to indicate that Premium RB grease had not been mixed with the Chevron SRI #2 grease in the fan motors. How do you respond to this statement?

A: (Sundergill, Jones) The first time mixing of greases in the Joy fan motors was raised as either an NRC Staff concern or a basis for the civil penalty was December 20, 1991, when Mr. Paulk raised it in his direct testimony.[1] Notwithstanding

[1]Mixing greases was raised with regard to Limitorque motor operators but the Staff has elected not to pursue enforcement action on this point.

this newly voiced concern, Alabama Power Company has experienced no incompatibility effects in the fan motors in fifteen years of Premium RB usage at Farley Nuclear Plant.

Furthermore, in 1987 Alabama Power Company submitted to the Staff a justification for continued operation regarding the use of Premium RB grease in the room cooler and containment cooler fan motors. Because neither compatibility nor mixing of greases was an issue at that time, Alabama Power Company did not include any such discussion in the JCO. Had the Staff in 1987 believed that mixing or compatibility were issues that needed to be addressed in order to continue plant operations, the Staff would have rejected the JCO. Instead, the Staff accepted the JCO as providing reasonable assurance that continued operation was justified. (Staff Exhibit 29).

Q158. The Staff also raises the issue of Alabama Power Company's failure to change out the grease "as required by the manufacturer." (Rebuttal Testimony Concerning Premium RB Grease, at page 9). Was there any such vendor "requirement" in 1977 when Alabama Power Company changed to Premium RB?

A: (Sundergill, Jones) No. In fact, the document identified by Mr. Paulk as "requiring" a specific procedure for changing out grease was not even developed until 1980 -- three years after Alabama Power Company changed to Premium RB grease in Unit 1.

Moreover, that document (Staff Exhibit 78 -- the Joy N[illegible] manual) has never been sent to Alabama Power Company.

Additionally, we understand that the first time such a "requirement" appeared in the Reliance containment cooler fan motor instruction manual was in Reliance manual B-3628-10 (APCo Exhibit 101), which was not issued until January, 1989 -- four years after the EQ deadline and twelve years after Alabama Power Company changed to Premium RB grease. The Reliance manual B-3628-9 (APCo Exhibit 100), which Alabama Power Company had in the Farley Nuclear Plant file in November 1987, contains no change out "requirements." Further, Mr. Paulk's contention that a change out procedure is "required" by the vendor is simply wrong. The change out procedure in the Reliance manual B-3628-10 is presented merely as a "note" and not as a "requirement" for maintaining qualification. This "note" reads in part: "Mixing lubricants is not recommended due to possible incompatibility. . . . Care must be taken to look for signs of lubricant incompatibility, such as extreme soupiness visible from the grease relief area." (APCo Exhibit 101, Section IV, Routine Maintenance). Notwithstanding that this "note" did not appear in the Reliance containment cooler fan motor maintenance manual until four years after the EQ deadline, to our knowledge, in the fifteen years of Premium RB grease usage on these fan motors at Farley Nuclear Plant, no such "extreme soupiness" has ever been seen, nor have any signs of incompatibility been observed.

IX. CONCLUSION TO ALL TECHNICAL ISSUES

Q159. Does this conclude your testimony.

A. (Love, Sundergill, Jones, DiBenedetto) Yes. We hope so. To be candid, since this inspection first began in 1987, we have noticed that the NRC Staff is rarely satisfied with any answer we give them. Each concern raised by them, and answered by us, begets yet another concern. There seems to be no end in sight. After five years, we are still addressing new concerns, new issues and new retroactive applications of current knowledge. We hope we are done. We genuinely do not know.

JUDGE BOLLWERK: My understanding again is that there is no cross examination from either party with respect to this testimony.

MR. BACHMANN: That's correct

MR. HANCOCK: That is correct.

JUDGE BOLLWERK: All right. Board questions. Judge Carpenter?

JUDGE CARPENTER: Not really, but just out of curiosity: I've never seen one of these fans or fan motors. How big is this motor in horsepower. What are you all talking about? That this grease is used on.

[Pause.]

WITNESS JONES: It's late in the day. I don't remember.

JUDGE CARPENTER: Is it bigger than a bread box or not?

WITNESS SUNDERGILL: It's definitely bigger than a bread box.

WITNESS JONES: Bigger than that.

JUDGE CARPENTER: I just was trying to get some feel whether this is a large motor, whether there are very severe demands on the bearings, or whether it's a relatively lightweight, little fan.

WITNESS SUNDERGILL: It's a large motor, a 600 volt motor.

JUDGE CARPENTER: Thank you.

JUDGE BOLLWERK: Anything else?

JUDGE CARPENTER: No.

JUDGE BOLLWERK: Judge Morris?

JUDGE MORRIS: No.

JUDGE BOLLWERK: I have one question for Mr. Paulk. I think it's fairly clear from the record -- and you can correct me if I'm wrong -- that the manual that you assert has the critical information is one that APCo asserts they did not have, which is, I guess -- What you're relying on is Staff 78, and they say that they did not have that manual at the time of the inspection.

WITNESS PAULK: Let me defer to Mr. Luehman, who has personal knowledge of information that I have only heard over the phone.

JUDGE BOLLWERK: All right.

WITNESS LUEHMAN: Well, I think that I'll add -- I mean, Mr. Paulk can speak for himself. I think that he still maintains that that manual was there. The only thing that I can add is that it's still the Staff's position -- we've had a number of conversations with the Joy Manufacturing Company. Having talked to them, the only thing I can hypothesize -- or give one possible explanation of how it got there -- is simply that they --

JUDGE BOLLWERK: Let me stop you. It meaning what? I'm sorry.

WITNESS LUEHMAN: It being the manual that Mr. Paulk has referred to in his rebuttal testimony.

It's simply that Joy Manufacturing has said that they have provided numerous copies of that manual to Bechtel, and it's likely that -- I'm only speculating -- Bechtel had one of those manuals on site with them.

Again, that's only our speculation, because Mr. Paulk does maintain that he saw it at the site.

JUDGE BOLLWERK: Do you maintain someone from Bechtel showed it to you, or that someone from the Licensee showed it to you?

WITNESS PAULK: I do not know. The way it was being dealt with is, we would ask for the information, and it would be brought to us. Usually Mr. Jones would bring it. There were a few times one of the other APCo employees would bring it.

I don't know who gave it to whom first.

JUDGE BOLLWERK: But you still assert that you think that the manual that's marked as Staff 78 is the manual that in fact you saw.

WITNESS PAULK: Or a copy similar to that.

JUDGE BOLLWERK: Any response from APCo?

WITNESS JONES: I'll just maintain my contention as documented in the surrebuttal: that there was not a copy of NP-408 manual in the Farley plant files.

JUDGE BOLLWERK: Even if it wasn't in the files, did anyone else give him a copy of anything else?

WITNESS JONES: Not to my knowledge, no.

WITNESS SUNDERGILL: There would not have been any Bechtel people that reported to me that would have given them that manual.

JUDGE BOLLWERK: One last question for Mr. Paulk or Mr. Luehman. Assuming that APCo is correct that the manual was not in their files, how do you find that relevant to this portion of the case?

WITNESS LUEHMAN: I think obviously, for the clearly-should-have-known case, that is a part of our clearly-should-have-known position. That manual obviously has the most direct notification about the use of a different grease.

However, as we have stated in our direct testimony and our rebuttal testimony, the issue of qualifying grease, I think, for nuclear and EQ applications is established. There are a number of documents that we went through in our rebuttal testimony which established that. The Licensee had notice of what kind of grease Joy Manufacturing used. If they were going to do a substitution, they had to take into account a number of considerations, one being compatibility and the other one being -- well, equivalency and compatibility.

On the first score, while we agree that they did put in another grease, which they contend was equivalent, we contend that the file was inadequate to support that.

On compatibility -- which, at the time they did it, was a while before, obviously, the deadline -- we don't know that any analysis was done to look at the compatibility of the greases. One way around the compatibility of the greases would have been, obviously, to do a complete change-out of the first grease before installing the second grease, thereby avoiding any possibility of compatibility problems.

If the Board finds that they have to exclude references to NP-408 in their consideration, the Staff still feels that we've made a clearly-should-have-known finding and that the violation should be sustained.

JUDGE BOLLWERK: Any response from APCo?

WITNESS JONES: I think our surrebuttal speaks for itself on the issue and our position.

JUDGE BOLLWERK: All right.

Let me raise one other question with Mr. Luehman or Mr. Paulk, whoever feels --

APCo raises this question on pages 232 and 233 of its testimony. If you look at the notice of violation -- or, rather, the order imposing the civil penalty, dealing with the fan motors at page 39 and you compare that discussion with the Limitorque operator violation discussion at 33 and 34, there doesn't seem to be any discussion, at least on its face, of the question of mixing greases under the fan motor violation. Can you explain -- if you need to get the exhibit, it's Staff 3.

[Pause.]

JUDGE BOLLWERK: What I'm asking you to compare is pages 33 and 34, dealing with Limitorque operators. Under the bottom of the page, the paragraph starting "Violation 1.C.1-A" talks about "unqualified or mixed grease." Compare that with page 39 of the order imposing civil penalty, which talks about premium RB grease in the center, the paragraph starting in the center of the page, under violation 1.C.4. They contend that there's nothing in there that talks about mixed greases. Can you point out anything that clarifies that?

WITNESS LUEHMAN: Obviously, there's nothing there that specifically talks about the issue. Again, I think that one of the things that this goes back to, I think, is that, if you look at NP-408, the warning against mixing greases or the potential for the incompatibility of greases is clear. I think that that is also discussed in other generic documents. I guess that's our position

Basically, I think, to make it really simplistic, if you mix greases, you essentially create a third grease. I mean, that's maybe a real simplistic argument, but -- or you potentially create something that's a third grease; it's not one or the other. I agree that there's nothing discussed here in specific.

JUDGE BOLLWERK: I take it you still maintain, in any event, that the premium RB grease was not qualified. Is that correct? Even if it wasn't mixed.

WITNESS LUEHMAN: Our position is that the Licensee did a change greases and that their file didn't support the grease they used, subsequently updated to, and it wasn't till analysis some time later -- and that was a fairly recent analysis -- and even that didn't address the potential for incompatibility of the greases.

JUDGE BOLLWERK: Again, this may be somewhat of a legal issue that the parties will be addressing.

WITNESS LUEHMAN: I agree.

JUDGE BOLLWERK: All right. I have no further questions, unless the other Board members do.

MR. HANCOCK: Judge, I have --

JUDGE BOLLWERK: Do you have redirect? Absolutely.

MR. HANCOCK: One follow-up.

BY MR. HANCOCK:

Q Just to make sure that the record is clear, the

Staff has asserted that the existence of NP-408 in Alabama Power Company's file is one of the bases for the clearly-knew-or-should-have-known. Is it Alabama Power Company's position that that document was not in the file at Alabama Power Company's Farley nuclear plant?

A [Witness Jones] Yes.

Q Just one other issue: On the mixing, I don't know where we are on that one, but let me just fine out. Do either one of you know when the Chevron was replaced with the premium RB?

A [Witness Jones] In the mid-'70s. I believe it was in the '75 time frame.

Q In 1975. This is 1992. Have we experienced any incompatibility problems with mixing since 1975 or '77, that time frame? In the last 15 years has there been any noticed incompatibility problems?

A [Witness Jones] No.

MR. HANCOCK: Nothing further.

JUDGE BOLLWERK: I knew this was going to happen. I could tell from the time you asked that question.

Go ahead, Judge Carpenter.

JUDGE CARPENTER: Mr. Paulk, I'm more familiar with lubricants in nuclear plants than I really care to be, because an intervenor once litigated lubricants, in the Sharon Harris proceeding. From that perspective, there are a lot of things that need lubrication. Is it your inspection finding that this was an isolated case, or do you have some reservations about many, many, many things that are being greased with undocumented -- in terms of qualifying the greases?

Is this an isolated incident or a programmatic breakdown?

WITNESS PAULK: In my numerous inspections of Region II, Region I, Region IV, and Region V plants for EQ, this is the only instance that I am aware of when mixed grease was like this. There were some issues at other plants --

JUDGE CARPENTER: I didn't ask my question properly.

WITNESS PAULK: Okay.

JUDGE CARPENTER: Does this inspection finding that's been identified -- the use of a grease for these fan motors -- I'm only asking, has that same issue occurred for other items at Farley or not?

WITNESS PAULK: Other lubricants?

JUDGE CARPENTER: Yes. Other pieces of equipment.

WITNESS PAULK: We really didn't look --

JUDGE CARPENTER: You put your finger on the fan motors. I'm just saying, did you look at any of the others?

WITNESS PAULK: Let me --

JUDGE CARPENTER: Is this an exception to the rule or not?

WITNESS LUEHMAN: I think it's documented in the inspection report, Judge Carpenter, that we did look at greases in other applications. We did have some problems with greases in other applications, but the questions raised were subsequently resolved to our satisfaction. That's not an issue.

JUDGE CARPENTER: So the concern doesn't go beyond this particular piece of equipment.

WITNESS LUEHMAN: No.

JUDGE CARPENTER: Thank you.

JUDGE BOLLWERK: Anything else from anybody?

[No response.]

JUDGE BOLLWERK: Any more redirect?

MR. HANCOCK: No.

JUDGE BOLLWERK: All right, then. I believe we're finished with this panel, as well. We thank all of you, Mr. Paulk and Mr. Luehman, Mr. Jones and Mr. Sundergill, for your testimony and your service to the Board. I hope you will express the appreciation of the Board to all your compatriots, everyone who has stayed late. We very much appreciate your sticking around so we could get this finished up tonight. Thank you very much.

[Witnesses excused.]

JUDGE BOLLWERK: I think we have no other exhibits that need to be moved into evidence into this point.

We have a couple of procedural matters to take up. The first one is the matter of APCo's response to Staff Exhibit 84.

MR. REPKA: Judge Bollwerk, we discussed the matter at the break. We have nothing we want to add to that. We'll address its relevance in the findings.

JUDGE BOLLWERK: All right. There's nothing you wish to get in the evidentiary record, then. Whatever arguments you'll make in your findings of fact.

MR. REPKA: Right. Exactly.

JUDGE BOLLWERK: All right.

The other matter I think we have to deal with is findings and conclusions.

I see Mr. Bachmann smiling. He is obviously looking forward to this.

Let's talk about timing. As I indicated earlier, I do not intend to close the record for approximately a week, to give the parties time to look over all their exhibits, make sure that all the pagination is good, that we have everything we should have. What I'd like is, if anybody has a problem, by close of business a week from tomorrow, that you let us know about any problems with evidentiary problems of any kind -- exhibits or whatever.

At that point we'll be issuing an order closing the record and setting the schedule for findings of fact and conclusions of law.

How much time does the Staff need -- or want, put it that way?

MR. BACHMANN: First of all, it's the Staff's cherished hope, shall we say, that we would have simultaneous filings. Otherwise, we keep staying out of synch all the time.

JUDGE BOLLWERK: What is your feeling on that, Mr. Miller?

MR. MILLER: We don't agree to that. They've got the burden of proof. We'd like to see what they have to say and let us write back to it.

JUDGE BOLLWERK: All right.

Staff, you will then get the last shot at it.

MR. BACHMANN: It was a question of either having a second shot or just finally filing.

JUDGE BOLLWERK: With simultaneous findings, basically, you're going to have two sets of filings, your initial ones and response to each other's. If that's the way you'd want to do it, we can set it up that way. Or we can set it up seriatim.

MR. REPKA: Judge Bollwerk, I don't believe the rules call for responses. It's 30 days and 40 days by the rule.

JUDGE BOLLWERK: Right.

MR. REPKA: I'm not suggesting those numbers of days --

MR. BACHMANN: I hope not.

MR. REPKA: -- but they file once; we file once shortly after they file; and that's it.

JUDGE BOLLWERK: You're exactly right. That's what the rules say. If the parties want to agree to something else, it's not necessarily something the Board will throw out, but if the rules are what you want enforced, we'll do that. That's not a problem.

MR. BACHMANN: Just let me check the regulations.

JUDGE BOLLWERK: Sure. It's rule 2.7.5.4.

[Pause.]

MR. BACHMANN: Two points: One, it's quite obvious from reading this that this was designed for licensing proceedings. Therefore, I would say that we have more or less a clean slate to write upon in a major enforcement proceeding.

Second of all, there is -- However, to the extent that it may apply, there is, of course, a right of the party with the burden of proof to file reply findings, or at least a response.

JUDGE BOLLWERK: That's right. I don't think Mr.

Repka is contesting that, either.

MR. BACHMANN: Okay.

JUDGE BOLLWERK: He simply, I understand, wants to follow the rule that's here.

I will say one thing: It strikes me that, if we went with simultaneous filings, we may shorten the time somewhat. I don't know what the parties are asking for here.

MR. BACHMANN: Since that's a dead issue, let me proceed.

From a very practical standpoint, we are looking at the months of June and July. We've got a federal holiday coming up. We have the big Fourth of July weekend. Mr. Holler has got his mandatory two weeks' reserve duty in the period of July.

If we're closing the record for all time on May 29, given the practicalities of the situation --

JUDGE BOLLWERK: It probably will be the week afterward. Around June 1, let's say.

MR. BACHMANN: All right. The Staff would propose its deadline for filing: July 31.

JUDGE BOLLWERK: In other words, you want 60 days.

MR. BACHMANN: Yes, sir.

JUDGE BOLLWERK: All right.

Any objection from APCo?

MR. MILLER: We'll do that. That's fine.

JUDGE BOLLWERK: Then you want 60 days, as well, for your reply.

MR. MILLER: Yes, sir.

JUDGE BOLLWERK: All right.

Then we're up to September 30; am I correct, approximately? August, September, right.

We'll memorialize this in an order, so you won't have to rely on your memories here, or the transcript. We're looking at September 30, then, approximately for your reply.

MR. MILLER: Yes, sir.

JUDGE BOLLWERK: Then the Staff would like how much time for their reply or response to the APCo filing?

MR. BACHMANN: Since they would have 60 days to analyze ours, I think for a reply we'd like 30.

JUDGE BOLLWERK: Thirty. All right.

Let me apprise you of one thing. The Board has been working on, and will be providing to the parties at the time we close the record and issue an order memorializing the schedule, a set of guidelines for filing findings of fact and conclusions of law. Basically, it's a statement of some of the issues we see in the case and how we'd like to see them addressed. You can certainly address anything that's outside of those; those are not in any way restrictive in terms of your ability to address any issue in this case. I would suggest that, to ignore them, you do so at your peril, in terms of the kind of information we're looking for.

To some degree, it's an attempt by the Board to put some bounds, as it sees it, one the issues -- that's not the correct term -- to put some order into the issues and try to get some kind of a statement from the parties that they're addressing issues in a way we'd like to see.

Anything else either of you all can think of? I don't think so at this point.

[No response.]

MR. BACHMANN: Judge Bollwerk, if you also indicate in that order the format if you wish this to be on computer disk, the size of disk, and --

JUDGE BOLLWERK: Right. We'll do that. I suspect we're going to want that on computer disks, probably in WordPerfect 5.1 That will all be in the order.

We'll probably also ask for these filings to be by express mail, so that we won't have to worry about five days for mailing. We'll try to give everybody the maximum time within the 60 days.

MR. BACHMANN: That would be express mail on the date.

JUDGE BOLLWERK: The date that it's due, right.

In other words, mailing will be service, and hopefully you will receive it the next day and can start on it right away.

Anything else either of the parties have for the Board?

[No response.]

JUDGE BOLLWERK: All right. At that point, I guess, we would like to thank counsel, as we did before. I think the cooperation of counsel in this proceeding has helped move it along quite a bit. The Board would like to express its appreciation for the cooperation of counsel for both the parties.

MR. MILLER: The record would not be complete without an acknowledgement by Alabama Power Company about working with the counsel from OGC. It really has been easy to work with them. Gene and Dick are first-rate people, and we've gotten where we are in an efficient manner because we really haven't had any quarrels -- the usual litigation haggling has not occurred in this case. The record needs to reflect that.

JUDGE BOLLWERK: Any time that can happen, that's certainly something the record should reflect. We certainly encourage it, obviously. It makes it a lot easier on the Board. We can spend out time looking at the issues, not worrying about the personalities involved.

All right, then. Judge Carpenter has one thing.

JUDGE CARPENTER: Mr. Miller, in that spirit of professionalism, can I ask, are there any more settlement talks going on, or not?

JUDGE BOLLWERK: Let's go off the record, and we'll talk about that for a second.

At this point, if there's nothing else from the parties or the Board, subject to our order closing the record, we'll adjourn this proceeding. Again, we thank everyone. Sorry about the lateness of the hour, but we did want to finish today, and I think we have.

Thank you very much.

[Whereupon, at 7:00 p.m., the hearing was concluded.]

REPORTER'S CERTIFICATE

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

NAME OF PROCEEDING: Alabama Power Company

DOCKET NUMBER: 50-348-CivP

PLACE OF PROCEEDING: Bethesda, Maryland

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

Mark W. Handy

Official Reporter
Ann Riley & Associates, Ltd.