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Agency: Nuclear Regulatory Commission
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Title: Nine Mile Point Nuclear Power Plant
Information Exchange Meeting

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

INCIDENT INVESTIGATION TEAM

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In the Matter of: :

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Information Exchange Meeting :

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Conference Room A
Administration Building
Nine Mile Point Nuclear
Power Plant, Unit Two
Lake Road
Scriba, New York 13093
Sunday, August 18, 1991

The interview commenced, pursuant to notice, at 8:15 a.m.

CHAIRMAN: Marty McCormick, Niagara Mohawk Power Company, Plant Manager, Nine Mile Point, Unit Two

PARTICIPANTS:

From the IIT:
Jack Rosenthal, Team Leader
Frank Ashe, Electrical Engineer
Jose Ibarra, Electrical Engineer
Paul Eddy, State Observer, New York State

From Niagara Mohawk Power Company:
Ralph Sylvia, Executive Vice President
Joe Firlit, Vice President, Nuclear Generation
Jim Perry, Vice President, Quality Assurance
Rick Abbott, Manager of Engineering
Bob Crandall, System Engineer, UPS System
Anil Julka, Electrical Design Supervisor
Perry Bertsch, Instrumentation and Control Technician
John Conway, Manager of Technical Support, Nine Mile Point Unit Two
Steve Doty, Electrical Maintenance
Tom Egan, ISEG Engineer
Ray Main, Maintenance Support Engineering
John Pavel, Site Licensing
Harold Light, Senior Engineer Specialist, Transformers

PARTICIPANTS (Continued):

From Exide Electronics, and from Consulting Organizations:

Rudi Machilek, Director, Power Systems Group, Exide Electronics

Bill Zug, Product Engineering, Exide Electronics

Warren Lewis, Consultant, Exide Electronics

Steve Tsombaris, Electrical Engineer, Stone & Webster Engineering

Warren Lippitt, INPO

Tom Walters, Magnetek

PROCEEDINGS

[8:15 a.m.]

MR. McCORMICK: Good morning, everyone. I'd like to get the meeting started. Let me introduce myself. My name is Marty McCormick. I'm the plant manager. I will attempt to do my best to coordinate the meeting this morning, and you each should have an agenda of the main goals and generally how we will proceed through to cover the topics that Jack Rosenthal and I in discussions yesterday felt would be the primary points of interest.

I appreciate you all coming here this morning. I know it's early, but we have certain initiatives that have to get under way, and that is to understand just what happened with respect to the UPS power supplies. We also have some expertise from Exide that may not be here through the early part of next week; I wanted to take advantage of your presence while the NRC was here.

To get things started, what I'd like to do is go around the room. To keep some sort of logic to this, we'll have the NRC people introduce themselves first, for the record, and then the NIMO people, followed by consultants and the Exide folks.

Jack?

MR. ROSENTHAL: Jack Rosenthal, IIT team leader.

MR. ASHE: Frank Ashe, electrical engineer, IIT

team.

MR. IBARRA: Jose Ibarra, electrical engineer, IIT team.

MR. EDDY: Paul Eddy, New York State public service commission. I am the state observer on the IIT.

MR. McCORMICK: Okay. All NRC people have introduced themselves. I'll ask that the NIMO people, then, introduce themselves.

Ralph?

MR. SYLVIA: I'm Ralph Sylvia, executive vice president.

MR. FIRLIT: I'm Joe Firlit, vice president of nuclear generation.

MR. PERRY: Jim Perry, Niagara Mohawk, vice president, quality assurance.

MR. McCORMICK: I'm Marty McCormick, plant manager.

MR. ABBOTT: I'm Rick Abbott, manager of engineering, currently assigned as event assessment manager.

MR. CRANDALL: I'm Bob Crandall, system engineer for the UPS's.

MR. JULKA: My name is Anil Julka. I'm the electrical design supervisor for Niagara Mohawk.

MR. BERTSCH: My name is Perry Bertsch, I&C technician.

MR. CONWAY: My name is John Conway. I'm manager of technical support for Nine Mile Two.

MR. DOTY: Steve Doty, general supervisor of electrical maintenance.

MR. EGAN: Tom Egan, ISEG engineer.

MR. MAIN: Ray Main, maintenance support engineering.

MR. PAVEL: John Pavel, site licensing.

MR. LIGHT: I'm Harold Light. I'm a senior engineer specialist involved with transformers across Niagara Mohawk's system. I'm with Equipment Analysis, out of Syracuse.

MR. McCORMICK: Does that complete the NIMO folks?

[No response.]

MR. McCORMICK: Okay. Exide, please, and consultant assistants.

MR. MACHILEK: My name is Rudi Machilek. I am a director with the power systems group of Exide Electronics, and my position is senior staff consultant.

MR. ZUG: My name is Bill Zug, director, product engineering, Exide Electronics.

MR. LEWIS: My name is Warren Lewis. I'm a consultant to Exide.

MR. TSOMBARIS: I'm Steve Tsombaris, electrical engineer with Stone & Webster Engineering.

MR. LIPPITT: Warren Lippitt. I'm with INPO. I'm acting as a consultant to the utility.

MR. McCORMICK: Has everyone in the room introduced themselves? One more.

MR. WALTERS: Tom Walters, with Magnetek, guest of Mr. Light.

MR. McCORMICK: Okay. You all should have an agenda, and I'd just like to very briefly review the purpose of the meeting this morning, and then we'll get right into the business at hand.

I have listed four items, goals, here. The first is to exchange information relative to the uninterruptable power supplies and the related components, such as the main transformer and reserve transformers.

We'll present a troubleshooting plan for NRC concurrence and look to obtain their approval to implement that plan.

We expect to provide data exchange on the lighting design for the normal, essential, emergency, and egress lighting fed from the UPS sources; however, time permitting, we can get into the details. What we will do is just to provide that package for further follow-up.

And we hope to clarify, then, as appropriate, interfaces for scheduled interviews and further data exchanges relative to the main transformer failure analysis

and the UPS component load list, which is currently being prepared and should be, probably, finished early next week.

With that introduction, are there any questions?

[No response.]

MR. McCORMICK: I'd like now, then, to begin into the procedural part of the meeting. We have arranged with Anil Julka, who is on Rick Abbott's team, to kind of set the stage and talk through, clarify for everyone the on- and offsite sources of power to the UPS buses, both safety-related and non-safety-related, and to explain how the various UPS buses are configured.

Anil, would you begin, please?

MR. JULKA: Thank you, Marty.

Before I start, I'm going to pass out this hand-out. Really what we did was put together a sketch showing the offsite sources coming into the plant. I know we talked to NRC a little bit yesterday, and it seemed like we needed something which shows how the relationship of the offsite power is to our system. I'm going to hand out a few. I'll wait until everybody gets one; then we can start going over it.

[Documents distributed.]

MR. JULKA: First of all, the Niagara Mohawk, the 345 kV system comes in at the top. You'll see line 23, Scriba station. That's the 345 line, and that's where the

generator goes through, via the four main transformers, which are shown there. Those are configured from left to right, X-Y-Z phases. The fourth one is the spare transformer, which is normally not hooked up. It's ready to go into either one of those three spots.

MR. SYLVIA: Your X-Y-Z corresponds to our A-B-C?

MR. JULKA: That's right. A-B-C, X-Y-Z, it's synonymous, really.

The generator is tied in there with the isophase bus to the main transformers and coming down to the normal station service transformers. The normal station service transformers are three-winding transformers, with each winding feeding down to the switch gear, 2 NPS switch gear 001 to your left and 2 NPS switch gear 003 to your right. That's a 13.8 kV level at that point. The way the plant is really designed is, there are two halves to the plant. Half of the plant is fed from one side, and half of the plant is fed from the other side.

Keep in mind that this is only the non-class-1E power in the plant.

If you go again to the top, to the left, there is a 115 kV source A, which is line 5, going to our switch yard. That feeds Division 1, all the way down, 2 ENS-star switch gear 101. That's the Division 1 power, which is normally lined up to the offsite source, 115 kV, which is

independent from the 345, although they do get lined up farther down in our 345 kV grid system.

At the same time, there is a second offsite source, which is on the other side, which is line 6. It is not written on there, but that's the line 6, which is going to Scriba. Oh, line 6 is written; it's there. That's the reserve bank B. That comes down feeding switch gear 103.

Does everybody see that?

[No response.]

MR. JULKA: So we have two offsite sources coming to two divisional power buses, the switch gear buses, where diesels are tied, and they are completely independent of the normal station service.

MR. ASHE: Excuse me.

Frank Ashe, NRC.

This diagram appears to show only one line going to each of the safety buses. This CUB. ONLY -- what does that mean?

MR. JULKA: That's a cubicle only; there's no breaker in that position.

MR. ASHE: Okay. So the only source to each of the two buses would be a delayed-access source, of which you'd have to go and pull another breaker from somewhere and plug into there before you could power from this alternate?

How would you power from the alternate to ensure power to one bus?

MR. JULKA: First of all, I think if you look at GDC-18, which is the criteria for the --

MR. ASHE: Seventeen.

MR. JULKA: Seventeen. Excuse me.

We need to have two offsite sources, and normally most of the other plants don't have the direct alignment to the offsite. Most of the plants feed their switch gear divisional buses from the normal station service, so they have to have an alternate source which is automatically transferred.

In our case, we have our two offsite sources, which are line 5 and line 6, which are directly connected to the switch gear, so normal station service has no impact on the offsite sources. Our design, I believe, is better than most of the designs, because we don't need to transfer, and it's directly providing us two lines of power, and those two lines are in accordance with the GDC-17.

MR. ASHE: Okay.

MR. JULKA: The first line, if that source fails for any reason, we do start the diesels.

MR. ASHE: Okay. They would start and then attempt to connect.

MR. JULKA: And they'll connect. If there is no

power, they will connect.

MR. ASHE: Should you need a second offsite source, where would you take the breaker from?

MR. JULKA: From the same cubicle.

MR. ASHE: Oh, okay. You would remove it from the primary cubicle and roll it over to the --

MR. JULKA: Next cubicle.

MR. ASHE: -- next cubicle and plug it in. Okay.

Is there a time for that process? Half an hour, an hour?

MR. JULKA: No. I guess we could go into an LCO if you lost one offsite power.

MR. ASHE: But I mean the actual time required to do that operation would be, what, an hour, maybe?

MR. JULKA: Not even that.

MR. ASHE: Thirty minutes?

MR. EDDY: Fifteen, twenty minutes.

MR. JULKA: Fifteen, twenty minutes.

MR. EDDY: What do you think, Ray?

MR. MAIN: I think 20 minutes is an adequate number.

MR. JULKA: But I think if you lose one offsite line, you go into a tech spec LCO, and you have a certain time to restore power.

MR. ROSENTHAL: Jack Rosenthal.

We have established that the 1E4160 buses are sitting on your reserve bank transformer or reserve auxiliary transformer, which is another name for it, from a 115 source. Going upstream of there, do you then have one more transformer between that source and Scriba, a step-down transformer? Can you just give us a little bit more?

Let me tell you, the point is that I think that there is a causal reason why the perturbation on the 1E buses would have been less than the perturbation on the non-1E buses. I would like to have you explain that to me.

MR. JULKA: Okay. All the lines from 345 go to the Scriba. The 115 kV line 5 and line 6 are physically, separately routed, so there is no common mode failure going into the yard. When you get into the 345 kV yard, there are two buses which can feed either of these sources, which are buses A and B, which are connected to the entire grid system of upstate New York.

MR. ROSENTHAL: So there's at least one more transformer.

MR. JULKA: That's right.

MR. ROSENTHAL: Every transformer is going to be so much of a dB loss in the impulse.

MR. JULKA: Yes. There is at least one transformer there.

MR. ROSENTHAL: At least one more.

MR. JULKA: Yes.

MR. CRANDALL: There's a 345-to-115 step-down at Scriba.

MR. JULKA: We have another level transformer back there, too.

MR. CRANDALL: We can provide a drawing, a configuration of that.

MR. ROSENTHAL: We'll be walking away, I'm sure, with the actual electrical drawings you're going to share with us.

MR. JULKA: This was just to give you an overview of how the systems are tied in the plant itself.

This is the overall sketch. Are there any other questions on this? If not, I can go on to the next one, which is the UPS tie-ins, how they are tied in.

MR. ROSENTHAL: At some point are we going to get traces, I guess from an oscilloscope, of what the buses saw.

MR. JULKA: Yes. I can give a brief description, but I do have my report. I can give copies of it later on; I did not make copies for this meeting.

MR. ROSENTHAL: Well, if you compare -- Can you just verbalize for a minute and qualitatively tell us?

MR. JULKA: Sure.

Do you see the middle phase on the main transformer at the top? There was a fault in that

transformer. The root cause, Harold and his people will determine why that happened, but the electrical protection system, we assume that fault did happen.

We had differentials across that transformer itself, which operated and cleared that fault. At the same time, we have a backup protection which covers the generator and the main transformers together, and that also operated and sent a redundant signal, although it was needed, to trip.

At the time of the fault, we cleared the fault. From the starting of the event to when all the buses were transferred, the total time was about 12 cycles. From the clearing of the fault to the restoration of the power, it was 6 cycles.

Now, at the time of the fault, the B voltage collapsed, because the fault was on the B line. The voltage that the Scriba oscillograph showed was approximately 80 kV. I just want to reemphasize that the charts we are looking at -- to determine all this, the main purpose of these charts is to really look at the events as it happened and not really the magnitudes of the voltages and currents. When I say 80 kV, that's our best approximation of what that is.

MR. FIRLIT: This is Joe Firlit.

I'd like a clarification on the cycles. It took 12 cycles for our differential relays to take off the

transformer; is that correct?

MR. JULKA: No. It took us 12 cycles from the initiation of the fault to when the power was restored.

MR. FIRLIT: To when the power was restored. Okay.

MR. SYLVIA: Is this transfer from station service to reserve?

MR. JULKA: Right. From the initiation of the fault.

MR. FIRLIT: How does the six cycles fit in there?

MR. JULKA: From the disconnection of that bus from the faulted source to the transfer was six cycles.

MR. FIRLIT: Was six cycles.

MR. JULKA: It took six cycles to clear the fault, six cycles to connect to the new source.

MR. FIRLIT: Okay. So that's where you're getting your total of 12 cycles.

MR. JULKA: Right.

MR. FIRLIT: I understand that now.

MR. JULKA: Our design is that, if normal power is lost for any reason, we take the 13.8 kV switch gear 001 and switch gear 003 and correspondingly transfer to the corresponding reserve transformers, because reserve transformers are, again, three-winding transformers with the tertiary wiring feeding the safety-related buses, and the

other winding is there for the 13.8. It's used for normal start-up and also for fast transfer.

Our oscillograph did show that, after that 12 cycles, we picked up the load on both buses, and all the relaying schemes operated as they were designed to operate, and all the load was transferred over as designed.

Given that six cycle time, we did probably see that from the initiation of the fault to the disconnection of the fault at six cycles there was a dip in the B phase voltage because B went to ground so that probably ran through the system but again it should not be a problem for a system to handle that because faults like that do happen and electrical systems are designed to take care of that.

As far as the protection schemes are concerned I feel very pleased to see that all the protection worked as it was designed.

MR. ROSENTHAL: So if you have a scrub trace of some sort in the switch yard and are there any other qualitative, quantitative traces that we will be able to look at in this lower down, or is that it?

MR. McCORMICK: We have additional monitoring on the lower buses.

MR. CONWAY: John Conway.

The additional monitoring that we have available is via the G-TARS computer which lost power during the

event. Therefore, that data is not retrievable.

MR. ASHE: Frank Ashe, NRC. You seem to be suggesting that the differential was the actual guy that cleared the fault. Could you take us through that and show us how you determined that?

MR. JULKA: The differential when the targets came in and they operated the knock-out relay which initiates the fast transfer.

MR. ASHE: Okay, when the target came in, though, that's not for a fact?

MR. JULKA: I guess when the target comes in, that's when the relay operates.

MR. ASHE: I know that but you wouldn't be there looking at it at the time at which it came in so how do you know that it was the first guy to initiate it? Couldn't you have initiated something --

MR. JULKA: We went through all the targets which came in. We made a list of every target which came in in the plant. The differential came in on the transformer. Differential came in on the overall protection scheme but they are coordinated so the differential of the transformer will go first.

If the unit takes you out first, then the differential of the main transformer will not go after that because your trip has already occurred. You know, the

sequence of events has to occur in the way the differential across the main transformer is set for a lower value. The differential across the transformer is set just to operate on the transformer fault so it is set for a lot lower value as opposed to the overall unit differential which is set for a lot higher burns. It's looking for more than just the transformer itself. It's looking for generator and the transformer so it is looking for overall protection scheme as opposed to just the transformer currents, so the transformer differential really has to operate first before the unit can operate.

That just isolates us. You know, we have separate differentials across the unit generator. If there is a fault in the unit generator they should operate first before the unit would go, overall differential scheme.

From there we concluded that, yes, unit differential based on the settings did go first and it was followed by the -- this happened all within a few cycles so the overall differential went and took out the lockout relays and generator overcurrent relays came in. They took out the lockout relay on the 345-kV. The ground overcurrent relays came in, so we have in the plant four protection schemes and every one of them operated, which they are supposed to.

MR. SYLVIA: Ralph, I have a question.

Differential is differential between the main transformer and generator?

MR. JULKA: We have one differential across the two windings of the transformer.

MR. SYLVIA: Okay, that's across the transformer?

MR. JULKA: Right.

MR. SYLVIA: Do we also have a differential between the transformer and the generator?

MR. JULKA: That's right.

MR. SYLVIA: Is that from CTs or PTs? Is that voltage or is that some combination?

MR. JULKA: It's mostly CTs, current. They are connected. What it's looking for is current going in the same as current going out. If it's not it's going to trip you for any reason.

We have one across the transformer, one across the generator and one across the overall.

MR. SYLVIA: And by the lockout relays you know it was differential? What lockout relays?

MR. JULKA: Those picked up. Corresponding lockout relays were picked up and lockout relays stay in that position unless they are reset.

MR. FIRLIT: You have targets, don't you, that little red targets that come on?

MR. JULKA: Yes. Targets come on the differentials

and the lockouts stay in that position unless we reset them manually.

MR. ASHE: Frank Ashe, NRC. The way you're arriving at that, and you correct me if I am wrong, is through your knowledge of the inherent characteristics of your design. After the fact, looking at the relays to see that the target was tripped is not going to tell you which one tripped first. I think you are using the design information to know that the differential would have actuated before some other thing based on the actual inherent characteristics of the design. Is it fair to say that?

MR. JULKA: Yes.

MR. ASHE: Okay. Rather than something that I go to avoid and actually look at. Just looking at a trip target and a relay is not going to tell me it actuated before overcurrent actuated because all the targets are going to be tripped, so how do I know which one?

Unless I was right there at the time, which I doubt that anybody was, then I wouldn't no.

MR. JULKA: Two differentials is hard too, but an overcurrent it's timed so overcurrent will come later.

MR. ASHE: So what you are saying the differential actuated basically because of your inherent design characteristics. You know it's going to be the

differential.

MR. JULKA: Yes, by design.

MR. ASHE: Right, by design.

MR. JULKA: Yes. If you have a fault in the generator you should disconnect the generator first so the differential on the generator should operate first. Differentials work very fast, very fast acting relays. Overcurrent relays are slow acting.

MR. ROSENTHAL: Can you share that list of flags and targets with us?

MR. JULKA: Yes, I have a complete list of every target which came in. I can give a copy to you.

MR. McCORMICK: And the calibration and the time settings that go with that, so that you can follow up on that, so that data is available and will be provided.

MR. IBARRA: This is J. Ibarra. Can you tell me the core protection schemes now?

MR. JULKA: Okay. They are called unit alternate protection I, unit alternate protection II and generator protection and one is generator backup protection.

We have two lockout relays in each one of those protection schemes so there is a redundancy within the redundancy.

MR. McCORMICK: Okay, any further questions on the general feeds to the station? We'll provide as

indicated the relay scheme and the calibration data to support the deductions we've made so for in terms of how the relay scheme worked and what it meant to us.

A key point of information I think for everyone here is to show the relationship of the various uninterruptible power supplies to the normal station feeds and I would like to get that discussion brought forward next. Anil?

MR. JULKA: I am going to pass out another handout.

MR. ROSENTHAL: Good.

MR. JULKA: Now for those, if you want to get into the details, I do have the bigger size drawings and they are highlighted showing how the systems tied in, but this is -- for information. If you want, I have fresh copies I've highlighted which are the station drawings.

MR. ROSENTHAL: Right. You will provide those.

MR. JULKA: You can have these, yes. They are highlighted.

MR. ROSENTHAL: And then you and Frank can separately meet on that and that would not be a transcribed meeting. We'll get the actual plant drawings highlighted. Thank you.

MR. McCORMICK: Now we are going to discuss the 109 UPS's and how they are both safety-related and non-

safety related and how they are tied to the various bus configurations within the plant.

MR. SYLVIA: While doing that could you also indicate which ones are the Exide and which ones are the other manufacturer and the name of the other manufacturer.

MR. JULKA: Okay. On this drawing we should go from the left, UPS 1-D, 1-C, 1-A, 1-B, and 1-G and 1-H. These are all Exide units.

UPS's 3-A and 3-B are Elgar, E-l-g-a-r and those are 10 kVA units, small units.

MR. SYLVIA: Could you repeat? 3-A, 3-B and --

MR. JULKA: 3-A and 3-B are Elgar and they are 10 kVA units.

UPS 1-H is 5 kVA.

Bob, do you want to correct me on that? 5 kVA?

MR. CRANDALL: That is correct.

MR. JULKA: And UPS 1-D, 1-C, 1-A, 1-B and 1-G are all 75 kVA units.

1-H is a different design as opposed to the other five, although they are all exide.

Now one key thing to notice is I guess they were all fed from different -- UPS 1-B was fed from switchgear 001, which is the left half of our distribution system and all others were fed from switchgear 003 except for UPS-3-A.

The normal source is shown on the top. The

alternate source is shown at the bottom.

At the bottom I have a single line for Class 1-E UPS's 2-A and 2-B. They were tied in separately to the Class 1-E switchgear so they had no relationship to the other supplies whatsoever. They are fed from our normal 115 kV offsite source which was not really impacted by this fault.

MR. JULKA: They are the Elgar also.

MR. ROSENTHAL: How big are they?

MR. JULKA: Those are 25 kVA units.

MR. FIRLIT: So we have a total of ten UPS systems.

MR. JULKA: Yes.

MR. SYLVIA: Excuse me, what are the other two again?

MR. JULKA: Elgar.

MR. SYLVIA: What are they supplying?

MR. JULKA: At the bottom.

MR. SYLVIA: Okay, and they are the Elgar too?

MR. JULKA: They are the Elgar. The reason all these four are Elgars, 3-A and 3-B were brought to the same requirement as the safety related UPS's although they are used in non-safety systems. These are for the RPS and the scram solenoids -- RPS logic.

MR. ROSENTHAL: I'm sorry, can you just repeat

that sentence?

MR. JULKA: These were the UPS 3-A and 3-B were brought to the same requirements as the Class 1 UPS's so they were bought from the same manufacturer. The 2's and the 3's are similar design.

Now going back to the loads, typically --

MR. ROSENTHAL: I'm sorry.

MR. JULKA: Go ahead.

MR. ROSENTHAL: Just to close out it so that we don't have to revisit, 3-A, 3-B were brought to the same standards as 2-A, 2-B because it had the scram solenoids?

MR. JULKA: It's the RPS logic.

MR. ROSENTHAL: It had RPS logic sitting on it.

MR. JULKA: Right.

MR. ROSENTHAL: And do those 3-A, 3-B have a QA, QC preventive maintenance, et cetera program commensurate, I recognize it is non-1-E, but a program commensurate with the importance that you place on that?

MR. CRANDALL: And let me clarify that too. All four were purchased non-1-E -- or all purchased Class 1-E and then we have since upon installation downgraded 3-A and 3-B to non-safety related and the design is such that there are what are called electrical protection assemblies on the output of 3-A and 3-B.

For that reason, they fall under the same criteria

as the non-safety related. They are under the same PM type of programs and everything because of the EPAs. The EPAs protect the scram solenoids for us.

MR. JULKA: Let me clarify that. They were purchased to the same requirements, same QA requirements at the time of procurement. I think that is the key.

MR. CONWAY: This is John Conway. Once or twice there were statements here about scram solenoids I want to clarify.

The scram solenoids are not fed from an uninterruptible power supply, use the logic itself.

MR. ROSENTHAL: I'm sorry. They come up from the generator sets?

MR. JULKA: That is correct.

MR. ROSENTHAL: Which is in turn fed from non-1-E, just AC power.

MR. JULKA: UPS 1-D and 1-C mainly feed the essential lighting in the plant and some communication, Gaitronics.

UPS 1-A and 1-B feed the control room circuits. 1-G feeds the computer. 1-H is strictly an isolated system for the stack.

Is that right, Bob?

MR. CRANDALL: Yes -- monitor system, single load.

MR. JULKA: And we went over 3-A and 3-B for the

RPS logic. 2-A and 2-B feed the safety-related system in the plant.

3-A, 3-B, 2-A and 2-B and 1-H, they were not impacted by this scenario.

MR. CRANDALL: Just to clarify, this is Bob Crandall, 2-A and 2-B saw a bump on their maintenance supply -- that we know, because there was an alarm for sink loss, so there was a bump, though non-impacting.

MR. SYLVIA: I have a question. Maintenance supply being the ultimate supply --

MR. CRANDALL: There's three common terms and maybe we should clarify it at this point.

The term "bypass," the term "maintenance," and the term "alternate" are all synonymous. When you are talking UPS, different people use different terms.d

MR. ROSENTHAL: You said that a 2-A and 2-B -- you picked up an alarm. Is there a quantitative answer?

MR. CRANDALL: We went out of sync. The UPS went out of synchronization with its maintenance supply. We don't know what period, whether that's you know when we transferred our station loads to the offsite or prior to that but we also got some undervoltage targets on the Class 1-E, 4160 buses.

MR. ROSENTHAL: So can you quantify then, you know, the undervoltage target comes in when it's three volts

off, 20 volts off? I mean, you know -- or later?

MR. CRANDALL: I don't know.

MR. ROSENTHAL: But we will be able to do that?

MR. JULKA: I can clarify that. When that fault happened the entire 345 kV system went down in that and particular phase and that impact was felt at FitzPatrick Nine Mile I and the entire upstate New York grid system.

The 115 kV system, the B phase, did go down a little bit on that time. It did pick up the targets on the switchgear 101 and switchgear 103 but it was for only a few cycles that it did not initiate any other action.

We have done the voltage relays on this switchgear 101 and switchgear 103 buses which are set at I am going to say approximately because I don't have the right number here, approximately 92 percent voltage for 30 seconds. At that time we disconnect the system if that condition persists.

Then the second line of protection on the undervoltage is also there, which is approximately 80 percent and that's for 3 seconds, so we have two lines of protection which will -- targets may come in but they do not initiated any action because of the time delay involved in those actions.

MR. ROSENTHAL: I'm sorry, if you didn't peg the target for the 80 percent, three second, if you did not then

you believe that the perturbation was less than that?

MR. JULKA: That's right.

MR. ROSENTHAL: Okay, but you did pick the target on 92 percent 30-second?

MR. JULKA: Target? Target, yes -- but it didn't time but we know it reached that voltage.

MR. ROSENTHAL: 92 percent, for some time less than 30 seconds, yes?

MR. JULKA: Less than six cycles, yes.

MR. CONWAY: Did both sets of undervoltage schemes, targets indicate for an actuation?

MR. JULKA: No.

MR. CONWAY: Just the fire and lighting?

MR. JULKA: Yes.

MR. CRANDALL: That was the same throughout all three divisions?

MR. JULKA: All three divisions.

MR. CRANDALL: That's 50 milliseconds. There's plenty of time for the UPS to sense that little bump and it locks in an alarm so we had some idea that there was something there but it didn't affect them at all.

MR. ROSENTHAL: Okay. I am not arguing that UPS 2A or 2B had a hard time fulfilling its safety function which clearly it kept up but rather trying to quantify what is going on here.

I think it will be useful to people chasing ground faults and just other stuff to bring it all out.

MR. McCORMICK: Okay. Do any of you have any other --

MR. ASHE: Frank Ashe, NRC. Where was the 345?

MR. JULKA: It's out in the switch yard. It's about a half a mile away.

MR. ASHE: Okay, because I think what all this is coming down to is the 345 fault did back into the 115 some kind of way and that's why you saw it on the safety buses a little bit.

Is it fair to say that?

MR. JULKA: Yes. It resulted in the entire upstate New York system, so I'm sure every other plant in the --

MR. ASHE: Do you believe that that's the explanation as to why, since its impact obviously having gone that distance would be far less severe than that being seen by the AC sources feeding into the non-class 1E inverters? Do you really feel that is the reason why you didn't lose the Class 1E inverters?

MR. JULKA: Well, I think that we are still investigating why we lost the inverters. By normal design we should not have lost the inverters. Faults like this do happen in the industry and I guess the main, the electrical

system should be designed to handle these faults and I think our protection schemes did handle this fault -- I guess that is the intent of the inverters, to keep operating under these changes.

MR. ASHE: What we're trying to come up with here is why -- maybe I should ask this directly really.

Why do you feel that you lost the non-Class 1E inverters at the same time you got evidence that clearly suggests that Class 1E inverters saw something as a result of this fault but yet they stayed all on. You didn't lost those.

What was the difference?

MR. JULKA: I guess we don't know.

MR. ASHE: It's still under investigation?

MR. JULKA: Right, so as far as I am concerned that is the only piece of the puzzle which still needs to be solved is why those converters failed.

MR. SYLVIA: I have a question on something you just said.

When you made the statement that you should not have lost the non-1E converters, were you thinking that the normal supply should not have opened or just generally a broader statement?

MR. JULKA: No, what I am saying is on faults like this we disconnect the faulted power supply at the 345 line.

The intent was to fast transfer to switchgears to go to a regular source and the UPS's should have hung in.

MR. SYLVIA: And there should have been no transfer, even to one of those, the alternate --

MR. JULKA: That's right.

MR. SYLVIA: The breakers should have stayed closed, the normal supply breakers.

MR. JULKA: Yes.

MR. McCORMICK: I think in the next group that will discuss this, Ralph, we'll get into the logic of what those inverters should have done given the interruption that we had with respect to the line fall.

We have the Exide folks and we also have our system engineer to walk us through the control logic of what should have happened as we think the design should have operated and then we also are prepared to talk a little bit about our experience so far with these devices through other transients that have taken place.

I think that's appropriate, unless there are other questions.

MR. ASHE: I have one question.

Is there any definitive information, like strip chart recorders or monitoring equipment, in which the magnitude of voltages occurring attendant to the fault could be somewhat assessed between the non-class-1E buses and the

class 1-E buses? It appears as though the class-1E buses -- the effects of a fault there appear to be far less severe, just due to the design arrangement and so forth. But is there any definitive information, like monitor or whatever you might have had, that really backs that up?

MR. JULKA: The same oscillograph charts from where we made this conclusion.

MR. ASHE: But do you monitor the secondary side or the 115 line?

MR. JULKA: We do -- no.

MR. ASHE: The 4160 aspects.

MR. CONWAY: Not with the oscillograph.

MR. JULKA: No.

MR. FIRLIT: This is Joe Firlit.

We talked about the oscillographs in our station. How about in the substation at Scriba? Do we have oscillographs in there that have a time delay on it to record continuously, like 60 cycles or something like that, so we could go back and look at those oscillograph traces?

MR. JULKA: I think the oscillographs we are talking about are the Scribe oscillographs.

MR. FIRLIT: Oh, is that right.

MR. JULKA: The plant one was not working.

MR. FIRLIT: Okay.

MR. SYLVIA: The normal supply breaker, is it

within the cabinet of the UPS, or is it a separate breaker?

MR. JULKA: Yes. For the UPS, it's within. It's got an output, input, and alternate. Every breaker is within the cabinet itself.

MR. SYLVIA: Controlled by the control circuit, and so forth.

MR. JULKA: Part of the UPS, yes.

MR. FIRLIT: In terms of mechanics here, we do have coffee out here for people, and there is some banana bread, so just help yourself.

This meeting will go longer than two hours, in my projection.

MR. JULKA: I think the key thing I wanted to emphasize is that faults like this do happen in the electrical system off and on. In my lifetime, I have seen four or five of these faults, and I think we have to go from there and make sure the system operates properly.

As to the UPS, in our judgement at this point, that is the only open piece of the puzzle, on the UPS, which we have the Exide folks here for, to resolve that, why that did not transfer. Other than that, I think we are pleased with our system, how it operated.

MR. McCORMICK: Okay. Are there any questions on the material covered so far?

[No response.]

MR. McCORMICK: We have been at it about an hour. We're at a point where there is a logical transition to get into the workings of the UPS systems. Perhaps if we take a five-minute break, make sure we're comfortable, and convene here in five minutes. Work that as precisely as possible, please.

[Recess.]

MR. McCORMICK: I'd like to convene what I'll refer to as phase 2 of our meeting, which gets down to the details of the UPS control logic and design and gets into some of the more important things relative to our needs to agree on a troubleshooting plan and to use the input from our technical experts who have come to help us out from Exide and to understand just what took place here.

I will ask Bob Crandall, our system engineer, to lead this part of the discussion and to introduce, as appropriate, the input from the Exide organization.

MR. CRANDALL: This is Bob Crandall.

We're going to split this into the logic, and then I will do the history and maintenance. I don't want to get into it very deeply, but I want to hand out something, just so everybody that may be looking back at it down the road can get a little concept of where we are different in some of the units. What this is is a packet.

[Document distributed.]

MR. CRANDALL: I hesitate to use the word "schematic," because it's on a really basic level, hand-drawn kind of stuff. There's nothing false in it, but obviously it's much more complex than this.

The first page is the Exide UPS's. One thing I just want to illustrate, more to get the other one out of the way, is that 1-H is the last page, and I want to just show just how drastically different that is and why it's not part of the discussion, why we're not concerned about it. It's because it's not even close. That question has come up a lot of times. It's not even close.

Okay.

MR. McCORMICK: Are you going to walk us through that logic?

MR. CRANDALL: Yes. I'll give you a real basic on what we're talking here.

Two sources of power in: the AC input three-phase is from our normal supplies, non-safety-related; it's 575 three-phase. It comes into the unit. That AC-to-DC converter is just that. It's like a battery charger in there that converts it to DC. We have our plant batteries connected to it through CB-2. CB-1 and CB-2 are both within the box of the UPS. That battery is a backup: if the DC voltage on that bus between the AC-to-DC converter and the inverter drops, then the batteries take over. It is not a

transfer type thing.

MR. ASHE: Frank Ashe, NRC. Excuse me one minute.

The AC input three-phase that you showed there upstream of CB-1, what's the magnitude of the voltage there?

MR. CRANDALL: It's 575. That's a delta input, by the way; it's not a grounded reference, I'm saying. We don't bring a ground into the unit from the AC input.

We convert down to 140 volts DC. We call it DC link. Then the inverter converts that back to 120-208 three-phase Y. That's a grounded output.

On the bottom is our maintenance supply, alternate supply, bypass supply -- those are all the same terms. Then 575 feeds into a transformer that transforms that to 120-208. That 120-208 goes through a regulator that really corrects for voltage, keeps it plus or minus 2 percent, and sends 120-208 to the -- towards the UPS; I'll leave it that way.

The way this device works: We're normally on AC, with the DC available. CB-1 and CB-2 are closed. When we're on UPS power, CB-3 is closed, feeding the critical bus, whether it's the computer, lighting, whatever that happens to be. There are a number of trips, a number of parameters, that the UPS monitors. One thing it does is, it looks at the output of the maintenance supply. If the maintenance supply is within certain parameters for

frequency and voltage -- and example of that is 60 plus or minus a half cycle -- if that maintenance supply is within those parameters, the UPS will adjust itself to exactly duplicate that frequency, so it's in synch. If the maintenance supply goes outside of those parameters, the UPS will run on its own internal clock at 60 cycles. That's a constant referencing back and forth.

MR. ROSENTHAL: Excuse me. That's both frequency and phase angle?

MR. CRANDALL: Yes. The zero crossings are looked at as well. It's not just the frequency; you're right. There are deadnuts on.

Exide, you can correct me if I'm in any way, shape, or form not saying that precise.

MR. MACHILEK: No, you're okay.

MR. CRANDALL: The situation we were in: We were in a normal configuration. As I say, we had AC, DC available. We had CB-3 closed. CB-4 was open, which was normal. When we have any type of off or trip to the UPS transfer bypass, the way the transfer takes place is this: First the static switch gates on, makes a connection between the maintenance supply and the critical bus. We're totally in synch, so that's not a problem. Then CB-3 will open; then CB-4 will close.

That particular transfer of power from UPS to

maintenance takes place in less than 4 milliseconds. We have seen that in a 1 to 2 millisecond range.

The tracers we took. Extremely rapid.

Things that can cause that: As I say, there are certain parameters, high voltage on the output, low voltage on the output, over-temperature, logic trips, things like that. When we get a trip of the UPS, what occurs is, CB-1, CB-2 both trip; the logic tells CB-3 to open; and, if the maintenance supply is in synch, it will tell CB-4 to close.

MR. MACHILEK: This is Rudi Machilek.

If I may substitute the comment that, in case of a transfer, the command to gate the static switch and the command to close the CB-4 bypass breaker occur simultaneously. The function of the static switch is solely to overcome the time it takes for the mechanical circuit breaker, CB-4, to close, which may take about 30 to 50 milliseconds. The static switch would gate within about 120 microseconds, so the function of the static switch is solely to overcome the time it takes for the mechanically breaker to close.

I also want to go on record that the synchronizing between the UPS output and the bypass source is done on phase A-B. That means we are comparing phase A-B of the inverter output to the voltage A-B on the bypass. The reason that I like to emphasize is that phase B is the one

which suffered a disturbance, and that would, of course, cause the transfer command to be not there.

Even if the UPS would say, Go to bypass, it would not do it.

MR. McCORMICK: Let me understand. Phase A-B?

MR. MACHILEK: Voltage A-B. On a three-phase system, the phase-to-phase voltages are A-B, B-C, and C-A, as compared to phase-to-neutral voltages, which would be A, B, C, neutral. We are using that one phase for the purpose of confirming that the frequency is identical, that the phase coincident it within about 7 degrees, and that the voltage difference between the two sources is no more than 10 percent apart. We call it a delta-V or the difference in the voltages, by magnitude.

MR. SYLVIA: Can I ask you a question about this? We're talking about synchronizing and how they have to be together in order for the maintenance supply to close in.

MR. CRANDALL: Correct.

MR. SYLVIA: If a transfer is taking place and, say, it starts with CB-1 opening and all of that goes to zero, what's the significance of the synchronizing if, on a transfer, your normal supply has gone away, it's zero?

MR. CRANDALL: Let me attack it from the other end, and maybe that will better explain it. Don't take the numbers -- Rudi, you can throw in the exact numbers for me

if you wish.

What we're talking about is an example where we get an under-voltage for some reason on the output of the UPS: inverter is failing or something like that. What occurs very rapidly is, we're normally at 120; we droop down to, say, 116, and it's crashing. It's still at 116, let's say, and before it actually has tripped the UPS, it has already given the command to transfer, and the transfer is already done, and then the UPS trips. Rather than, the UPS has tripped, and now it's going to transfer, it has really transferred, and then the UPS goes away. Do you follow what I'm saying?

The wave shape isn't broken at all. It's merely a small ripple on it.

MR. SYLVIA: This storage battery really wouldn't have the capacity to carry load for any period of time; it's just to keep the voltage steady.

MR. CRANDALL: No. That has the ability to carry it for two hours.

MR. SYLVIA: Oh, two hours. Well, why is it so important that this transfer take place really fast.

MR. CONWAY: John Conway.

Let's clarify the difference between the battery carrying the critical load and the battery just carrying the logic load in the UPS. Which battery are you talking about?

MR. ROSENTHAL: The storage battery shows on this diagram.

MR. SYLVIA: That's the station battery.

MR. CRANDALL: The design basis for that is to be able to supply all of the UPS's on a particular battery, or all of their loads, for two hours with no AC power to the plant. They have that capability.

MR. ROSENTHAL: How big is battery 1A?

MR. CRANDALL: It's 5100 amp-hours.

MR. SYLVIA: So that's not a problem. Why wouldn't the system be able to just run the battery for a while?

MR. CRANDALL: One thing we do know occurred: We didn't have a failure of the UPS to go to battery; we had a trip of the UPS. A signal was generated, though we haven't identified where that came from -- we're looking in some areas -- but we do know that the UPS got a trip signal that told logically CB-1 and CB-2 to trip and CB-3 to open. It would go to the battery if we had a loss of power into the UPS, and that's not what caused it to fail.

MR. ROSENTHAL: How do you know that? You said that you got a logic signal to CB-1, -2, and -3.

MR. CRANDALL: From the investigation with the operators and the things that I recorded when I went down there. There were indications locked on -- and it's in the

package; I can give you a little bit -- that tell us exactly what those alarms were, and we had standing in what's called a module trip, which is a signal that tells those breakers to trip, tells the UPS to go away.

MR. ROSENTHAL: Not necessarily at this meeting, but at some point, Frank's going to have to get into the details enough to confirm that.

MR. CRANDALL: Certainly.

MR. MACHILEK: Before we go into a failure mode of the system, maybe it would be educational for one of us to describe the system, how it should work, and how it was intended to work, and, of course, to everybody's surprise, it did not do so.

In its normal operation, the AC input, of course, is there. Also, the battery is there. Both sources, as you see on the connection between the converter and the inverter, simply running in parallel, are trying to provide power to the inverter. Now, which one of the two sources is contributing the band switch when it is there, and which one has the higher DC voltage at this particular moment?

If the AC input would go away, such as was the case when the transformer failed, the battery simply keeps supplying DC to the inverter, and the inverter would not know that anything happened, because the inverter cannot differentiate if the DC comes from the battery or comes from

the rectifier.

The intended operation was that the critical load on the output of the UPS would not have seen anything, either, because the inverter would have continued running, and, last, not least, that was the purpose of purchasing, installing the UPS, to achieve that.

In case of a difficulty -- let's say the UPS, due to an internal problem, decides to quit at an inopportune moment -- it would give a command to the input circuit breaker, CB-1; the battery breaker, CB-2; the output breaker, CB-3, to open, and simultaneously give a command to CB-4 and the static switch to conduct. The voltage on the output of an inverter does not suddenly cease; it decays. During that decay period, which needs only 120 microseconds, of course we can effect the transfer. Now, if the transfer conditions are not given -- in other words, if the frequency should be not matching, if the phase coincidence should not be within 7 degrees, or if the voltage would be more than 10 percent apart, our system would give a transfer-prevent signal, which means it says, No, you cannot go to bypass, because the bypass is not of sufficient quality to maintain the load.

If we would transfer out of synch, you would get a phase hop or a rapid frequency, with a slew rate which computer systems and electronic systems simply cannot take.

Since the critical load is so, no power is better than bad power; because, if you could accept bad power, you wouldn't have the UPS. Therefore we do not transfer to raw power if that power is not of sufficient quality to supply the load successfully.

This would be the normal operation of the system. If we go to the scenario which happened, we can only fall back on what was reported, which was that --

MR. FIRLIT: Before you go into that phase, I still want to understand the normal sequence, okay?

MR. MACHILEK: Okay.

MR. FIRLIT: You said, if I understand it correctly -- I just need to understand it -- that the system is designed so that, if you have a fault, you trip CB-1, you trip CB-2, and you open up CB-3.

MR. MACHILEK: You give a command, yes.

MR. FIRLIT: What is the purpose, then, of having that storage battery there, if you automatically take it out of the circuit?

MR. MACHILEK: No, no. This is only taking place if the UPS suffers an internal fault.

MR. CRANDALL: To protect the UPS.

MR. ROSENTHAL: The purpose of having a UPS at all is, if there is a loss at the bus, 575 volt, three-phase, external to the UPS, if that's a fault --

MR. MACHILEK: -- then the output is maintained.

MR. ROSENTHAL: -- then you'll go back onto a battery and support the output. That's the function of --

MR. MACHILEK: -- the function of the UPS.

MR. ROSENTHAL: In fact, the whole maintenance supply connection need not be to perform its primary function, but all of this stuff is provided they don't have an internal fault within the box.

MR. MACHILEK: Yes.

MR. ROSENTHAL: Frank Ashe tells me that it is common practice to have such an arrangement on non-1E buses such as this, providing computers et cetera, including the bypass.

MR. MACHILEK: Yes.

MR. ROSENTHAL: But on 1E uninterruptable power supplies, it's common practice to have a bypass, but that it be a manual bypass.

MR. ASHE: Frank Ashe, NRC.

I don't think that's quite what I was trying to convey. On the non-class-1E inverters, I think, a point here is being missed. That is, a UPS is intended as an uninterruptable power supply. That means it stays on line for whatever goes wrong, and it provides power. All this business about transfers and fast transfers -- I think the key issue that's being missed here is, you're trying to

continually power your downstream loads, regardless of what's going on upstream.

That's the bottom line. To get back to what Jack has stated, in this area of power plants this kind of design if in fact it works is considered desirable from an operational viewpoint because you always power the necessary controllers to keep you up or alive. If something is going wrong per se on the 575 AC three-phase input it won't reflect back down to the 208 and everything that is being powered on the 208 goes smoothly and in fact the plant continues to operate even though something is going wrong -- something may be going wrong in 575.

The point I'd like to correct, I don't believe I said it's common practice for Class 1E inverters not to have static transfer switches. Some Class 1E converters will in fact have static transfer switches but there are cases in which 1E converters do not have static transfer switches.

MR. SYLVIA: Is the part about the fact that that's out is due to a failure of the UPS itself correct?

MR. MACHILEK: No, sir. I was referring to a failure of the UPS such as the failure of the transformer, a failure of the basic mechanism of the box to perform its function.

MR. SYLVIA: But that's not true --

MR. MACHILEK: -- reason for the bypass --

MR. SYLVIA: Let me finish. Maybe I can get you to understand my question a little bit better. Seems to me if you're worried about some external problem you just disconnect and let the battery do it.

MR. CRANDALL: That we do. If there is a transient occurring on the AC input the unit is designed not to trip. It won't trip. There is no sensing actually in the unit for -- there is no trip sensing on the AC input.

It will sense if it is outside its parameters and it does just what you said. The charger will shut itself down and will go on batteries and it will sustain for however long it takes for that to come back.

Where we're talking the trip we are talking about a ground in the inverter section for example and we blow a fuse. We don't want to lose our output so we send a trip signal to the inverter to protect it at the same time we transfer to maintenance.

Another key thing that I wanted to just clarify that Rudy was talking about too though, it is true we don't want to lose the output but we have got to quantify loss.

To a computer system 105 volts, 100 volts is still a loss so in a case where we have a transient or some bad voltage on the maintenance supply we don't want to go to it because a bad voltage on the maintenance supply can actually do damage to the equipment we are protecting so therefore in

some cases it is better to lose it than to send something down there we don't want and damage it.

That is why that protection is there not to go there.

MR. SYLVIA: Thank you.

MR. McCORMICK: The line feed, main feed, normal feed I guess to each of these -- the alternate feed for example, if the normal feed is bus 001, is the alternate feed 003?

MR. CRANDALL: No. Not necessarily.

MR. McCORMICK: But it would be a feed that was affected by the --

MR. CRANDALL: Both were affected.

MR. McCORMICK: Both were affected by the same fault, by the initiating fault.

MR. CRANDALL: I can hand this out but we'll go into it later.

MR. McCORMICK: Well, if you're going into it later, but I just want to get on my mind that when we go looking at the alternate feed in some cases it is the same for at least the opposite bus, all of which would have been experiencing the same transient.

MR. CRANDALL: That's true and that isn't per se a factor because again we are saying that if that bus has bad voltage, transients or whatever not acceptable then we shut

down the charger and we go on DC anyway. We don't want to go main.

MR. LEWIS: My name is Warren Lewis. I wanted to make a comment.

One of the things that hasn't really been said clearly -- it's been kind of circled around -- is that when a UPS makes a transfer it makes a make before break transfer.

The two supplies, the maintenance supply and the inverter supply, are briefly bridged. Then one disconnects. It's a hand lock, so on that basis that's where you get the uninterruptible power system.

Now the comment that Rudy has made is you never want to make a handoff if the supply you are attempting to hand off is worse than the one that you are already on and that comment was made that on a bus, on a maintenance bus, experiencing a serious surge or something like this and you make a very fast subcycle transfer to it, it can damage your sensitive loads so it is better usually by decision to lose the loads than to damage them.

Now the question that came up is why do you have the input breaker tripping, the DC source breaker tripping, and the output breakers all tripping on UPS?

The answer to that is that's an unusual condition. The only time you would normally do something like that is

if someone as an example saw a UPS on fire and you push an emergency "off" button and then you disconnect the input and output so that the key here is you must also disconnect the DC because the DC could feed the fire if you had it or whatever the arc-ing is or the problem that you are dealing with.

Normally you never disconnect all breakers unless it is a catastrophe.

Now what you have got in this situation is the breakers being tripped and should not have been tripped int he quantity that they were tripped. In other words, why trip the DC? Because it got a signal that told it to trip that it probably shouldn't have gotten, so the name of the game here is they may have wanted to disconnect a bypass line or refused to go to a bypass line but there is no reason to disconnect all power unless something went wrong. That is the real understanding. The battery should have maintained the load unless it was disconnected and it is normally never disconnected unless there is some major problem or the fear is that the battery will feed energy to a fault that would then be self-sustaining until the battery depleted.

MR. McCORMICK: And there is logic within this device that will do that?

MR. LEWIS: Yes, sir, there is.

MR. McCORMICK: And we will be able to understand what it looks at in order to make that decision?

MR. LEWIS: Yes, sir.

MR. McCORMICK: And we will be able to understand what it looks at in order to make that decision?

MR. LEWIS: Yes.

MR. McCORMICK: You will be able to get through that.

MR. LEWIS: Yes, you will be able to see what logic commands would normally be developed to cause things to trip. You would also notice that there are things that will not cause things to trip but you can always generate a false signal if something goes wrong.

MR. CRANDALL: Why don't I do this, because we are at that point maybe. I don't have enough for everybody.

[Documents distributed.]

MR. CRANDALL: Certainly we can make more copies. I definitely would like Frank to have a copy of that.

On the very last page of this tells you what those trips are.

I am not intending to go through this. There's some things referenced in there that I think are good information to give you the basis.

So Attachment 6 are -- those are the trips that protect the UPS from that failure.

MR. McCORMICK: The trips.

MR. SYLVIA: Bob, do any of these cause the output to transfer to the maintenance supply?

MR. CRANDALL: Those are the things we are talking about. Every one of these will cause CB1 and CB2 to open, CB3 to --

MR. McCORMICK: They all do it?

MR. CRANDALL: -- CB1, CB2 to trip and CB 3 to open, every one of those. It will literally take the UPS out of service.

MR. McCORMICK: And prevent CB-4 from closing?

MR. CRANDALL: No. It put a permissive, a signal to tell CB4 to close.

In the scenario we have, our maintenance supply was out of spec so that permissive to allow CB4 to close wasn't received, okay?

You can consider it as two contacts in series if you will. One of them is the signal we have to close the contact to tell CB4 to close but if the contact isn't closed it says it's in spec, then it's not going to happen.

MR. McCORMICK: How much power will the static switch carry? That doesn't look to be interrupted by anything.

MR. CRANDALL: It's logically turned on and off. It is not in their --

MR. McCORMICK: So it's logically turned on, okay.
MR. CRANDALL: Sustained, it's a dated on and dated off -- yes?
MR. IBARRA: Jose Ibarra. That diode that we are seeing here downstream of the storage battery, was that good?
MR. CRANDALL: Yes. We have put UPS 1C in part of our testing. We removed the AC supply from it and put that unit on DC.
That unit is running at -- it's over 90 percent loaded and it handled that fine, without a problem.
Another thing I was going to hand out a little later and you can look at, during our startup testing we tested all of those things, timed all of those things and verified that all of that does work exactly the way we are describing it.
MR. FIRLIT: Are you going to be prepared today to tell us why the wiring circuits decided to trip BC1, CB2 and CB3?
MR. JULKA: Exide has something --
MR. CRANDALL: Right, but we are hoping to get to, work to that. With not having this understanding it's hard to really even discuss it.
MR. JULKA: Do you want to go through that at this point?

MR. FIRLIT: No. Continue on. I just want to make sure that -- I don't know understand why all three of those -- he explained, you know, why it's designed that way and the example of the fire was a good example but I'd still like to know what inside there told all three breakers to trip because normally you would think that you just took out the storage battery as one alternative power supply if you did that.

MR. CRANDALL: I guess the question I would like ask at this point before we actually broach that, it's clear or is it clear to everyone how the mechanism of the trip works, not how it worked in the case we had but any of those will send the trip and how that works. We lose both breakers and we attempt to go -- that's clear, correct, so when we start getting into the scenario type we don't lose everybody.

MR. ROSENTHAL: And you just repeat again why you believe that CB1, 2, and 3 were given a demand signal to open by the logic as distinct from an overcurrent condition or something else existing. What is the bases for that statement?

MR. CRANDALL: And that's what we are going to get into. We had a module trip alarm and in that report I gave you it tells you exactly what we found on those units. I wasn't intending to go through that but you can read that

later.

It tells you all the alarms we got. The units had a module trip on, which says when you have a module trip that is the initiation to trip the unit. CB1, CG1 trip, CB3 opens.

We had that alarm so we know we got a trip of the unit. We don't know from where.

MR. ROSENTHAL: And some time Tuesday morning people went down all five UPS's, observed a module trip alarm and reported it back to the TSC or the EOF where people were collecting this sort of information.

MR. CRANDALL: We found when we went down to recover the unit found that alarm on four units -- one unit did not have it. That one unit is the unit that operations tried to recover. We have separate operators and it is their belief that alarm, and I say this guardedly, probably was there. We do not have one who can say absolutely that alarm, that module trip alarm, was there.

MR. ROSENTHAL: On which one?

MR. CRANDALL: On 1D, which the one they tried to recover. It is the normal practice that as you attempt to recover that, you reset those alarms though, so we have a pretty comfortable feeling that that was there and based on the other four, it's --

MR. SYLVIA: Bob, I've got a question about the

design logic.

You all have explained how we were conducting this maintenance supply -- what I don't understand is if this is going down, something is going down in the environment and you have to close in this maintenance supply to the output to bypass all of that, why do you have such stringent synchronization requirements? You know that's going down already.

MR. CRANDALL: Again, you can only put it in perspective, I guess.

Let me do this and again this is just as a reference, not to get all totally in.

This is our startup test and when you start -- just look at the last page or next to last and I don't think you can understand that until you can get a concept of the speed that we are talking about where Amil said six cycles, which is a blink of an eye. Nobody knows anything happened. That is an eternity to a UPS. Look at the -- let's see, I'll pick the worst case -- the very last page of this.

This is a trace. I apologize again. I don't have a lot on me.

What this is and what we did with this particular unit during startup, this is fully loaded 100 percent. We loaded the AC breaker. We then opened the DC breaker and what you are seeing here in the middle here, now each line

is one millisecond, all right? That is 1000th of a second.

You are seeing the transfer, you are seeing the output of the UPS go away, the static switch gate on and go on maintenance, so I think from that you can get an idea what I am talking about.

This thing is absolutely perfectly in sync absolute. I mean it's dead nuts-on so that the output doesn't even know anything happened.

MR. SYLVIA: It's so fast it can detect something going wrong as still check synchronization before it trips in.

MR. CRANDALL: Yes, before the output really goes anywhere where it would cause any problem at all. It has already detected that little bit of going down before it is actually --

MR. SYLVIA: And the speed with which it works, that makes sense.

MR. CRANDALL: Just to correct a little of what you said, the check to go to maintenance is a continuous, so it's not a case of it checks it. It is either there or isn't kind of is what I am saying. If it is not there it won't go. If it is there, it will.

MR. McCORMICK: But if maintenance and normal are going bad together, there has to be a second level. They are both going down together. They could be in sync together

failing but now there has to be a second level check to say that I want to go anyway --

MR. CRANDALL: Except I want to qualify that too. If maintenance and AC are going bad the unit should go on DC. See, what we have or would appear to have is we had -- and I am just doing this for illustration, this is not what we had
-- if you have two failures at the same time, which the theory is it's not going to happen that the UPS has a bus fault in it at the same time the maintenance goes, then you lose it, we don't try to protect against something like that. You would -- the theory is that if something is going wrong in the UPS you don't have a simultaneous failure on your maintenance. It will protect it against simultaneous problems on the AC because it is making an assumption that everything is working in the UPS.

MR. McCORMICK: DC should have just fed in as we said?

MR. CRANDALL: Yes. The phenomenon that we had was that we got initiation from the fault. We know it is from the transformer. We got an initiation into the logic of the UPS that told it something was wrong and tripped.

MR. MACHILEK: Bob, may I make a suggestion?

MR. CRANDALL: Yes.

MR. MACHILEK: The presence of the bypass, the

static switch in the bypass breaker, really had no bearing on any of the happenings during the incident.

In judging what happened we can disregard that the static switch in the bypass breaker is even there.

These two elements are only there if there is a physical breakdown of a component within the UPS such if your car breaks, if your transmission breaks, it doesn't go nowhere. In this period you know we are talking about a failure of the UPS.

Normally -- let's assume for a moment that the static switch in the bypass breaker CB4 would not be there and we go into the scenario of the transformer fault or what should have happened is that AC to DC converter would have phased bad which means it would have controlled itself not to accept that input because it was no good. It would have, seems to have put out DC, and the battery simply would have taken over and then would have kept running.

You would as of today not even know that there was a transformer fault, okay? There was no reason to transfer. There was no reason to do anything whatsoever now.

We have to look now what happened to the UPS equipment. Something within the equipment broke, to put it bluntly, okay? Not physically apart mechanically but seems to work. If that happens we are giving a command to the UPS module to switch itself off from all power, input, output

and battery. That means that we say any power present within the box, within the confinement of the UPS the equipment would be or could be dangerous, cause a fire for instance or maintain one or if a fuse blows within the switching of the circuitry of course you have to shut down because in a sense you would short circuit the battery internally, okay?

There are many reasons for doing that.

What happened is exactly that. That means the AC input went away. Normally the UPS would have gone on battery, except internally a fault occurred which prevented the continuation of operation of the UPS equipment

Unfortunately at the same time the bypass was not there so we could not transfer to it but that is really academic.

MR. CONWAY: Rudi, when you use the term "a fault internal" you mean some kind of a malfunction?

MR. MACHILEK: Some kind of --

MR. CONWAY: Some kind of interruption, not necessarily an electrical fault.

MR. MACHILEK: A malfunction. Let's say if the logic for instance now quits to do what it is supposed to do, then of course you lose the brain of the whole thing and it shuts down on you, okay?

MR. ROSENTHAL: With normal design operations, if my input is 575, three-phase and I drop to 10 percent

voltage for a few cycles, and then restore on the input, what would I expect to happen?

MR. MACHILEK: You would have to drop it further than that, because our normal operating range is plus 10, minus 15 percent. If you dropped the input voltage below 15 percent, then the charge at the rectifier would phase back -- it means it would no longer accept your power and quit to operate -- which causes the output of the rectifier to go to zero, but this doesn't matter, because the battery would supply power to the inverter and simply continues maintaining the output power from the inverter.

MR. FIRLIT: In that case, you're saying that the battery power from the storage batteries would take precedence over the maintenance voltage?

MR. CRANDALL: Yes.

MR. MACHILEK: Oh, yes, definitely. Please consider for a moment that there is no maintenance circuit at all. The maintenance circuit is what it says it should be: to be used for maintenance. That means, if you want to work on the equipment, if you want to have preventative maintenance or whatever, you would go to the maintenance bypass. Under normal operation, you only go to maintenance bypass if you have a physical breakdown of the UPS equipment as such.

MR. LEWIS: This is Warren Lewis.

Or, if you have lost the rectifier input to the UPS, you're running on batteries, and then the battery gets depleted. Rather than shutting the inverter down, you then go to the maintenance bypass, because that keeps your loads up.

You could, for example, have a burned out breaker on the input to the rectifier, which then would not affect the maintenance bypass line but would deplete the battery. So, at the end of the battery period, at some point when the battery voltage goes down, you make a maintenance transformer to keep the loads up -- transfer.

MR. SYLVIA: When we were talking about this synchronization circuit, did I hear someone say that the design concept was that, if you couldn't maintain this high quality of voltage, you would be better off not to have any?

MR. CRANDALL: Yes. That's the theory behind it. That's why -- I guess you could say there is a number of theories. One is the transfer itself, also, so that you don't transfer out of phase and actually send one heck of a shot; but a lot of the equipment we're protecting we don't want to send low voltage to, or any type of transient as well.

Computer systems don't do real well with transients, for example.

MR. LEWIS: This is Warren Lewis again.

One of the reasons the tight synchronization is maintained is that, again, if you initiate a static transfer, it's make before break. If you were 90 degrees out of phase and initiated a make-before-break transfer, that would vaporize the static switch, and everything would go down. That's the reason that's done.

MR. SYLVIA: And all of it's based on the idea that, if you can't maintain the quality, you're better off with -- If you can't maintain this high quality of UPS supply, you're better off to trip the unit.

MR. CRANDALL: Yes. And if the maintenance supply still has that acceptable quality, it will put it to that. If it doesn't, it won't.

MR. LEWIS: It's not quite like that. What is really happening here is that the inverter and DC operation is not only preserving continuity of power, which is where the name "uninterruptable power source" comes from, but it is also providing power of very high quality, because it is buffering the load from disturbances on the AC line. Now, if the idea is that, if you can't maintain pure power and it would therefore be better to lose the loads, by logical extension you would say we would have no maintenance bypass, because a maintenance bypass would by definition be of less quality than an inverter. It's not an iron-clad rule.

The rule is that the bypass line will be excellent

power for computer loads, except statistically it will have disturbances on it. Therefore, the name of the game is, what are the odds that you would have a UPS inverter failure that would force you to the maintenance bypass at the same time statistically the maintenance bypass would have poor quality power. That's kind of low probability. The idea is that you do force the transfer; the UPS goes down; allow your critical loads to operate on what might be referred to as raw utility power -- on the statistical basis that you're not going to take disturbances on that line for the brief period of time that you may be doing this.

If you're concerned about that then people go to redundant operations, where they have a second UPS to feed the maintenance backup line, so you're transferring between UPS's.

And it gets worse than that, but you don't want to get into that.

MR. McCORMICK: Have we talked about this so-called regulator here? Does this have a factor in it at all? I see a transformer to regulator on the maintenance supply.

MR. CRANDALL: In this particular case, we don't feel it does.

MR. ROSENTHAL: Except as we may get into the issue of tracing ground faults.

MR. CRANDALL: Yes. The ground itself going through there, it may be, but where we're talking quality of power and those kinds of things, I don't think it's an issue.

MR. McCORMICK: Can we go off the record for a second?

[Discussion off the record.]

MR. ROSENTHAL: Without going into the detailed maintenance history and prior events, et cetera, have there been situations in which AC power to the UPS was lost and the UPS went on DC as designed?

MR. CRANDALL: Oh, many times. Our loss-of-power tests.

MR. ROSENTHAL: When was the last time? Do you have a feel for it? A few months ago? Years ago?

MR. CRANDALL: He's saying the last time we actually lost AC power to one of the buses.

MR. FIRLIT: When was the last time we lost offsite power? We had that in Boltman.

VOICE: That didn't affect us.

MR. CONWAY: When was the last time you opened CB-1?

VOICE: I haven't done that before.

MR. CRANDALL: I can't come up with a time.

MR. ROSENTHAL: Okay.

MR. CRANDALL: It's not a singular event, I guess, is the best way I can describe that, though. There have been multiple times where we've lost a bus for one reason or another. They have also at times administratively put them on DC because they were going to do an evolution in the plant that they felt they wanted them on DC for.

MR. ROSENTHAL: Okay.

MR. CRANDALL: We have confidence in the DC part of that.

MR. ROSENTHAL: I want to wrap before we get into the logic.

I'm understanding that the ground straps, ground fault, some grounding-related activity was done within the last year, two years?

MR. CRANDALL: Yes.

MR. ROSENTHAL: I'm thinking in terms of change analysis from the last it was tried until now.

MR. CRANDALL: Each unit -- and I'm going to take exception to 1H, because 1H was installed exactly the way the vendor sent it to us, and it was installed grounded. The other nine units all came in grounded. VAE, which was Stone & Webster at that time, specified that they would be ungrounded, and that's the way the installation draws them for. We removed the grounds from those nine units as part of the installation and ran that way until -- I can get

dates -- about a year ago.

MR. FIRLIT: Stone & Webster recommended that we remove the grounds when the manufacturer had recommended that we ground that equipment?

MR. CRANDALL: Yes. The specification was actually out as "shall be ungrounded."

MR. FIRLIT: But something much have reversed that decision later that said, No, go back and ground it. Is that correct?

MR. CRANDALL: From what we were seeing from failures in the field, we were seeing hits on the computer and unexplained things. We had problems with maintainability and that electricians would go out and read voltages and panels, and they would read 30 volts to ground and 20 volts to ground and open a circuit, thinking there was bad voltage there, when in actuality we had problems with references. We were also concerned someone could go in a panel and read no voltage to ground and get across it and get hurt.

MR. FIRLIT: If I was to go to another nuclear power plant that has this equipment -- and I hope we're not the only one in the United States that has this equipment -- would I find their system grounded or ungrounded?

MR. CRANDALL: Most I talked to are grounded. When engineering went into this, we asked the question --

system engineering -- because of the inconsistencies. We were seeing some logic types of things that were not explainable, that appeared to be some noise types of things, on the loads as well as the UPS systems. When engineering got with the vendors, it's my understanding they got the word. In my talking to them, both Elgar and Exide said, What do you mean you're running ungrounded? Why? So it was their recommendations to put those grounds back on. What we saw was a lot more stable units from that.

MR. FIRLIT: Are we going to also find out today whether or not any other nuclear power plant in the United States has ever had failures of the UPS systems? If they did, has this information ever been transmitted to the other users of the Exide system?

MR. CRANDALL: We know that at Yankee Rowe they had a similar event. We haven't been able -- They have had a problem. We have not been able to tie it together. We're still looking at a lot of that. We have some things out on Notepad.

Before I answer your question, I'd like Warren to answer the question on grounding, because he is here because he is a grounding expert.

MR. LEWIS: Warren Lewis.

Because this is a generating station, an electrical utility, the National Electrical Code contains

with it an exemption for conductors and things that are under the exclusive controls of utilities. In a way, perhaps, somebody could say that they could choose in some cases to not follow the National Electrical Code, and there may be some argument that could be raised to say, Well, we don't want to do it that way, but, in order to not follow the National Electrical Code, which is a safety-based document, one would have to have one hell of a good argument to want to do it a different way.

Having said that, let me mention that the grounding issue that we're talking about here is thoroughly and accurately covered in the National Electrical Code. There are two sections which are offered within the code, section 250-5 and section 250-26. The first one I mentioned describes AC systems required to be grounded, and the second one describes the methods of grounding for systems which are to be grounded.

What you're dealing with here is an inverter output and a maintenance bypass, a 208-volt Y-120 volts. Both of these systems, because they have a neutral involved, or a midpoint, if you want to think of it that way, or common -- if you ground that neutral -- and ground by definition in this case is to connect a conductor between that terminal and the metal framing closure of the equipment, making it common to the green-wire safety

grounding system, and also running a connection to building structural steel and an earth-grounding mat kind of thing for a grounding electrode -- that kind of constitutes the term grounding. If you do ground that neutral terminal, you then limit the voltage from any phase to ground to 150 volts or less on a 208-volt Y. The NEC is structured to state that it is mandatory that any circuit that can be grounded to limit its voltage to 150 volts or less to ground must be solidly grounded -- i.e., not with a resistor, not with an inductor, but with a solid strap. We do have a grounding requirement.

I'm stressing because the manufacturer, Exide, provided the equipment in conformance with the National Electrical Code by providing the equipment in grounded fashion, with its Y output grounded. Then the equipment was installed, and the strap was removed, and the bypass circuit was not grounded, so you had the bypass and the inverter floating.

Now, in the NEC, the purpose for this grounding is described up in the early sections, the 90 sections, of the code -- pardon me: section 250. The purpose of grounding is to limit the voltage to ground between any conductor and, in the case of a phase or line being shorted to ground, to allow current to flow through the fault of sufficient magnitude to trip the old current device in a prompt

fashion.

Now, if the floating system had been installed and you had experienced a short circuit from a phased frame, there would have been no circuit breaker trip; there would have been no fuse blow. Instead, you would have had the whole AC system go up in voltage on the neutral point, and then you would then have a dangerous situation as defined by the National Electrical Code.

Also, if you had a floating AC system, you have a system which is in fact grounded by stray reactances, meaning the capacitance of the wiring through the system to the metal conduit, as an example, and then the inductances of all the wiring in the conduit. What happens under these conditions, with these small amounts of reactances: If you get any kind of electrical disturbance -- some non-sinusoidal impulse, something hits it -- they will oscillate and ring and create disturbances between any line and ground and neutral and ground.

Now, electronic loads are quite sensitive to noise of this type on the lines, so it is quite reasonable that you had unreliable operation of your sensitive loads.

In addition to that, the manufacturers of the load equipment almost universally -- and definitely if the load equipment is listed by a product safety laboratory such as UL -- have designed the equipment to only operate properly

if it's looking back into a correctly National Electrical Code-grounded input power circuit. Therefore, if the power circuit feeding the load equipment does not meet the NEC -- i.e., for grounding or whatever, the load equipment is not operating within its design parameters -- it should therefore be considered to be subject to unreliability.

If this line voltage to ground is not controlled and it becomes high because of a lightning impulse of something that sights this, you can get voltage breakdowns, things like this which are quite dangerous.

You do have the requirement to ground, which is why I found it amazing that the grounding was eliminated during the initial installation. Now, having decided to ground in order to meet the code, there's a basic decision that has to be made. You have two Y sources: you have the bypass sources and you have the inverter source. Now, which one shall you choose to ground?

The National Electrical Code does not give you advice in this matter, because it is not a safety question as to which you choose to ground, but it is normal practice in the industry to ground the AC supply that is designated as the prime supply for the sensitive load. This is the basic reason you will find that the Exide equipment came in with the grounding strap installed: it was to minimize the voltage difference that could appear during normal

operation -- and I stress the words "normal operation" -- between neutral and ground on the inverter output.

Now, that means that the bypass supply would normally be the supply elected to be not jumpered to ground, but it doesn't mean the bypass supply is ungrounded, because you have a four-wire Y in each case, and the neutrals are not switched. Therefore, the neutrals are brought together. They take the Y from the bypass and the Y from the inverter and physically tie the two neutral conductors together by a solid connection. That's called a solidly interconnected AC system.

On that solid interconnection, the inverter is normally the neutral terminal that gets grounded, so the bypass supply sees its ground by looking at the ground on the inverter winding. What we now have installed here is the opposite. We have a situation where the loads see their ground normally by looking at the bypass transformer ground, but the normal operation of the system is on the inverter, so it would be considered normal or recommended practice -- say, IEEE-recommended practice, for example -- to exchange power between the sensitive loads and the inverter with the inverter being the grounded source. Then, in a maintenance bypass operation, this being considered an abnormal operation of short time period, to then allow the system to operate on the maintenance bypass and seek ground back to

the inverter point.

There were two things that have occurred here that have some bearing on your problem: the initial decision to remove the grounding and operate ungrounded, which was strange and didn't conform with the code, and then the second decision, which was basically correct, to ground, but, for reason of judgement -- which I do not understand -- someone chose what would be the nonstandard system to ground out of the two systems.

If you have some questions, I'd be glad to try to answer them.

MR. CRANDALL: That's how it came from Exide --

MR. SYLVIA: So when we grounded it, we didn't ground it like it was grounded when they came from the manufacturer.

MR. CRANDALL: Yes, we did. We grounded it just like it was. We re-grounded it as it was.

MR. SYLVIA: So that your question about why was it grounded this way goes back to the manufacturer then.

MR. LEWIS: My understanding is that by physical inspection I see the bypass transformer is the one grounded from its neutral to ground. I can't say that I saw a grounding jumper in the Exide unit from the Exide neutral to ground.

MR. SYLVIA: Are you saying that we didn't ground

it like it probably came from the factory?

MR. CRANDALL: Well, my understanding is that --

MR. MACHILEK: I have to inject here, please, for reasons of proprietary information that is supposed to come from. The equipment was ordered by specifications to be ungrounded. I have the specification with me if you want to observe it.

MR. CRANDALL: That is correct. They came ungrounded --

MR. MACHILEK: It was not shipped by the factory contrary to --

MR. LEWIS: I will withdraw my comments on that because I was operating on the basis of what I heard yesterday and what I know is the normal practice for the company but I was not aware of the special order.

MR. SYLVIA: Let me make sure I am clear now, okay? We ordered it ungrounded but it actually came into the plant grounded?

MR. CRANDALL: That's not what he just said.

MR. MACHILEK: It was ordered ungrounded. It was shipped and delivered ungrounded but the installer should have, would have had to ground it in order to meet the electrical requirements.

MR. CRANDALL: Let me rephrase it. What he is saying is correct but what we are saying is correct too and

maybe I need to qualify that.

The maintenance supply that was purchased through Exide was not Exide's. It's Heavy Duty. The equipment came in grounded through Heavy Duty's equipment so he's right.

Exide sent it as specified, meaning the UPS was ungrounded. The ground was in the heavy duty equipment. We lifted that but the one thing I want to go with here is -- and the only reason I wanted Warren to come back in, we have confidence that the ground itself is correct, that it needs to be grounded. We don't in any way, shape or form feel that that is a problem that we even want to address to remove it because that is worse because of the problems that we get in through our loads downstream.

Any filtering that is on those loads would not work if we removed that ground.

I just want you to know that we have done something --

MR. JULKA: There was a question I think we meant to Dr. Warren separately but the way we have grounded it, it was done on a modification in '88 time frame.

The way we have grounded it is the way I think 90 percent of the nuclear plants in the U.S. have those grounded. I think we need to talk separately about the grounding practices but it's no different than any other plant.

MR. SYLVIA: I want to understand what Warren said. He also said that normally the inverter circuit should be grounded and the maintenance supply should be grounded and they should be connected between the two.

MR. LEWIS: No, that's not correct. If I understand your question, you never ground both AC systems that you are going to connect on a UPS. You only ground one system. The word "ground" means in this case to take the neutral terminal and place a jumper between it and building steel, framework, things like this.

You only have one jumper that you are allowed to put in so you have to choose the AC system to place the jumper in.

It's IEEE recommended practice and normal practice in the industry to place the jumper in the inverter supply as opposed to place the jumper in the bypass supply but remember both neutrals are tied together by a splice so the neutrals are made common.

If you visualize two Y's common on the neutral, we're simply saying where do you place the jumper, in the supply A or supply B? We always choose the supply which is the inverter because that would be normal operation and the idea would be to minimize voltage difference between ground an neutral during normal operation.

This installation appears to have the jumper in

the maintenance bypass transformer as opposed to the inverter.

MR. FIRLIT: But there is a hard wire line between the neutral of the inverter to the neutral of the maintenance supply and the maintenance supply neutral is the one that's grounded?

MR. LEWIS: That's my understanding.

MR. FIRLIT: Okay. I didn't understand that, okay.

MR. SYLVIA: Is that a significant fact as to which one you ground as long as the neutrals are tied together?

MR. LEWIS: It's a significant fact if you ask the question does it have to do with continuity of power questions or quality of power questions.

If it is the former, for continuity of power, it is of negligible concern. If it is for quality of power it is of significant concern because if you use a power line analyzer to look at power quality to compare it to what electronic loads will tolerate or not tolerate, you find again if you are on whichever supply is the one grounded will have the least noise and disturbance on it while you are connected to it, so the idea is to have the inverter to be the best power quality so you ground it, and you look at it with the analyzer and it looks good but the bypass line,

when you transfer to it, will then on occasion have a little more noise but people tend to accept that, that it would not be a good idea to have the bypass line with a good ground to neutral noise situation with the inverter to have a poor neutral to ground noise because 99.9 percent of the time your computer would not get the quality of power it desires.

MR. SYLVIA: So that doesn't have anything to do with tripping off the end.

MR. LEWIS: I hesitate to say it does not because the B phase as I understand it did involve ground fault which therefore did involve the injection of current into the safety building, grounding system. Therefore any connection into that grounding system could be viewed as a noise injection or return point and it could have a bearing but I can't say it did.

MR. SYLVIA: Any grounding could but not necessarily how we grounded it, is that right?

MR. LEWIS: I understand that question. Let me put it this way. Since we are at a disadvantage that we could not reconstruct this problem by restoring the plant and then going out and grounding Phase B again to see what happens, it could have been that if the inverter had been the grounded supply that the event might not have caused this.

On the other hand, it might have had no bearing on

it but by experience I think you would have had less opportunity for a problem of any kind of this nature if the ground had been in the inverter, but I would not be prepared to say definitely.

MR. SYLVIA: Then the question I have is do we have any idea why Stone & Webster specified ungrounded system.

MR. CRANDALL: Nothing I can come up with from any of the documentation. You know, nothing written down. Our verbal communications to Boston were that they wanted to limit the ground current or any potential for ground current on a load-related fault from being reflected back to the UPS?

MR. FIRLIT: If you took both units and you grounded both of them, okay, because the grounds may be physically different from the standpoint that they may not be grounded at the same reference, then I could see why there would be a difference but if you are hard wired from one system over the other system electrically it doesn't know really where it is grounded. It's grounded, so you really are tying physically the two systems together with a ground.

There is where I have trouble understanding why one would be different from the other in terms of a reference. They are both grounded.

If you are saying because I have a hard wire and that wire is 50 foot long or 100 foot long and I've got some losses from that ground to the other -- you know, I am having trouble understanding if they are hard-wired why that reference. To me it doesn't make any difference whether you are in the cabin or the other one.

MR. LEWIS: I do understand your question.

The situation is such that with a heavy conductor connecting the two together and having limited length, say 10 or 15 feet, you can stand there and see the two supplies nearly adjacent to one another, so the question is what difference does it make if you have the ground at one end of the heavy conductor or at the other?

It makes very little difference from a safety standpoint, which is why the national electrical code provides no information in that area.

The safety situation is such that you are dealing with high currents at low frequencies. You are dealing at the fundamental power frequency and some harmonics thereof.

The impedance of the wire, which is what the electrical code, it's only value if you will is very low at the power frequency and fundamentals thereof, so 10 or 15 feet worth of heavy wire makes no difference.

On the other hand, if you begin to deal in terms of impulses, i.e., noise, electrical noise which affects

electronic equipment and causes it to malfunction, you are then talking about disturbances in the hundreds of kilohertz into the megahertz range.

In these frequencies wires in excess of several inches long become significant. One can develop very large voltage drops on impulse conditions from one end to the other of a wire due not to its resistance but its inductance.

The length of the wire has a tremendous effect upon the inductance of the wire which is a magnetic function. Therefore we try to minimize the inductive reactance in the wire and the reason for this is because from an electronic standpoint we are worried about developing impulses due to the LDI over DT effect. The fast rates of current change on inductance produce big transient voltages so you could have large impulse voltages just by having one ground as opposed to the other ground.

The question is do you want those impulses which will occur to occur during normal operation on the inverter or to take the chance that they are not going to get you when you are on the bypass temporarily.

MR. CRANDALL: I'd like to interject. I'm not questioning anything Warren's saying -- it's all legitimate -- but I think we're splitting some hairs of how much effect. What I would suggest is that, yes, maybe we can

look at how much this might have affected it one way or the other and whether. What I'd like to do is go on more with where we might have been hit by some of those things, if we can. I understand how everybody is trying to understand.

MR. IBARRA: Just one question: When are we going to know for sure how it's grounded? Can we determine that right away?

MR. JULKA: It is grounded at the transformer on the drawings.

MR. IBARRA: Okay.

MR. LEWIS: I got on the floor and looked down there and saw the wire going up into the transformer, but I didn't take the cover off.

MR. CRANDALL: The 5 Exides are grounded at the maintenance supply transformer. The 3-series is grounded at the maintenance supply transformer. The 2-series are grounded on the output of the UPS.

MR. FIRLIT: I appreciate your comment, but, by the same token, we don't know what really caused that logic to lock out CB-1, CB-2, and CB-3, and I think we ought to pull that thread until we find out an answer, because what we're going to get involved with later on is what Stone & Webster recommended in terms of ungrounded systems and why we grounded on the other system when that's not the preferred way to ground. I think those are salient points

that have to be brought out, and they've just got to be discussed here.

MR. CRANDALL: I'm not questioning whether they should be brought out. I'm just wondering whether we need to get into the design differences and all of that in order to totally understand. That's what I was questioning.

MR. MACHILEK: Please let me make one more comment so not to create the wrong impression that Stone & Webster may have done something wrong. The method of grounding which my colleague, Warren, is describing here is only valid if you have one transformer solely operating one UPS. If you have one building input transformer which is supplying four or five UPS systems then obviously you cannot ground at the UPS systems points, because it would generate more different grounds.

Therefore, the safe way to specify grounding if you don't know what the systems are going to look like is to specify ungrounded UPS, for the sole reason that you can ground at the UPS, if it's appropriate, and you do not ground if it's not appropriate, such as if you have more than one UPS system working off the same transformer or if you have essential loads which require a grounding of the transformer on the building entrance at other sections of the electrical code.

I'm just saying that, from Stone & Webster's point

of view, which are systems designers', the safe way would be to order the equipment ungrounded and leave it up to the installer or the systems engineer who is responsible for the actual system then to decide whether to do it.

MR. LEWIS: Let me make a comment that I agree with Rudi on what he has said. I avoided getting into a discussion of the various ways of grounding based upon exceptions and if you have this and if you have that. I wanted to only address myself to what you have here.

The key to understanding -- Rudi is correct -- is that there are many times when the National Electrical Code would require what we call the maintenance source to be the grounded source and the inverter to be the one connected to it, but that was not what you had here. The thing that I would say is that the electrical installer follows the blue-line drawings. If the blue-line drawings do not show instructions to ground and a grounding symbol and a wire size and so on and so forth, he isn't going to add a ground wire where he was not instructed to install one.

It really goes back to the drawing that the installers followed. If the drawing showed no ground symbol, then the question is, who prepared the drawing, who approved the drawing, and what was their reasoning process for rejecting the National Electrical Code at that point.

MR. TSOMBARIS: This is Steve Tsombaris, from

Stone & Webster.

If I may interject one thing: As Bob described, there was an EDCRS that shows how the system is grounded today, and it was in that configuration that the system was grounded when the disturbance occurred. As a result of the disturbance, we observed certain things, including a module trip.

Two things, basically, happened. One thing that we noticed was that we lost voltage on phase B as a result of the dip. We know on the other two phases the voltage stayed pretty much what it was prior to the fault. We also know that, during a ground fault, arcs may be present, and we know that there will be ground faults into the ground grade. It's likely that a combination of the voltage dip or some ground currents could cause the unit to malfunction, resulting in a trip, the unit shutting down.

Knowing what the grounding system was, knowing what the voltage was, given those two things, I think we can now go ahead and try to evaluate how these changes in the system affect the UPS. I think, talking about grounding and how it could be or how it was ordered or whether the grounding that is recommended by NEC for getting good-quality power during normal operation as opposed to during a disturbance -- that's various scenarios that may or may not be applicable, or may be studied, but later on.

I think Exide could probably look in terms of the unit and tell us how the disturbance would affect the logic. Having that as a starting point, we can go ahead and exhaust the possibilities that could be present and, hopefully, lead to a logical conclusion as to what happened.

MR. CRANDALL: Can you go at this point into the differences between the Exide and the Elgar.

MR. TSOMBARIS: One of the things --

MR. SYLVIA: Along the lines of the point you're making, we want to be as thorough as possible, and we just don't want to take any chances. Many of us are hearing this for the first time; we don't know as much as you know. You'll just have to have some patience with us.

MR. TSOMBARIS: Absolutely. What I was saying is that I heard a lot of talking about grounding, and I think Bob can demonstrate how the system was grounded, so we can then attack our problem the way it's grounded. The fact that ten years ago it was other than ground is not relevant today.

There were some reasons for it, but I'm not in a position to discuss it at this point.

What Bob has asked me to do: One of the things we did was look at the difference between the UPS's made by Elgar and the UPS's made by Exide, which were supplied normal power from the same buses. I have a few sketches to

pass out.

[Documents distributed.]

MR. McCORMICK: Are you comfortable proceeding as we're going?

MR. ROSENTHAL: The original intent of introducing the grounding thing was just to set up the thing that's done, to do what's called a change analysis. You knew it was working at one time, and then the plant has been modified, or the equipment was modified subsequently, so we know that it would be -- Were there other modifications to the UPS in the last two years?

MR. CRANDALL: No.

MR. ROSENTHAL: No. Okay. Then you'll be able to provide some experience. Let's restrict those hopes to maybe the last two years.

MR. CRANDALL: The point we're making with the grounding may be viable. What we're trying to do is see if it has an effect, and then we'll look and see if maybe the change contributed to this.

MR. ROSENTHAL: There weren't any substantive changes?

MR. CRANDALL: No.

MR. McCORMICK: We'll be able to document, by virtue of mod paper, what we did to return this system to a grounded state when that was done in '89 or at the last

refueling outage, so we'll have that mod paper, where it was put in, and so forth, to document it.

MR. CRANDALL: You have that right, Frank? Or do you need that?

MR. IBARRA: Jose Ibarra.

That's just what you provided, right?

MR. CRANDALL: Yes. I think you've already -- If not, I'll get it for you. Let me know if you need it.

MR. McCORMICK: I have a bit of housekeeping, one item. We have a new expert in the room; Dr. Chang Chiu has arrived, and I just wanted to introduce him and indicate that he will be part of the discussion from here on.

Also, Richard Hackman of failure prevention.

Now, Exide, do you have anything more that you want to bring to the discussion of the relays and the breakers? I just don't want to get off on this path until Exide finishes their presentation.

MR. CRANDALL: Marty, part of the analysis we're going through with Exide, though, I think might only make sense if you see the difference. We're not saying extensively, but --

MR. ROSENTHAL: How much time do you want?

MR. CRANDALL: Let me put it this way: We're looking at how grounding can affect the logic of the Exide, and we have found an isolation of the grounding for the

Elgar units. We just think that should be on the table first, because that is a definite difference.

MR. McCORMICK: All right. Let's introduce that difference, and then we'll move back to Exide.

MR. TSOMBARIS: This is the Elgar unit, and this is the Exide unit.

[Documents distributed.]

MR. McCORMICK: This is the Elgar you just passed out, and that's the Exide.

This is Exide coming through now.

MR. TSOMBARIS: There is a note at the bottom of the page.

MR. McCORMICK: Okay.

MR. TSOMBARIS: Trying to see what would cause all those breakers to open, we thought perhaps the logic that controls all those things may be the source of the problem. I think we mentioned that before. We looked at the power supply that drives the logic on the Elgar units and the Exide units.

If you were to look at the first sketch, that serves the Elgar unit, you would notice at the breaker CB-1 there is a tap there that goes to power supply, and that goes to the rectifier logic. Then, right after the battery, there is another power supply, which is a DC-to-DC power supply, which goes to the inverter logic. That's

highlighted with yellow here.

Now, all the other components are basically the same in the three units, except that DC-to-DC power supply -- The Elgar unit has a DC-to-DC power supply that feeds the inverter logic, while the Exide unit has an AC-to-AC power supply unit that feeds the same logic. This feed comes upstream from breaker CB-4.

I have another highlighted that shows CB-4. Here is the bypass source. There is a tap here that Exide uses to pick up control power for the inverter unit. Now, the control power eventually is plus or minus 20 volts DC. The AC is converted to plus or minus 20 volts DC. On the Elgar unit, the 125 volt DC is converted to 25 volts DC. Actually, they have a couple other voltages, lower, for different functions.

That is a difference. What that difference says is that, on the Elgar unit, there is no connection between the AC system and the power supply that feeds the inverter logic.

MR. CRANDALL: So the logic would not be affected by disturbances on the AC.

MR. TSOMBARIS: By the disturbance.

MR. CRANDALL: Thank you.

MR. TSOMBARIS: At this point I would like to turn it over to Rudi, who could then --

MR. CRANDALL: Can I just make one comment?

The Exide unit being off of the AC, it could be affected by that AC disturbance.

MR. TSOMBARIS: Well, originally, yes.

MR. McCORMICK: It also looks as though the supply is taken off the bypass source, which is the source that's grounded.

MR. CRANDALL: Exactly. Correct.

MR. McCORMICK: So the ground that we were talking about earlier is on the bypass source.

MR. CRANDALL: And prior to CB-4, so it doesn't matter whether CB-4 is open or closed.

MR. TSOMBARIS: And we will also see that we're cutting off phase B for that power.

MR. CRANDALL: Which had the disturbance.

MR. TSOMBARIS: Which had the disturbance.

MR. ROSENTHAL: Why don't we stop now? Rudi, I don't mean to be rude to you, but, rather, I think that the next session is going to last at least an hour. Rather than having people pop up and down while you're talking, I think it would be more courteous is we all took a five-minute break, refreshed our heads, and then we're going to turn the floor over to you and listen well.

[Recess.]

MR. CRANDALL: I think we're at the point where we

now want to go into our Exide people.

MR. McCORMICK: Roy, are you ready now to give us your estimate of what you think took place and what you think needs to be done to verify or proceed in an orderly fashion if we have to check anything out?

MR. MACHILEK: The information which we received in order to analyze the problem was faxed to us on August 14 at 4 o'clock in the afternoon --

MR. McCORMICK: Roy, could you hold up a minute? We've lost Frank.

[Pause.]

MR. McCORMICK: Frank, the whole meeting's waiting for you.

[Pause.]

MR. McCORMICK: Okay. We're ready to resume. Roy? Or Rudi. I'm sorry.

MR. MACHILEK: I started to explain that we received an account of the happenings on August 14, 16:05, by fax, and immediately started to analyze the situation from the information received. The information says basically that a scenario happened; an upstream transformer was lost; and all five of our UPS systems shut down. The one thing which was striking -- that all five UPS systems shut down at the same moment -- meant that something had to happen which was common to all five systems. If such a

commonality would not exist, of course, each one of the inverters, if they would have all gone down at the same time, would have had differences of why, the indications, the alarms, and so on.

We started to look for some commonality, and the only documented commonality was that, besides each one of the UPS system was shutting down rapidly; that means it received a command to shut down -- not a fluke, not a transient, not anything but a solid command for the modules to say, Shut down. That fact is documented by the presence of a lamp, which is stored, which says that the module tripped. That lamp can only be lit if there was a legitimate, hard, enduring signal telling the UPS module to do so. Simply a smaller flick of a transient or anything like this would not have accomplished that. It would not have latched on that lamp.

We suspected that we had problems with maintaining the logic, specifically the logic power.

MR. MACHILEK: The problem with that conclusion was the fact that if logic power loss was causing an UPS shutdown there was also another lamp which had to precede the one which says shutdown which power supply failure, logic failure, which also is a latched-on lamp.

So the proper sequence of getting to an UPS shutdown is to first have a latch on the lamp indicating the

reason for the shutdown, which can be any one of I believe ten different sources which are listed in the UPS failure report on the last page, Attachment No. 6. There are 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 -- 10 probable causes for generating an UPS shutdown.

Now the problem with our system, well, let's say the way the system is designed that whichever of those ten sources is telling the UPS to shut down does so by lighting a lamp over a static latch and that lamp stays on, it's latched on until an operator would come and reset that latch.

That latched lamp signal then is forwarded to a summary gate which tells the UPS to shut down. That means any one of those ten lamps is summed in a gate which resides in one signal which goes to the trip lamp and the trip circuit and says shut down. Now --

MR. ASHE: Excuse me. Frank Ashe, NRC. When you say shut down, what you mean is all breakers open up --

MR. MACHILEK: All breakers open up.

MR. ASHE: Inverters--

MR. MACHILEK: Completely dead.

MR. McCORMICK: That's CB1, CB2 and CB3 open up.

MR. MACHILEK: That is correct.

MR. McCORMICK: And CB4?

MR. MACHILEK: CB4? Forget it. You lost the UPS,

okay?

MR. ROSENTHAL: CB4 is locked out.

MR. MACHILEK: CB4 couldn't because there was no voltage there. We lost Phase B so the bypass source was not available.

MR. CRANDALL: The maintenance supply was out of sync. We didn't have a permissive to close CB4 so it would not have closed.

MR. MACHILEK: What happened was in six cycles now, okay? That means during the six cycles by losing the Phase B -- C or was it B? B.

MR. McCORMICK: But doesn't the same logic for CB1, CB2, CH3, and the decision not to let CB4 close all come from the same --

MR. MACHILEK: It all comes from the control circuit of the UPS.

MR. ABBOTT: CB4 also does?

MR. MACHILEK: Yes, sir. The command to close, the actual power to close is taken from the bypass.

MR. McCORMICK: So the command to have CB1, 2, and 3 open up and 4 not close --

MR. MACHILEK: No. It also tells the 4 to close but there is another circuit which is the transfer control which says no, you cannot do it, so you would get an opening command for CB1, CB2, CB3, a gate in command to the static

switch and it goes in command to CB4, except those last two commands they are blocked by the transfer control saying bypass is not good so you cannot go there.

MR. McCORMICK: Then there is something else then. There is another transfer control not in this logic panel that would prevent CB4 from closing?

MR. MACHILEK: Yes, sir. There is.

MR. CRANDALL: Suffice to say that the one problem that he is getting into is the trip. The CB4 worked her design exactly the way it was supposed to.

MR. MACHILEK: It is included in the little block which says static switch control 834.

MR. McCORMICK: That helps me because I couldn't figure out what it was doing.

MR. CRANDALL: It wasn't supposed to close. We didn't have sync.

MR. MACHILEK: Under a normal situation, if the bypass supply would have been of acceptable quality CB4 would have closed and the static switch would have gated of course and you would have had a transfer of power to bypass and your load would not have had an interruption, okay?

MR. McCORMICK: Once it makes a decision not to close it is locked out. The power was recovered and when the disturbance cleared, it would not go back and see.

MR. MACHILEK: No, sir, no. Everything locks up.

Now the UPS, the problem with the report we received was that the initiating lamp, one of those ten lamps which we had the latch in in order to tell the trip to function, none of these lamps was reported to have been lit.

Maybe we thought you know it was an oversight so we went back and reassured that none of these lamps were lit and we have been assured that enough people looked at it and said no, there was no lamp.

MR. CRANDALL: That analysis is based on interviews with five separate operators, some of them more than once, going down to the unit.

They are telling us to the best of their knowledge there was no lights there and then we have one unit, G, that no one reset a single thing and it also did not have a light so we have relative assurance from all of that that none of these lights were on in any unit. It is not absolute 100 percent but I mean as best as a memory can be on five guys.

MR. MACHILEK: So -- after we were reassured that was a correct condition, we thought we knew why lost the logic which I will explain to you in a second but we could not explain the absence of any one of the initiating commands. Therefore we were searching for what possibly could generate such a condition.

The only thing we could come up with was that there may have been a ground disturbance introduced, signal

injected, which logically cannot be reasoned out, and for that reason we of course you know went to the foremost expert on grounding. Mr. Warren brought him in from the West Coast and said, hey, you know I discussed the matter with him on the phone and of course he said, gee, you know without seeing the installation I can't tell you anything, so he came and looked at the installation with the sole reason to tell me not what should have been done -- you know, we had a little, maybe a straighter discussion before, but the reason for having Mr. Warren here is to tell us if there was a possibility to inject a signal into all five models at the same time, which would wipe out all the lights which had to be lit in order to get the trip.

We decided yesterday that to search academically for that reason is moot because we will never find out. The prime concern or the prime problem was that the UPS was shutting down. If there was a light or no light is really, if you excuse me to say that, academic, okay? It is of great interest of course because we have no explanation of why that happened but basically we feel that the UPS should not have shut down in the first place, okay?

If there was a command to shut down, we elected to assume that there was a light and we don't question that there wasn't, please, okay -- we do not question the fact that there was no lights stored. We have to assume there

was.

Why do we have to assume that? Because any test you would run right now to induce a shutdown of the module would first generate such a light.

MR. MACHILEK: There is no break or malfunction that we can prove here in order to duplicate that situation.

MR. McCORMICK: Do we know -- I don't guess the same light would be defective in every panel but it would seem to me that --

MR. MACHILEK: Right now if you go out to the UPS modules and you would introduce a condition which ends up in a shutdown you will get the initiating light.

MR. McCORMICK: On every one of these lights?

MR. CRANDALL: On Attachment 6 we have done the DCUV, the ACUV, the ACOV. We have given it a logic failure and in each case the light came on and the unit tripped as specified and it transferred to maintenance.

MR. McCORMICK: Frequency failure?

MR. CRANDALL: Frequency failure we did not.

MR. CHIU: Is it possible you have some kind of disturbance or transient but were not triggering any of the ten trips, but the signal going to the board and causing the logic to be scrambled?

MR. MACHILEK: It is not.

MR. CHIU: It is not possible?

MR. MACHILEK: That is not possible.

MR. ROSENTHAL: You know that you generated a module trip alarm.

MR. MACHILEK: In that actual module trip it did do it.

MR. CRANDALL: Right. That is based on the actual indications found.

MR. ROSENTHAL: We know that? We believe that?

MR. FIRLIT: I think that's a better characterization.

MR. ROSENTHAL: Okay. If we believe that we have a module trip --

MR. MACHILEK: Yes, sir.

MR. ROSENTHAL: So that trip then is CB1, 2, 3.

MR. CRANDALL: There is a light for a module trip and that was on four of the five units.

MR. MACHILEK: -- the modules tripped and we lost power, otherwise we wouldn't be here right now.

MR. ROSENTHAL: Do you have a sense of how long in duration and of what quantity a signal you have to provide to the module trip unit?

Are we talking about microseconds, milliseconds, many volts, little volts?

MR. ZUG: Microseconds.

MR. MACHILEK: Yes. Mr. Bill Zug, he is the

Director of Engineering. He has those figures.

MR. ROSENTHAL: So you believe that how many volts? Repeating a little TTL, sir?

MR. ZUG: C-MOS logic takes between 3 and 7 volts.

MR. MACHILEK: So it's you know between 3 and 7 volts for some milliseconds is a good healthy signal -- microseconds is a good healthy signal in terms of logic, you know, to latch. We have to latch --

MR. ZUG: It called an RS type latch.

MR. MACHILEK: So you know that, and we are talking about five different systems here, okay.

MR. FIRLIT: Can we back up just a second?

MR. MACHILEK: Yes.

MR. CRANDALL: Might I just interject by the way, I mean we know the ground grid disturbance was there and you may not realize that also hit fire panels so we know it was of sufficient magnitude to do these kinds of things.

MR. ROSENTHAL: Just repeat what you said for me?

MR. CRANDALL: There were some disturbances noted on some fire panels that are a solid state device within the plant as well. What I am saying is, you know, we have been looking for other things that can give us some pointers too, commonalities, and that would give us one also that would give a sense not of magnitude but a sense that we could be in those magnitudes of disturbances on the grounds.

MR. ASHE: Excuse me, if we could just back up for a second. You showed us these ten trip alarms.

MR. CRANDALL: Yes, sir.

MR. ASHE: I thought what you said and I thought it was significant was that before the logic unit trips these lights happened to light and the reason you know that is because the signal that lights these lights then goes on from that point in the circuitry to trip the unit.

MR. MACHILEK: Correct.

MR. ASHE: So the light has to be on one way before the unit can trip because the unit gets its signal from this lighting. Is that what you said?

MR. MACHILEK: Correct.

MR. ASHE: Okay.

MR. ROSENTHAL: By virtue of your design now.

MR. MACHILEK: Correct. There is a serious progression of action toward a trip.

MR. SYLVIA: If it did come on it didn't lock in.

MR. MACHILEK: No, the problem is that the latch which locks in initiates the lamps as well as gives the signal on to the next latch, which then is associated with the trip.

MR. SYLVIA: What's implied, it never got the signal.

MR. MACHILEK:. You had ot have the signal in order

to generate the end result, yes, sir.

MR. McCORMICK: Could the light have been reset by an operator without resetting the trip lights?

MR. MACHILEK: You can only reset both lights, not one of the two by itself.

MR. McCORMICK: I just want to make the point -- you have got something going on here that we don't --

MR. MACHILEK: There is a reset button and if you reset, if you push that button you reset both lights.

MR. McCORMICK: But we do know we had the module trip light still on so we could not have introduced an operator in there and by doing something that would have changed the state.

MR. MACHILEK: Correct.

MR. ASHE: Is it possible by design that the signal is being sent to the trip unit at the same time it goes to the trip alone? Not possible?

MR. MACHILEK: It is the same signal which is causing both actions.

MR. CRANDALL: It's not parallel tasks. It's a series package.

MR. ASHE: That's what I am trying to get to.

It is a serial path. The light must be lit before the trip unit is signalled to trip. Must be there. Must have a signal --

MR. MACHILEK: It happens simultaneously.

MR. ASHE: I think you are saying a parallel task, not a series.

MR. MACHILEK: Yes. The lamp and the --

MR. ASHE: -- and the trip unit is signal at the same time.

MR. MACHILEK: What I meant by serial path is that one latch triggers the next latch which gets me the final lamp. See there is one latch with the initiating lamps. It triggers the second latch -- I'm sorry -- which triggers, they open which is the summary gate. I'm sorry, not to mislead you here.

MR. SYLVIA: So it's parallel?

MR. MACHILEK: The lamp and the signal should be considered parallel.

MR. BERTSCH: But the latch is one. There's only one latch.

MR. ZUG: This is Bill Zug. We are dealing here in technicalities. If you send a signal that is being fed through logic gates, what you call parallel and what you call series, it is the same signal that branches off. The output of the latch goes through a buffer gate to light the lamp. That same signal is then processed over two additional gates to trip the unit.

Now if you are dealing in hair-splitting

nanoseconds, it's series but it is the same initiating signal.

MR. McCORMICK: And it doesn't have to go through one to get to the other.

MR. ZUG: That is correct.

MR. ASHE: That's the point. So have you investigated response times? The answer is no, right? Because you think it is ten to the minus nine and the light didn't light --

MR. BERTSCH: It's one latch though. It's one latch that lights both lights.

In order for the light to be latched in it's only one latch that would latch both lights. It's not two separate -- one latch for here and one latch for here.

MR. ASHE: When you say latch what are you talking about? What do you mean? A transistor? An operational amplifier?

MR. ZUG: It is a logic gate that is called an RS latch. It is a device 4044. When you give it a signal it sends the output low. If you give it a reset signal in the same chip, it sends the output back high.

MR. ASHE: Suppose it loses power in between? What happens?

MR. ZUG: It unlatches and the default state is power high and if that would have happened you would not

have either lamp. Neither is shut down.

Now the question was asked if we know that by design. Yes, we know that by design but also the physical evidence is that there was a latch set because only after the reset button was pushed on all five units did the trip lamp go out so there is the physical evidence that a latch was in fact latch.

MR. McCORMICK: So the particular trip light that we can't find was not a factor in the actual tripping. We didn't -- by design one of these should have gone on but it didn't have to go in order to do the module trip. That is the way I'm saying it.

MR. CRANDALL: Let me put something in perspective a little bit too because what's been very difficult for the team is to go right out there and find the actual smoke and what we have been really --

MR. FIRLIT: Time out, time out. Let's have one conversation at this table here, okay? One at a time.

Go ahead.

MR. CRANDALL: What we have been really digging for is the anomaly between finding this target so to speak that gave us the trip and that has been absolutely totally unexplainable by any of the design.

The trouble is we know what happened so what I would like to put in perspective is the fact that we do know

we got a trip.

We do know we didn't get a normal trip of what these things are listed because they all latch and most of those we have checked but we did get a trip in the circuitry.

We have been unable to and I am not sure whether we ever will be able to explain precisely how that happened but we have been able to make some concrete decisions so to speak that we know that signal came into that board.

The direction we are going to is how can that get into the board and we are sort of saying that maybe we don't want to beat it to death as to why we didn't get the light. Maybe that is not as big a deal.

It's going to be uncomfortable that we are not going to be able to explain that but what we want to address is -- we want to go back and look how can that come into the board and in essence say we are not going to be able to find that little piece, if everybody is comfortable with that.

MR. CHIU: Can I make a comment? Isn't it true what we right now assume, we have to have a signal going to the board and the board will generate all the actuation for the breakers. Will there be a possibility of spurious actuation?

We never had a signal going to the board.

The board itself through some other environment --

MR. CRANDALL: There's three signals that were generated off the board in order for this to happen.

Is that right, Rudi?

MR. MACHILEK: Yes.

MR. CRANDALL: Two signals had to be generated off the board so we know it came from the board. We know that so we know something came into the board but not any of these ten.

Is that answering your question?

MR. CHIU: No. My question is, right now we are assuming none of the ten actuation signals go into the board. Then the board will generate the three --

MR. CRANDALL: No, we're saying not. We are saying we note one of the ten did not go to the board.

We know that.

Part of that is based on a failure of five units when we have a confidence level that those trips do indeed work.

So we know it's not the ten; we know there is a trip; we know it went into the board.

MR. McCORMICK: Is there a test that we can perform on each of these trips to check that they will work?

MR. CRANDALL: We have done it on most.

MR. McCORMICK: Is there a test we can perform for each one?

MR. CRANDALL: There are some we would prefer not to. I was going to get that in the troubleshooting. The DC overvoltage we would prefer not to do that, because that can cause damage in filter units and things like that.

MR. McCORMICK: Okay.

MR. CRANDALL: I'm not saying that's not valid that could be addressed, and maybe we need to do that, but we --

MR. McCORMICK: Let's go back to Rudi.

MR. CRANDALL: I just want to put in perspective -- and I don't want to get off on a tangent of this -- Like Rudi said, we're analytically saying we didn't have a light, but we're saying to ourselves, Okay, we're assuming an 11th light that doesn't exist must have done something, and we're not getting off on that lack of light.

MR. McCORMICK: Okay.

Rudi, go ahead.

MR. MACHILEK: What is of main concern is, why did the units trip? Why was a trip signal initiated in the first place? The trip signal which was stored -- we have a lamp which says we had a logic failing. That means the failure in the module was not in the power circuit, but it was in the logic circuit.

Investigating that, where it possibly could come from, we established that the way we are generating logic

power under certain conditions can lead to a momentary loss of logic power. That momentary loss of logic power, of course, would shut the module down, would give you a lamp indication which says, logic problem, and would give you a trip. Since that is the only common denominator for all five modules, resulting in the same result in all five, we pretty much thought it was a certainty that the problem had to be in that portion of the equipment.

We started to investigate what the possible scenario would be to cause that loss. We do have a mini-UPS system within the UPS, in order to generate logic power. That consists of two power supplies, a plus and a minus 20 volt power supply, which works in parallel with a small control battery supplying battery power to the logic. The AC supply to the two power supplies can come from either of two AC sources: either the bypass source, which is the maintenance bypass, or the output of the inverter itself.

MR. CRANDALL: Excuse me one second. Just so everybody is up, he's talking right in here, on this drawing.

Sorry. Go ahead.

MR. MACHILEK: At the time of shipment of those units, the standard procedure at Exide Electronics was to have the bypass source as being the preferred source for the power supplies generating the DC control power. If the

bypass source would go away, if it would cease to exist suddenly, a relay would switch over to the other supply, which is the inverter output, and would continue power to the power supplies. The little switching transient would be made up by the battery, which is in parallel with the output of the AC, DC power supplies.

Now, we demonstrated yesterday to ourselves that such a loss of bypass power in fact was reaching the logic power over to the other source, without an interruption to the output. Can that be confirmed?

MR. CRANDALL: With a correction, sort of. We proved that, with the unit on-line, maintenance power available, that logic is on maintenance power.

MR. MACHILEK: Yes. And it would shut down --

MR. CRANDALL: And it's on the B phase. That should be pointed out. It's a single phase, 120 volts on the B phase.

MR. McCORMICK: But you did prove that it would switch.

MR. CRANDALL: We did prove.

MR. ROSENTHAL: Last night you stood there and turned off the bypass supply, and you observed K-5 in quotes relay the armature move.

MR. MACHILEK: Yes, sir.

MR. CRANDALL: No. I want to get that specific.

Not CB-4. The input power into the maintenance supply.

MR. ROSENTHAL: I said K-5.

MR. CRANDALL: You said we opened CB-4.

MR. ROSENTHAL: No. I'm sorry. You opened up an upstream breaker on the other side of the regulating transformer.

MR. CRANDALL: Okay. I misunderstood that.

MR. ROSENTHAL: Right?

MR. CRANDALL: Yes. We shut off the maintenance supply.

MR. ROSENTHAL: And you observed this K-5.

MR. CRANDALL: Yes.

MR. MACHILEK: K-5 was switching over to the inverter output as being the AC supply to the power supplies.

MR. ROSENTHAL: Do we have a drawing that shows where K-5 is?

MR. CRANDALL: It's really right there.

MR. MACHILEK: It is in the block which says Logic Power and relay panel 8-1, in the middle of the box.

MR. CRANDALL: We have that on a UPS drawing that we gave you, but we didn't bring it with us, I don't think, the specifics.

MR. MACHILEK: This is really the way it was designed, and it does in fact operate this way. What we

suspect does not operate so well: If the bypass would not suddenly cease to exist, but would greatly reduce itself in the amplitude -- which it did, because unfortunately the supply power to the power supplies comes from phase B neutral, and B was the phase, unfortunately, which was affected by the scenario on the input power transformer.

If that voltage would, let's say, have dropped to 40 percent or so, which was reported it did, that relay not necessarily would switch. It could, in chatter, resist to switch over to the other supply, which of course could lead to a momentary loss of the output of the power supplies, in case the battery would not be able to carry through.

The point is now, is the battery able to, or is the battery not able to, carry through. We suspect that the battery of that little mini-UPS is in a condition where it cannot sustain logic power through that scenario.

MR. SYLVIA: Can you test these batteries?

MR. CRANDALL: In the one unit we have tested that battery, it is dead.

MR. ROSENTHAL: Which one is that?

MR. CRANDALL: 1C, UPS 1C. We haven't gotten into the other four to check, but 1C's battery is dead. We do know that.

MR. ASHE: Wouldn't you like to qualify that? Dead -- you mean degrading.

MR. CRANDALL: It's .06 volts out of 20, I think it is. It's dead.

[Laughter.]

MR. ASHE: All right.

MR. ROSENTHAL: It's a little nicad battery, about -- how big?

MR. CRANDALL: It's a series of them. They're little D cells combined together.

MR. McCORMICK: D cell batteries?

MR. CRANDALL: Nicad, yes, 48 of these things.

MR. ROSENTHAL: And you know that that battery is dead because --

MR. CRANDALL: We tested it.

MR. ROSENTHAL: When?

MR. CRANDALL: We opened up logic power --

MR. ROSENTHAL: Tuesday, Wednesday, Thursday?

MR. CRANDALL: The first day we were out there, which I think was Wednesday or Thursday. I'm not sure which day; I'd have to look. The days are running together.

MR. ROSENTHAL: You go out there, and you physically remove the battery, and you hold it to a voltmeter?

MR. CRANDALL: If you look on the drawing, there is, I think, CB-1 -- A27 CB-1 -- that connects it.

MR. ROSENTHAL: Right.

MR. CRANDALL: Down below, there is a switch or a breaker that ties this to the maintenance supply.

Right here. We opened the S1 switch. We went on maintenance power, had the unit down. Under that condition, the maintenance supply is feeding the power supplies. We opened the S1 switch to take that AC away, and the battery should have sustained it. The lights went out. We then proceeded to check across the bus and got .06.

MR. BERTSCH: I think one was .06. The other one was maybe half a volt.

MR. CRANDALL: It's effectively zero.

MR. BERTSCH: It's nothing.

MR. SYLVIA: Do we know how long that battery had been in there?

MR. CRANDALL: They were replaced during startup.

MR. ROSENTHAL: When was that?

MR. CRANDALL: It was about six years ago.

MR. ROSENTHAL: And the batteries are not part of a specific -- Are the batteries part of a PM program?

MR. CRANDALL: We do not have the program written, though we wrote a DER, and I think I gave that to Frank.

MR. ROSENTHAL: So for the last six years the batteries have not been --

MR. CRANDALL: No, they haven't been.

MR. ROSENTHAL: I'm sure in the future they will

be.

MR. CRANDALL: We just flew some in last night.

MR. SYLVIA: What is the recommended replacement time?

MR. CRANDALL: My understanding was five years. I have not put my hand on a piece of paper for that.

MR. SYLVIA: It's not in the manual?

MR. CRANDALL: No.

MR. McCORMICK: What do you mean, not in the manual?

MR. CRANDALL: I didn't find it in the manual.

MR. JULKA: We have to check that.

VOICE: It's four years.

MR. CRANDALL: He's saying it's four years.

MR. MACHILEK: The basic problem is that it is four years at 77 degree F.

MR. ROSENTHAL: Keep going. How hot do you think it is in there? If you put your hand on that panel outside, it is hot.

MR. MACHILEK: I would say the inside temperature should hover around 120 degree F.

MR. CRANDALL: When you're saying 77 degrees, are you saying the environment of the batteries, or you're saying the ambient?

MR. MACHILEK: The environment around the battery.

MR. CRANDALL: But we know that's not going to be 77 in there, right? Ever.

MR. ASHE: You're operating beyond that.

MR. JULKA: It may have to be two or three years.

MR. ASHE: It would be shortened.

MR. CRANDALL: Okay.

MR. ROSENTHAL: At first I thought we might have maintenance which wasn't a direct contributor to the event but simply would be life-shortening on stuff. It now may be very germane. Is there any way to get a thermocouple or a means of measuring the internal temperature of the --

MR. CRANDALL: I think we have those.

MR. ROSENTHAL: With the doors closed and fans running.

MR. CRANDALL: What we have done numerous times -- I've got to make sure I can put my hands on the numbers, and we don't have it on every unit; C and D are the ones that are hot.

MR. ROSENTHAL: Okay.

MR. CRANDALL: We have done comparisons where we've taken a surface pyrometer. It's difficult at best to put a thermometer in there, to secure it, because of the nature of the equipment, so the way we have done it is, everybody ready, open the door, stick the surface pyrometer on, and take a reading on the surface of the inverter legs,

which is a relative indication of the heat in the box. We have some numbers that give us some --

MR. BERTSCH: But that's on the surface of the metal, which is actually part of the heat sink for the SCRs. The batteries are located further back, but they're actually a little cooler, because they're in an open area.

MR. ROSENTHAL: When I stand and face the front of the inverter, on the upper left I see a whole bunch of logic cards. Is that the area in which the battery is located?

MR. CRANDALL: No. The batteries are in the back section at the top, just underneath the grating.

MR. ROSENTHAL: And the SCRs are two, three feet down from that.

MR. CRANDALL: About a foot below, or so.

MR. BERTSCH: They're also in front. The batteries are mounted physically on the back, and the SCRs are further in the front; you've got a capacitor bank in between them.

MR. MACHILEK: The only significance of it is, whatever temperature it is, it is not 77 degree F. Therefore, we should not expect five-year life. How much less -- [Pause]

MR. McCORMICK: Okay.

MR. MACHILEK: So far this was our conjecture of the probable scenario. The proof of the pudding is in

showing it, and we suggested a test sequence yesterday to prove the point. If it bears out, then we do have a remedy.

About three years ago, the 827 was redesigned to have redundant power supplies on it. That means instead of having one plus-minus 20 power supply pair, it has two. One power supply pair is supplied from the inverter output; the other power supply input is coming from the maintenance bypass. We have a diode option of the DC output of the two power supplies; therefore, any switching or any switching transient is eliminated.

MR. CONWAY: Therefore, that relay potentially chattering on a degraded condition is eliminated.

MR. MACHILEK: No more relay.

MR. CONWAY: No more relay.

MR. JULKA: Do we know what type of relay this is?

MR. ZUG: It is actually a small contactor. The manufacturer escapes me at the moment.

MR. JULKA: I was more interested in the drop-out voltage for that relay.

MR. MACHILEK: We'll find out. That's why I was suggesting to reduce the voltage on the bypass input to see at which point it starts chattering and establish what we have going there.

MR. ASHE: By the way, there should be something pointed out here: That task was not completed yesterday

because of other problems. However, I would assume you plan to continue to test.

MR. MACHILEK: Yes. We had hoped that we could test before that meeting. It would have maybe shortened the discussion time by two hours.

MR. ASHE: But right now, at least, there has been no change in the thinking.

MR. MACHILEK: No, sir. The tests are --

MR. ASHE: So as soon as this inverter becomes available again, you're going to try --

MR. MACHILEK: As soon as we get permission to get at it, yes, sir, we'll do so.

MR. McCORMICK: That will be one of the things we hope to conclude, that we could go ahead and fix whatever.

MR. MACHILEK: I talked to the factor last night, and there is a new version of the 827 power supply pan on the way. It should be at the Syracuse airport this afternoon or tomorrow morning.

In case the test bears out what our conjecture is here, we can repeat the test with the new power supply and show that the same scenario would not cause a shutdown of the modules.

MR. FIRLIT: Am I to understand that we have uninterruptable power supplies that, if the battery voltage that supplies the logic circuit there gets below a certain

level, takes out the whole system, then, in one transfer?

MR. MACHILEK: If you --

MR. FIRLIT: What I'm trying to figure out is, is that battery a cause of why we didn't transfer? That's what I'm trying to figure out. I have not figured that out yet.

MR. MACHILEK: Not why it didn't transfer. Why you did shut down the module.

MR. CRANDALL: But specifically to this particular --

MR. FIRLIT: It caused a problem. That's what I'm getting at.

MR. SYLVIA: You mean there's no light that tells you when the battery's going bad or anything like that? There's just a word in the book that says, should be replaced?

MR. CRANDALL: Can I interject? We're saying the battery is definitely the concern here, but it's not that the battery is bad and therefore, any time it's bad, we'll have the problem. It's the battery bad with this kind of transient coming in on the power supply.

MR. McCORMICK: The question is, there's no monitor across that to tell you it's bad before you get into this problem.

MR. CRANDALL: Strictly through a preventive maintenance program, which is what we are instituting on

these units.

MR. LEWIS: It was mentioned that this supply picked off at phase B. If, for example, it had been picked off at phase C, by chance, you might never have seen this problem. It's things adding up together that makes it.

MR. MACHILEK: Or if the transformer failure would have been on phase C or A, we would not have seen it, either.

MR. CRANDALL: It's very possible that the --

MR. SYLVIA: Batteries that are supposed to last four years could go bad in six months.

MR. ROSENTHAL: I'm not defending the PM program; we need the PM program. But if it's that critical --

MR. CRANDALL: That's what I'm saying. That's what I'm trying to point out. I don't think it has the critical -- In the scenario we're in, yes, it's critical, but in a normal mode of transfer it is not.

MR. ASHE: At this point I don't think you can actually prove it's that critical. I really don't. You don't have anything to provide that it's that critical, nothing. Have I missed a point someplace? Is it critical even to the situation that we had?

MR. SYLVIA: No.

MR. ASHE: You can't prove the battery is that critical, even in this kind of transient. You can't prove

that right now. You have no information.

MR. McCORMICK: Chattering may be enough.

MR. ASHE: May be. May be. I'm saying prove it, not may be. We want to take the uncertainty out of it. You're going to make it repetitive; you're going to duplicate it. But right now, you can't do that.

MR. CRANDALL: We don't know if all five batteries are bad in all five units, either.

MR. McCORMICK: Do all five have the battery?

MR. CRANDALL: No. That's the key to those two, by the way. Elgars use the DC-to-DC converter; they do not rely on AC. That's why I asked Steve to go into that first. A DC-to-DC converter is not susceptible to transients on AC.

MR. IBARRA: This is Jose Ibarra.

In the technical manuals that are delivered when the UPS is delivered -- does that manual itself address that battery and whatever has to be done to keep those units operating on a regular basis?

MR. CRANDALL: Steve just showed it to me. When I made the comment that I couldn't find it, I was looking for it when we were doing the PM. It says nothing about it in the troubleshoot section. It's a note. I'll read it, just for the record.

It talks of the A27A1 card and there is a parentheses: The control battery discharge sensing is

located on the A27A1 card. These batteries should be replaced at four year intervals.

It is in as a note in the paragraph.

MR. FIRLIT: Okay, I go back to the gentleman there that says with this product we don't really know whether or not the battery played a key role or not so I don't know, I could surmise that the battery deteriorated over a six year period but I can't -- I don't know if that's what caused the battery to be low or if something in this transient zapped that battery to make it low.

MR. McCORMICK: Obviously it's probably been working a little above its temperature -- but as Ralph said it could have been for all we know that battery. There is no indicator on the front of the panel. You are kind of in the blind. It could fail first but I don't think we were doing anything to mitigate the potential for it being a failure, we've got a number of things going.

Do you have a trouble-shooting plan? Is there a trouble-shooting plan that can get us through from where we are now to find out --

MR. MACHILEK: We submitted the test sequence yesterday.

MR. McCORMICK: And has the NRC reviewed that, would agree to that?

MR. ASHE: That's been modified because we had a

little problem as you are well aware with the impurity that was in the test so I would assume that this plan is going to be modified, right?

MR. ROSENTHAL: Not yet. Wait a second, wait a second. I'm sorry -- I thought you said "the plant."

MR. ASHE: The plan. This test plan -- p-l-a-n.

MR. ROSENTHAL: P-l-a-n-t will not be modified -- yet!

[Laughter.]

MR. ROSENTHAL: We agreed with what you said yesterday. When it went down we witnessed, we were going through this thing, this other failure. Now we have this meeting here.

Yes, today we have to agree to some test plan. We want to review what we heard this morning, review what you are saying now or as modified.

MR. McCORMICK: We need to fix what broke last night.

MR. ROSENTHAL: We know that.

MR. CRANDALL: What I would like to present is to the degree that we are able to is to present to the NRC whatever, in whatever format, whether it is in this meeting, another meeting or whatever, the overall plan of how we want to attack the overall troubleshooting with knowing that we are going to have to get deeper in, Frank and I or whoever.

Troubleshoot plans are going to change as we go along.

MR. McCORMICK: Yes. Are you willing to entertain that now?

MR. ROSENTHAL: That troubleshooting plan? Today? Yes, I mean within the hour, surely, or less.

MR. ASHE: Could I just comment on that, please? In terms of a plan and I am just asking now, we would like to keep modifications to a minimum so we can try to duplicate it, if at all possible so if the unit went down, we're not only going to replace it, we are going to change the state of it, and now I am not sure what they are doing here anymore.

If we keep changing it we are not going to be able to duplicate what we had when we had the failure.

MR. CRANDALL: I would want to reduplicate the failure on at least the second unit before I started to look at --

MR. ROSENTHAL: Okay.

MR. CRANDALL: That's my opinion but again I think those, on that level, you know maybe that is not at the level we're at. The specifics of that may be on your or my level is what I am thinking and it may be the plan to go through it. The overall should be here.

MR. ASHE: We're on that second aspect there

because the other four as I understand it are frozen and so they should be basically the same state and this particular one you know we had a problem with yesterday so I wasn't aware of that aspect of your plan, okay, about duplicating the same test on a second unit.

MR. SYLVIA: How are we going to duplicate the failure?

MR. ASHE: Well, we are talking a narrow base, a very restrictive test here on the logic to attempt to see if--

MR. MACHILEK: If our scenario is demonstratable.

MR. SYLVIA: I guess I don't know enough about it to know whether that is any good or not.

Does this narrow or the bounds of this test really tell us that we are duplicating what happened, starting with the transformer failure or are you just duplicating that if the battery fails the logic won't work.

MR. MACHILEK: No, you would have to rely on our ability to analyze the circuitry which we designed to respond to a certain --

MR. CRANDALL: I think it's a scenario that probably we can try and go out and if we get lucky we will be able to reproduce it but I think we are going into it with the probabilities are probably against that. We have got to try it and have some hopes we can do it.

If we can't then we need to sit down and based on what we are seeing then you know deduce some things.

MR. LEWIS: Warren Lewis. You can reduce the voltage and reproduce the chatter but you can't reproduce the transient that accompanied it through the grounding system so what the hope is if you can say finding trouble is something you are hoping for, you are hoping that a simple reduction in voltage will reveal the problem.

If a simple reduction in voltage doesn't reveal the problem that doesn't mean that you can declare that this is an invalid test. It is a test which is incomplete. You can't say there is no problem. You may still be right on the right track, let's put it that way.

MR. ROSENTHAL: Before we get into the troubleshooting today and I guess I am working off this Drawing C-110-611-234, let me ask just a simple question.

K5, is that normally energized or normally de-energized/

MR. MACHILEK: Normally energized.

MR. LEWIS: From the bypass line.

MR. ROSENTHAL: And these contacts are shown on this drawing in DN.

MR. MACHILEK: De-energized.

MR. ROSENTHAL: So you plug it into the B Phase. You would close K5. You would align Power Supply 1 and 2 to

get roughly 110 volts AC and then Power Supply 1 and 2 put out plus or minus 20 volts with the batteries in parallel with those two power supplies.

MR. MACHILEK: Correct.

MR. ROSENTHAL: That's what I am reading.

MR. MACHILEK: Correct.

MR. ROSENTHAL: Okay. What is the CB1, contacts 1 and 2, on the output of the battery?

MR. MACHILEK: That is the battery breaker, the breaker which disconnects the battery for purposes of testing, replacement or whatever.

MR. ROSENTHAL: Okay, now you went out and you measured a battery and you said that it is one volt and that is in parallel with which battery?

MR. CRANDALL: The way we did it was we put the unit on maintenance supply. We opened the S1 which took power from the maintenance away. We left CB1 closed and read the logic voltage.

MR. LEWIS: Under load.

MR. CRANDALL: Under load, that's true. It was under load.

MR. McCORMICK: Why would that not be a part --

MR. CRANDALL: No, it was an open circuit. It had load on it, which could drag it down. It may not be dead open-circuited. There we are talking about a degree of

degradation, I guess.

For safety reasons I chose really not to have somebody go way up inside.

MR. ROSENTHAL: I'm sorry. He might as well see, too.

MR. JULKA: This is the AC source.

MR. ROSENTHAL: This is the AC. This is now closed.

MR. JULKA: Right. This is closed.

MR. ROSENTHAL: Because this is energized. This is now closed. Into this power supply is -- the output of the power supply is here. Here's the battery, with this closed, in parallel.

MR. JULKA: That's right.

MR. ROSENTHAL: Okay.

Then you open this, and you measure the voltage here.

MR. McCORMICK: This is now handling whatever load is on there.

MR. ROSENTHAL: ES-2 is dead.

And you still have all the cards.

MR. McCORMICK: Yes.

MR. ROSENTHAL: And you reviewed this?

MR. ASHE: Yes. I think we understand that aspect of it. It was good for you to take the time to go through

it like that.

MR. ROSENTHAL: Before we get into the tests, can somebody go -- Maybe, Frank, you're better to verbalize. Okay. Please pick up.

As I understand it, what we've said this morning is that there was a logical disturbance on the B phase of this power plant. Five uninterruptable power supplies tripped out. I need an adjective now that they were probably tripped out because of a larger failure, that breakers were demanded to open.

MR. ASHE: I wouldn't call it a failure. I would characterize it as a logic signal which caused the breakers to open.

MR. ROSENTHAL: Do we know that? What adjective do we want to use? We think that CB-1, 2, 3, times five units, were demanded to open.

MR. ASHE: I would still say logic signal.

MR. CRANDALL: We know that.

MR. ROSENTHAL: You say that we know that.

MR. ASHE: We know that.

MR. CRANDALL: We do know that, because our modules tripped alike.

MR. ASHE: Right.

MR. ROSENTHAL: So we know that.

MR. ASHE: Yes. That's known. That part is

known.

MR. ROSENTHAL: So, then, we know that it was some command signal that we're now tracing down.

MR. ASHE: Right.

MR. ROSENTHAL: The reason I'm trying to get this out is, I don't want to be sitting here with this crew three days from now, saying, Ah ha; we did so much testing; this all fell apart; now we're going to go back into the heavy power said of this. We really think we're on the control side of this, the logic of this.

MR. ASHE: This discussion has been centered on the control logic power supply.

MR. ROSENTHAL: Do you concur?

MR. ASHE: Yes.

Obviously, this man knows more about his unit than I do, or let's hope so.

[Laughter.]

MR. ROSENTHAL: I just want to get a little summary going.

Now we're off the logic --

MR. ASHE: The principal focus has been the logic power supply area. It appears -- it may be -- it is possible that degradation in the batteries, in this area, may have been a contributing factor or cause to generating the trip unit signal which isolated all of these UPS's.

MR. ROSENTHAL: Let me back up. We agree that we had a trip unit --

MR. ASHE: Is there anybody here that disagrees with his statement? If somebody disagrees with that, we want to hear?

MR. CHIU: Will you restate his statement?

MR. ASHE: His statement says that we know -- not think, or it is not maybe -- that the logic unit trip signal was sent to isolate the inverters.

MR. LEWIS: I disagree.

MR. ASHE: You disagree. We do not know that.

MR. LEWIS: Wait. I disagree with a word.

MR. ASHE: Okay.

MR. LEWIS: The logic signal was erroneously sent.

MR. ASHE: Okay.

MR. LEWIS: And this is important, because it differentiates between a failure of logic and so on and so forth. The second thing was that we had a phase B failure, but we had a phase B-to-ground failure, so we had two conditions: fault on B, current injected into the grounding system.

MR. ASHE: Wait a minute. That part is different from what he said. Let's go back to your word. Would you agree an erroneous trip signal was sent?

MR. LEWIS: Yes.

MR. ASHE: Okay.

Does everybody agree with that, then?

MR. TSOMBARIS: No. I think it was a trip signal that was sent. I don't think it was erroneous.

MR. ASHE: Okay.

MR. ROSENTHAL: Moving on --

MR. ASHE: I think we should get -- It was my understand that everybody was in agreement that some signal was sent from the trip unit. Now, you call it erroneous, call it this, call it that, or what have you. Call it whatever you want to call it, but the trip unit sent the signal.

MR. TSOMBARIS: And I think the unit performed the way it was supposed to, given the signal it received. The signal it received, given what it was, it tripped the unit, which it was supposed to do.

MR. ASHE: Well, we're getting into semantics. I think I understand.

MR. McCORMICK: If the trip signal was sent, I don't know how the word "erroneous" is in there.

MR. ASHE: Well, it's a semantic problem here. I understand what you mean by erroneous. In my line of thinking, the module either sent a signal, or it didn't -- for whatever reason you can think of, and there can probably be a thousand. It sent a signal or it didn't.

If I've got the wrong understanding, then we need to back up and get the right understanding.

MR. MACHILEK: The module did exactly what it was designed to do. We don't like what it did.

MR. ROSENTHAL: So the module tripped, changed state.

MR. MACHILEK: Yes, sir.

MR. ROSENTHAL: At the other end of the logic, you have sensors, and to date we don't believe that any of those conditions were detected in those things. Somebody had better verbalize better than me.

MR. ASHE: I think we aren't able to clearly establish why the logic sent that signal. Is that wrong wording?

MR. ROSENTHAL: No.

MR. MACHILEK: We did not have any visual indication of which of the signals initiated the trip, yes.

MR. SYLVIA: Let me ask you another way. By design, if the logic signal existed due to the batteries being dead, would we have gotten the logic fail light? We still should have gotten the light?

MR. MACHILEK: Oh, yes. The logic fail says you have a problem in the logic. Now, what problem in the logic: we would have to resort to the lamp switch, but it didn't light.

MR. SYLVIA: To me, just from a pure logic point of view, you haven't said the battery caused the failure; you're saying it's a good possibility, so you want to do this test. But the fact that we didn't get the light causes me to doubt that.

MR. MACHILEK: Well, we cannot duplicate not getting the light.

MR. McCORMICK: I don't know that we want to say the battery caused the failure; it could have prevented it.

MR. ROSENTHAL: No, you don't know that. I was just trying to narrow it down at least to cards from the whole plant, and the troubleshooting is going to determine this. One can come up with alternates in terms of ground faults; we could go in there with a small RF generator and see if that causes changes in logic states -- I mean, there are things that can be progressively done, but at least we're focused on the card level and a sub-unit of this thing.

MR. FIRLIT: Where I'm lacking with the battery is, If the logic circuit got a signal -- we all agreed that was some kind of a signal that got in there -- and I heard a statement saying that the circuit did the job it was supposed to do. If it did the job that it was supposed to do, how does the battery fit into it? It would have tripped either way; you've got a trip signal to pop all those

breakers.

MR. CRANDALL: Maybe I can word it.

The module got a trip signal from somewhere, and it is likely that the power supply, being connected to the AC, is the avenue that that transient entered the unit, and that disturbance affected the power supply such that that trip signal was generated.

MR. TSOMBARIS: Can I say something? Maybe that will help understanding.

One of the reasons the UPS shut down itself is, If the control power supply drops. I think you can correct me if I'm wrong. Normally it's plus or minus 20 volts. If, for some reason, that voltage drops below a certain value, that in itself would generate a trip signal. Is that true?

MR. ZUG: Yes.

This is Bill Zug.

The power supply voltages, both the plus 20 and the minus 20 volts, are being supervised by a circuit. If that voltage drops below 16.5 volts, a trip signal is generated. Now, the probable scenario is that, in the reduction of the phase B power supply voltage, to what appears to be 40 percent of normal, there was insufficient voltage on the power supply to hold up the 20 volts. Additionally, due to a degraded -- let me use the word "degraded" -- battery, it could not substitute and hold up

the voltage, so a decrease in that voltage to below 16.5 volts would have generated that trip signal.

The only thing that is not consistent is that there should have been a lamp on the protection board that would have said, Power supply failed. The only thing in this scenario that doesn't fit is the absence of the lamp. However -- and this was pointed out before -- a latch was set, because it had to be unstored, and the pushing on the reset button, the unstoring, cleared the trip lamp.

MR. ROSENTHAL: On the C UPS --

MR. ZUG: Yes.

MR. ROSENTHAL: -- but not on the other UPS.

MR. ZUG: All the trip lamps were cleared by pushing the reset button, except on --

MR. CONWAY: G.

MR. ZUG: Was it G?

MR. CONWAY: Right.

MR. ZUG: -- except G, which most likely was reset, because the operator tried to restart the unit. The only way you can restart the unit is by resetting the alarm. I think there is conclusive evidence that that was the case.

MR. ABBOTT: That was the D-delta unit.

MR. CONWAY: Yes.

MR. ZUG: UPS 1D, as in dog.

MR. SYLVIA: So there is no load on these small

batteries normally?

MR. ZUG: Normally there's no load on these batteries, because the power supplies -- the DC power supplies -- provide logic power. The battery just floats, in the same way as the main battery floats on its battery charger, simply providing a maintenance charge, to prevent self-discharging.

MR. SYLVIA: How much load do they have to carry when they are called on to do something?

MR. ZUG: Under normal operation, approximately 5 amps on the positive supply, approximately 3.5 amps on the negative supply. Under non-operating conditions, it's less than one half amp.

MR. SYLVIA: So for this battery to have caused a problem, we have these batteries in five units that were supposed to last four years, but it has been, what, six years?

MR. CRANDALL: Yes.

MR. SYLVIA: With no load on any of them, and they all went bad to the same degree that caused them to fail when the load was put on them. That's what we believe.

MR. ZUG: Yes.

MR. CRANDALL: That scenario -- I disagree. I agree there is a failure related to the power supply. That maybe contributed to a lower degraded battery. It is

conceivable that, with a good battery and the transient we got, the relay could still have chattered with a good battery and maybe caused the same thing.

MR. SYLVIA: Yes. I said with the battery, Bob. I didn't say with the idea of the failure. If these batteries caused the problem, the logic that I went through would have to be improved.

MR. CRANDALL: Well, see, we've proved that batteries being bad alone don't cause the problem, because we've gone through and done all these trips, and it works fine. Nothing locks up. It transfers over; everything works good. The batteries could be contributing.

MR. SYLVIA: We're going to get the new batteries to prove or disprove the point about whether or not the batteries did it.

MR. CRANDALL: We can go through and try the test and hopefully prove something.

MR. CHIU: One thing we want to consider in your test: If you have a short on capacitor, or of a power supply -- capacitor holding up with DC power, but if you have -- For example, right now we're hypothesizing a microsecond of AC power transient. Somehow, DC power would be dropped. The one possibility there is somehow trigger the capacitor -- that is one possibility -- short it out. It has happened in the industry several times now.

If we shorted out, we can also drain the DC power supply at the same time. Then, after the transient, maybe the spurious thing disappears. Now we don't have the evidence. So it may be of less consequence on the effect. But we need to factor into that --

MR. CRANDALL: Sure. I don't want to focus on the battery. I want to keep with what we know.

MR. CONWAY: John Conway.

I don't think we know -- or maybe we can show -- that we're talking about a 40 percent decrease on the B phase -- or a 60 percent decrease on the B phase voltage. Don't we have indications that the voltage did not degrade that far, or can we not disprove that, that the voltage in fact went that low on the in-house 600 volt power board?

MR. JULKA: Six cycles for that period and six cycles previously, the whole system would go down on the B phase. It was effectively shorted.

The phase was effectively shorted. Again, what I'm saying is based on the Scriba oscilloscope. At that time, system was still connected.

MR. CONWAY: Throughout the plant?

MR. JULKA: Throughout the plant.

MR. CONWAY: Even at the lower voltage.

MR. JULKA: Right. We disconnected six cycles later. During the six cycles, it was connected. Like I

said before, the approximately value of phase B voltage was estimated to be around 80 kV. Normally it should be 220 kV to ground on a 345 phase-to-phase system.

Since the system was still connected, the system saw the same thing. The proper transformations in the transformers and everything else down the line.

MR. McCORMICK: Okay.

Does Exide have anything more that they want to bring to this discussion at this point?

MR. MACHILEK: No. At this point we want to maintain the suggested test sequence.

MR. McCORMICK: Can you draw any conclusions or make any recommendations until you get the results of that test?

MR. MACHILEK: No, sir.

MR. McCORMICK: Okay.

In order to proceed on that test on the C unit, we have to make certain repairs to problems that occurred last night.

MR. MACHILEK: Something broke. It had nothing to do with what we were doing. We lost a chip or something.

MR. McCORMICK: I would expect that all tests would still be -- It would be appropriate to continue all testing on the C unit, which is the only one that we haven't done anything to to change it from the state that it was at

the end of the day Tuesday.

MR. MACHILEK: Well, it has not really changed the state of what the unit was.

MR. McCORMICK: Do we know hat we have to do to the C unit to put it back into its state?

MR. BERTSCH: High confidence, yes.

MR. ASHE: Back up. Do you really know, or do you think you know? You think you know.

MR. BERTSCH: I think I know. It's just a matter of pulling two cards and checking a couple of chips.

MR. ASHE: Oh, okay. All right.

MR. BERTSCH: Put a scope in there and look and see what we've got for voltages.

MR. ASHE: Okay. So actually you're just planning to remove cards and put on a scope and try to check some things.

MR. BERTSCH: Replace the chips.

MR. ASHE: When you replace the card, you do the whole card, or do you just --

MR. BERTSCH: No, I'm just going to replace the chips.

MR. ASHE: Okay.

Has this happened before? Is that why you've got such high confidence in this?

MR. BERTSCH: Yes.

MR. ASHE: Okay.

MR. SYLVIA: Are you using the scope or electronic voltmeters to check that voltage, or are you using a Simpson's meter?

MR. BERTSCH: No, we don't use Simpson's for this. It's all either a scope or digital voltmeters.

MR. SYLVIA: Okay.

Does the fact that the battery was really dead and we didn't get this trip and transfer tell us anything?

MR. CRANDALL: We don't have enough information yet.

MR. SYLVIA: Well, we said if the battery was less than 16 volts, we're supposed to get this logic power supply failure on these ten things. If we get that, we're supposed to get a trip of the UPS, and it's supposed to switch over to the maintenance.

MR. CRANDALL: The total power supply battery and power supplies have to go below 16 volts.

MR. SYLVIA: But when we took it out, it was dead.

MR. CRANDALL: Right. What I'm saying is, the trip is not monitoring the battery; it's monitoring the whole logic bus, which is normally fed by power supplies which hold it above.

MR. SYLVIA: Oh. So the battery could be bad without this working.

MR. CRANDALL: We'd never know.

MR. LEWIS: Until you call on it to do its thing, you don't know it's dead.

MR. CRANDALL: It could have been bad a month after it went in.

MR. ZUG: It's like you don't know if you have a bad car battery until you try to start your car.

MR. ASHE: Unless the cells shorted out. Then you'll know.

MR. CRANDALL: We also only know we have one bad battery.

MR. ASHE: Without a signal, starting the circuit's fine.

MR. ROSENTHAL: I'm reluctant to -- At this point I think that you ought to be doing the troubleshooting on the C and not start on the other uninterruptable power supplies. I think we're in agreement on that.

MR. McCORMICK: That's correct.

MR. ROSENTHAL: We feel that we'll gain confidence, knowledge, et cetera. Based on what's learned about the C, when you then go and open up the next UPS, we'll be that much smarter. I think that we at this point should be doing things sequentially.

MR. CRANDALL: What I would like to do, because I think it would be worthwhile for the expediency, would be

to address to you what our overall plan is, accepting that you put hold points in, but I'd like the ability to say, This is the direction we're going, and you agree, and then Frank or whoever it has to be says, All right; you can go past this whole point to our next point -- rather than resitting down each time.

MR. ROSENTHAL: Fine. We will make ourselves available independent of the hours, et cetera.

MR. McCORMICK: Do you have a troubleshooting plan, or at least a sequence, of how you would propose to do that?

MR. CRANDALL: Yes. That's the logic we would like to take. I don't know if we want to address that here.

MR. ROSENTHAL: It's up to you.

MR. McCORMICK: I'd at least like to have it generally discussed -- we don't have to conclude -- at least have it handed out here so it's for the --

MR. FIRLIT: So I don't lose this thought: Is there any possibility that there are any batteries from the generic standpoint anyplace else in any control or logic circuit that we don't know about that's buried in a manual someplace that says that we ought to check this? Is somebody looking at that?

If you fix this problem, I'm not still going to be satisfied that you don't have a battery out there someplace

else. I certainly don't want to be in the horrible situation that something else happens there.

MR. McCORMICK: We'll certainly ask that question. We can't answer it here, but, if there is something.

MR. FIRLIT: Okay.

MR. McCORMICK: The question is, from where we sit right now, we want to at least initiate thought on the part of a system engineers as to whether there's another potential battery backup supply for some unit which could be sitting here and not in a PM program.

MR. BERTSCH: Yes.

MR. McCORMICK: There could be. We have to know where they are. As an aside.

MR. CONWAY: We'll talk. I'm not sure I follow you. You want me to find every place in the plant that might have another battery that needs to be replaced? Is that essentially what is being asked?

MR. FIRLIT: If we start up again, say that something else happens to our plant -- two weeks later we trip off -- and somebody says, Oh, there was a battery in this supply that said it should be changed out every two years, I want to rest assured before we start this plant up again that that doesn't happen again.

MR. CONWAY: I understand. That's the question.

MR. FIRLIT: Yes.

MR. CONWAY: I don't know how to make that happen.

MR. FIRLIT: Okay.

MR. McCORMICK: But we will make an attempt.

MR. CONWAY: Somebody is going to have to. That's a large effort -- I guess is what I'm saying.

MR. CRANDALL: What this is -- what we did is we looked at the units we wanted to attack first and what we're proposing to do because number one we have C and we agree with you, Jack, we want a complete C. We want to get a complete picture all the way around before we go on.

Our intent is to focus in on the specific troubleshooting plan for that which we'll handle specifically.

Overall, what I am looking for on this plan and that you agree and what we wish to do is to do one C, complete that to your satisfaction and ours and then continue on the same thing with 1A, looking at trips and set points, the batteries, similar to what we are doing at C, verify that we have consistency and then at that point go on to UPS 1B.

1B has a bad CB3. We want to first replacer CB3 because we can't do any trips without that being replaced and then continue on that same trip set point verification.

If we find the control circuit problem, whether we do that to the other units I would like to address at that

point.

MR. McCORMICK: You skipped 1A.

MR. CRANDALL: 1A I had second, I think.

MR. McCORMICK: A2. You are going to replace that breaker --

MR. CRANDALL: I'm sorry. Let me -- A we know we have a problem within its charger supply that we would repair first.

MR. McCORMICK: But we would do no testing.

MR. CRANDALL: Once that is repaired we would do the testing on it. We can't do testing without it. Again, on the lower level I think we can look at exactly what troubleshooting we do to repair that to make sure that we are not missing something -- if that's agreed. You know what I am saying?

MR. McCORMICK: So you want to perform the same tests that you scheduled on 1C on 1A after you change that breaker.

MR. CRANDALL: Breakers on B but same logic. Let me reiterate.

We are going to complete C, hold point on the other units. We then go to A, make its repair. There is a charger problem in there. Make that repair, then do the same test on A that we did on C, then go to 1B, make the breaker repair, do the same tests that we did on C and A.

MR. McCORMICK: That's what you call check-trip set points and record voltages?

MR. CRANDALL: Yes. In the description down there on the left is what we are intending as trips and set points.

MR. McCORMICK: And you want that statement under 1A. Do you troubleshoot the breaker? I am looking at your second page.

MR. CRANDALL: Our listings don't give it probably as well as it does on the little bubble chart there.

MR. McCORMICK: On your second page it was replace the breaker and check trip points and voltages on 1B. You didn't make that statement under 1A but you do want to propose that?

MR. CRANDALL: Yes. Again, we are taking exceptions to a couple tests that we feel would be destructive and probably not going to an area that is going to give us any good information, like the DC-OV. We don't want to stress out those DC caps. Again we handle that I think on a lower level. If you feel you want us to do that we'll come up with something.

Once we are done with those three units, our plan is to evaluate what we have got, the set points, what kind of data we received and there may be a high confidence level at that point that we have enough.

I would like to make the decision at that point, whether you want us to do the rest of those tests on the other two units.

I would like not to play with UPS 1G if I don't have to. I'm saying that upfront and not because I am trying to trick anybody or anything else. G is our plant computer. I don't want a failure on that unit or do much repairs on that unit if I don't have to.

UPS 1B is loaded. I don't have much confidence in how its logic works. I am actually concerned whether testing on it will give us the same reliability of testing on A, B and C and again I am just kind of putting that on the table upfront.

If you feel that you want us to do that, certainly we can. My plan at this point is not to do that because that actually may confuse the issue.

MR. McCORMICK: 1A and 1B do have plant impact, forward impact.

MR. CRANDALL: Yes, they do but those are already addressed in the repairs anyway.

There is repeatability in A and B.

MR. McCORMICK: I suppose what we can say is we'd like to offer this for consideration only and that we would ask that we could proceed for the troubleshooting on the C that we have -- and that would allow us to fix the cards

on the C, do that testing and then recycle back with A being probably the next one depending on how things come out.

MR. CRANDALL: I guess the point I would like to get at is a single point, clearance of ability to work, you know, rather than the overall quarantine, just, Frank, tell us to go and we can go. That's kind of the agreement I am trying to get to.

MR. ROSENTHAL: Frank?

MR. ASHE: Let me ask something here. It's very right here that 1D is what we got to show what the problem is and I can certainly understand that.

Is this another one that we can run this test without doing any repairs on it first?

MR. CRANDALL: We could do it on D. We could do it on G and if I had a choice I would do it on D prior.

MR. ASHE: -- settings, F, 1G. What about G?

MR. JULKA: Same design except it feeds the computers.

MR. ASHE: So you can do it on B, you say, without replacing the circuit breakers, is that --

MR. JULKA: Not B. D - "David," D as in David.

MR. CRANDALL: B we can do some things. We can't do the actual trans-- you know, we can't put it on line and transfer it off line. There are certain things we can't do with it until we replace the breaker.

MR. ASHE: Excuse me, I'm sorry. This test that you are going to run on C, if I understood you correctly earlier, what you said was, oh, I will -- the concern came up about changing the units. If we keep changing the units, then we are no longer going to be duplicating what we have and then I am not sure how valid the tests are and trying to relate that back to what really happened.

So you said, well, okay, I got to repair 1C so we'll make some modifications in that repair but before I really provide some confidence in that area what I thought you said you were going to duplicate that same test with another unit to see if you could duplicate it on another unit.

MR. CRANDALL: Yes, sir.

MR. ASHE: What unit is that going to be in?

MR. CRANDALL: I would like to go to A and duplicate that.

MR. ASHE: Before you repair it?

MR. CRANDALL: No, I can't. Unfortunately I can't because I can't get the engine running.

MR. ASHE: What I am trying to get to is can we duplicate this test we are going to do on 1C without having to repair the unit or something?

MR. CRANDALL: We might have to go to D to do that probably.

MR. CONWAY: The B, the Bravo UPS we're talking -- again I'm being too practical but just replacing the CB3 breaker is the only repair we are talking about doing there. It's not logic related. It really -- the way we we're working at it really should be done --

MR. ASHE: That's nice and all but there are things that occur in the installation as you well know that perhaps we can't always characterize by, you know, design kind of things.

MR. CRANDALL: I guess maybe that I have then and in that case we could do it on all three units and the theory would be that if we put an anomaly into A for example, it wouldn't be the same anomaly we would put in B.

MR. ASHE: What I'm trying to get to is to have further confidence in this test and then I think we can make more positive statements about the battery and the logic and all of that. That's what I was trying to get to, but without modifying or repairing the unit before you've done the tests.

MR. CRANDALL: The reason we've got confidence we can do it by repairing two of those, that the fault in 1A -- at this time and again I am saying we have got to look at that close as we go -- the fault in 1A is in the charger section. The charger section doesn't send trips to the module, and I understand, yes, there can be some things

that you end up inadvertently modifying to get you out of that, I know what you are saying, but we have got a high confidence that we are not in any way affecting that particular section of the unit.

MR. FIRLIT: Marty, can I make a suggestion that maybe you and you and the gentleman from the NRC work that out together, the details?

MR. McCORMICK: Yes. Well, all I'd like to get here today is get the C done and then we can move into the others and that's been the point.

MR. ASHE: Okay, and as I understand the 1C, the troubleshooting plan for 1C is you want to go in and pull two cards and take them to a bench and look at them through the oscilloscope and do some things.

MR. BERTSCH: No, we've got some on the extended board inside the unit to see what's bad. We have got to do the troubleshooting in the unit, then pull them out and repair them.

MR. ASHE: All right. Do we have anything in terms of a plan or procedure that you --

MR. BERTSCH: Not yet.

MR. ASHE: Okay.

MR. BERTSCH: That was late last night. I don't know, you haven't put them together yet, have you?

MR. CRANDALL: No.

MR. ASHE: Maybe we should leave that first because I think I generally understand what you are going to do --

MR. CRANDALL: No, we are going to clear -- the individual pieces we are going to clear between us. I am not questioning that. I am trying, what I am really intending to do is get us one level less than we are now and we have got the overall quarantine on all units and I just want to get it down a little lower so that we can expeditiously go through these things is what I am saying.

MR. McCORMICK: They'll work out with you, get your concurrence, go to the next thing.

MR. CRANDALL: And just get from our management as well the word back through that these are off quarantine if Bob and Frank say they are -- you know what I'm saying? I don't want to go all through these and have to go through a mechanism that we have got to get, you know --

MR. McCORMICK: We'll work that out, out of this room but the key player is Frank's authorization to go ahead of the troubleshooting plan. Once you have that, I'll take care of the rest of it.

MR. CRANDALL: Okay.

MR. McCORMICK: Let me just try and end this. Let me kind of try and pull this back now.

We owe you I think some other things which we'll

do off-line.

We owe you an operability history and a maintenance history, which we'll provide separately.

We owe you the PM routine monitoring and other operating procedures that go with both Class 1E and Class Non-1E UPS's. We'll provide that separate as a handout for review.

We will not be able to get Exide's formal report because they need the testing. However, we would expect from Exide with that testing in hand to have very appropriately for, provided their formal conclusions on what they think happened and corrective action.

Yes?

MR. ASHE: Before the test or after the test?

MR. McCORMICK: After the text.

MR. ASHE: Oh, okay.

MR. McCORMICK: I understood Rudi to say that he needs this information --

MR. ASHE: I'm sorry, I misunderstood.

MR. McCORMICK: But following that with that data in hand we are looking for paper to say here is what Exide's conclusion is, as soon as practical once you have the data in hand, with appropriate recommendations to fix, which also have to be cleared before we go into it.

Now on the closing bullet on the second page,

there is a series of other data which Jack has looked for and this involves other players, some of which are in the room and others are not, but we need to work out a contact arrangement for the main transformer, details to interface with that, with our experts. Howard Light is here, the AC-DC relay, if there is a need for any more data on that, and we have those. Some photographs have been taken and you have been given those and there will be others taken.

Another key thing is the plant lighting and we have the package of the plant lighting breakdown. That goes to Jose, and they can interchange that.

We're working on the UPS component loading, which won't be available until Monday, and we'll hand you that.

The sequence of events is ready and completed under Tomlinson.

MR. ROSENTHAL: He has been working with Jan Jensen on that.

MR. McCORMICK: And then a decision on the restoration of equipment, which will be at your --

MR. ROSENTHAL: We do have cameras with us, but it really is easier for me to use your photographer.

MR. McCORMICK: Okay.

MR. ROSENTHAL: If you look at the Vogtle report, you'll see some photographs throughout it. I'll work out a list with you, if you wouldn't mind.

MR. McCORMICK: Sure.

MR. ROSENTHAL: The photographer can take pictures of the office and the other stuff.

The AC-DC relaying and main transformer: We have a gentleman from Duke Power coming up to join us. We arranged it through INPO. He's due in tomorrow. Stoner. I would intend to ask him to look into that.

MR. McCORMICK: Mr. Light, you'll be available for that transformer discussion, which will be tomorrow or sometime; we'll work that out with you and Steve.

MR. ROSENTHAL: Let me just bet back to the troubleshooting plan in broad terms.

MR. McCORMICK: Okay.

MR. ROSENTHAL: You come up with hypotheses about what went wrong, you go into the 1C unit. If those hypotheses are borne out, then you proceed on to the next unit. They may not be, in which case everybody stops. Let's not interpret this as more of a work plan of what you do each day. I mean, yes, you do what you have on day 2, provided that day 1 worked out. I think everybody understands that.

MR. CRANDALL: Certainly. Yes.

MR. ASHE: Yes.

MR. CRANDALL: If we find the problem to everybody's satisfaction, there may be no reason to go try

and duplicate that, either, but I'd like to make that decision at that point, too.

MR. ASHE: Quite frankly, at this point I don't think this is a static thing. It's going to be changing as time goes on. It's not static at this point.

I don't know. Do I have the wrong idea?

MR. BERTSCH: No.

MR. ASHE: Okay.

MR. McCORMICK: I think I'm about ready to say we're done this meeting, unless someone has some other topics they feel ought to be covered. I've covered the main things I wanted to get done, and right now I'm leaving with what I think is the authorization to arrange to make the fix to the card in the C inverter, logic card or power supply; and then arrange in a formal fashion to proceed with the tests which the Exide people have proposed to us and perform that test. When we're ready to do that, we will get a-hold of the appropriate NRC personnel to be in attendance.

MR. ROSENTHAL: Right.

We'd like to attend as much of the actual troubleshooting as we can support, too.

MR. McCORMICK: We're proceeding with the B transformer work; all that's going ahead. And we will not move beyond what we already have agreed to -- the tests on the C and its repair -- although we have a schedule of how

we think we will proceed, assuming things go together.

I'm prepared to conclude this meeting unless there are some other main topics, and we can pick up the others as we go.

We're done.

MR. ROSENTHAL: This meeting is over.

[Whereupon, at 12:53 p.m., the meeting 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: Information Exchange Meeting

DOCKET NUMBER:

PLACE OF PROCEEDING: Scriba, N.Y.

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.

Jon Hundley

JON HUNDLEY

Official Reporter
Ann Riley & Associates, Ltd.

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NUCLEAR REGULATORY COMMISSION

INCIDENT INVESTIGATION TEAM

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In the Matter of: :

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Information Exchange Meeting :

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Conference Room A
Administration Building
Nine Mile Point Nuclear
Power Plant, Unit Two
Lake Road
Scriba, New York 13093
Sunday, August 18, 1991

The interview commenced, pursuant to notice, at 8:15 a.m.

CHAIRMAN: Marty McCormick, Niagara Mohawk Power Company, Plant Manager, Nine Mile Point, Unit Two

PARTICIPANTS:

From the IIT:

Jack Rosenthal, Team Leader

Frank Ashe, Electrical Engineer

Jose Ibarra, Electrical Engineer

Paul Eddy, State Observer, New York State

From Niagara Mohawk Power Company:

Ralph Sylvia, Executive Vice President

Joe Firlit, Vice President, Nuclear Generation

Jim Perry, Vice President, Quality Assurance

Rick Abbott, Manager of Engineering

Bob Crandall, System Engineer, UPS System

Anil Julka, Electrical Design Supervisor

Perry Bertsch, Instrumentation and Control Technician

John Conway, Manager of Technical Support, Nine Mile Point Unit Two

Steve Doty, Electrical Maintenance

Tom Egan, ISEG Engineer

Ray Main, Maintenance Support Engineering

John Pavel, Site Licensing

Harold Light, Senior Engineer Specialist, Transformers

PARTICIPANTS (Continued):

From Exide Electronics, and from Consulting Organizations:

Rudi Machilek, Director, Power Systems Group, Exide Electronics

Bill Zug, Product Engineering, Exide Electronics

Warren Lewis, Consultant, Exide Electronics

Steve Tsombaris, Electrical Engineer, Stone & Webster Engineering

Warren Lippitt, INPO

Tom Walters, Magnetek

PROCEEDINGS

[8:15 a.m.]

MR. McCORMICK: Good morning, everyone. I'd like to get the meeting started. Let me introduce myself. My name is Marty McCormick. I'm the plant manager. I will attempt to do my best to coordinate the meeting this morning, and you each should have an agenda of the main goals and generally how we will proceed through to cover the topics that Jack Rosenthal and I in discussions yesterday felt would be the primary points of interest.

I appreciate you all coming here this morning. I know it's early, but we have certain initiatives that have to get under way, and that is to understand just what happened with respect to the UPS power supplies. We also have some expertise from Exide that may not be here through the early part of next week; I wanted to take advantage of your presence while the NRC was here.

To get things started, what I'd like to do is go around the room. To keep some sort of logic to this, we'll have the NRC people introduce themselves first, for the record, and then the NIMO people, followed by consultants and the Exide folks.

Jack?

MR. ROSENTHAL: Jack Rosenthal, IIT team leader.

MR. ASHE: Frank Ashe, electrical engineer, IIT

team.

MR. IBARRA: Jose Ibarra, electrical engineer, IIT team.

MR. EDDY: Paul Eddy, New York State public service commission. I am the state observer on the IIT.

MR. McCORMICK: Okay. All NRC people have introduced themselves. I'll ask that the NIMO people, then, introduce themselves.

Ralph?

MR. SYLVIA: I'm Ralph Sylvia, executive vice president.

MR. FIRLIT: I'm Joe Firlit, vice president of nuclear generation.

MR. PERRY: Jim Perry, Niagara Mohawk, vice president, quality assurance.

MR. McCORMICK: I'm Marty McCormick, plant manager.

MR. ABBOTT: I'm Rick Abbott, manager of engineering, currently assigned as event assessment manager.

MR. CRANDALL: I'm Bob Crandall, system engineer for the UPS's.

MR. JULKA: My name is Anil Julka. I'm the electrical design supervisor for Niagara Mohawk.

MR. BERTSCH: My name is Perry Bertsch, I&C technician.

MR. CONWAY: My name is John Conway. I'm manager of technical support for Nine Mile Two.

MR. DOTY: Steve Doty, general supervisor of electrical maintenance.

MR. EGAN: Tom Egan, ISEG engineer.

MR. MAIN: Ray Main, maintenance support engineering.

MR. PAVEL: John Pavel, site licensing.

MR. LIGHT: I'm Harold Light. I'm a senior engineer specialist involved with transformers across Niagara Mohawk's system. I'm with Equipment Analysis, out of Syracuse.

MR. McCORMICK: Does that complete the NIMO folks?

[No response.]

MR. McCORMICK: Okay. Exide, please, and consultant assistants.

MR. MACHILEK: My name is Rudi Machilek. I am a director with the power systems group of Exide Electronics, and my position is senior staff consultant.

MR. ZUG: My name is Bill Zug, director, product engineering, Exide Electronics.

MR. LEWIS: My name is Warren Lewis. I'm a consultant to Exide.

MR. TSOMBARIS: I'm Steve Tsombaris, electrical engineer with Stone & Webster Engineering.

MR. LIPPITT: Warren Lippitt. I'm with INPO. I'm acting as a consultant to the utility.

MR. McCORMICK: Has everyone in the room introduced themselves? One more.

MR. WALTERS: Tom Walters, with Magnetek, guest of Mr. Light.

MR. McCORMICK: Okay. You all should have an agenda, and I'd just like to very briefly review the purpose of the meeting this morning, and then we'll get right into the business at hand.

I have listed four items, goals, here. The first is to exchange information relative to the uninterruptable power supplies and the related components, such as the main transformer and reserve transformers.

We'll present a troubleshooting plan for NRC concurrence and look to obtain their approval to implement that plan.

We expect to provide data exchange on the lighting design for the normal, essential, emergency, and egress lighting fed from the UPS sources; however, time permitting, we can get into the details. What we will do is just to provide that package for further follow-up.

And we hope to clarify, then, as appropriate, interfaces for scheduled interviews and further data exchanges relative to the main transformer failure analysis

and the UPS component load list, which is currently being prepared and should be, probably, finished early next week.

With that introduction, are there any questions?

[No response.]

MR. McCORMICK: I'd like now, then, to begin into the procedural part of the meeting. We have arranged with Anil Julka, who is on Rick Abbott's team, to kind of set the stage and talk through, clarify for everyone the on- and offsite sources of power to the UPS buses, both safety-related and non-safety-related, and to explain how the various UPS buses are configured.

Anil, would you begin, please?

MR. JULKA: Thank you, Marty.

Before I start, I'm going to pass out this hand-out. Really what we did was put together a sketch showing the offsite sources coming into the plant. I know we talked to NRC a little bit yesterday, and it seemed like we needed something which shows how the relationship of the offsite power is to our system. I'm going to hand out a few. I'll wait until everybody gets one; then we can start going over it.

[Documents distributed.]

MR. JULKA: First of all, the Niagara Mohawk, the 345 kV system comes in at the top. You'll see line 23, Scriba station. That's the 345 line, and that's where the

generator goes through, via the four main transformers, which are shown there. Those are configured from left to right, X-Y-Z phases. The fourth one is the spare transformer, which is normally not hooked up. It's ready to go into either one of those three spots.

MR. SYLVIA: Your X-Y-Z corresponds to our A-B-C?

MR. JULKA: That's right. A-B-C, X-Y-Z, it's synonymous, really.

The generator is tied in there with the isophase bus to the main transformers and coming down to the normal station service transformers. The normal station service transformers are three-winding transformers, with each winding feeding down to the switch gear, 2 NPS switch gear 001 to your left and 2 NPS switch gear 003 to your right. That's a 13.8 kV level at that point. The way the plant is really designed is, there are two halves to the plant. Half of the plant is fed from one side, and half of the plant is fed from the other side.

Keep in mind that this is only the non-class-1E power in the plant.

If you go again to the top, to the left, there is a 115 kV source A, which is line 5, going to our switch yard. That feeds Division 1, all the way down, 2 ENS-star switch gear 101. That's the Division 1 power, which is normally lined up to the offsite source, 115 kV, which is

independent from the 345, although they do get lined up farther down in our 345 kV grid system.

At the same time, there is a second offsite source, which is on the other side, which is line 6. It is not written on there, but that's the line 6, which is going to Scriba. Oh, line 6 is written; it's there. That's the reserve bank B. That comes down feeding switch gear 103.

Does everybody see that?

[No response.]

MR. JULKA: So we have two offsite sources coming to two divisional power buses, the switch gear buses, where diesels are tied, and they are completely independent of the normal station service.

MR. ASHE: Excuse me.

Frank Ashe, NRC.

This diagram appears to show only one line going to each of the safety buses. This CUB. ONLY -- what does that mean?

MR. JULKA: That's a cubicle only; there's no breaker in that position.

MR. ASHE: Okay. So the only source to each of the two buses would be a delayed-access source, of which you'd have to go and pull another breaker from somewhere and plug into there before you could power from this alternate?

How would you power from the alternate to ensure power to one bus?

MR. JULKA: First of all, I think if you look at GDC-18, which is the criteria for the --

MR. ASHE: Seventeen.

MR. JULKA: Seventeen. Excuse me.

We need to have two offsite sources, and normally most of the other plants don't have the direct alignment to the offsite. Most of the plants feed their switch gear divisional buses from the normal station service, so they have to have an alternate source which is automatically transferred.

In our case, we have our two offsite sources, which are line 5 and line 6, which are directly connected to the switch gear, so normal station service has no impact on the offsite sources. Our design, I believe, is better than most of the designs, because we don't need to transfer, and it's directly providing us two lines of power, and those two lines are in accordance with the GDC-17.

MR. ASHE: Okay.

MR. JULKA: The first line, if that source fails for any reason, we do start the diesels.

MR. ASHE: Okay. They would start and then attempt to connect.

MR. JULKA: And they'll connect. If there is no

power, they will connect.

MR. ASHE: Should you need a second offsite source, where would you take the breaker from?

MR. JULKA: From the same cubicle.

MR. ASHE: Oh, okay. You would remove it from the primary cubicle and roll it over to the --

MR. JULKA: Next cubicle.

MR. ASHE: -- next cubicle and plug it in. Okay.

Is there a time for that process? Half an hour, an hour?

MR. JULKA: No. I guess we could go into an LCO if you lost one offsite power.

MR. ASHE: But I mean the actual time required to do that operation would be, what, an hour, maybe?

MR. JULKA: Not even that.

MR. ASHE: Thirty minutes?

MR. EDDY: Fifteen, twenty minutes.

MR. JULKA: Fifteen, twenty minutes.

MR. EDDY: What do you think, Ray?

MR. MAIN: I think 20 minutes is an adequate number.

MR. JULKA: But I think if you lose one offsite line, you go into a tech spec LCO, and you have a certain time to restore power.

MR. ROSENTHAL: Jack Rosenthal.

We have established that the 1E4160 buses are sitting on your reserve bank transformer or reserve auxiliary transformer, which is another name for it, from a 115 source. Going upstream of there, do you then have one more transformer between that source and Scriba, a step-down transformer? Can you just give us a little bit more?

Let me tell you, the point is that I think that there is a causal reason why the perturbation on the 1E buses would have been less than the perturbation on the non-1E buses. I would like to have you explain that to me.

MR. JULKA: Okay. All the lines from 345 go to the Scriba. The 115 kV line 5 and line 6 are physically, separately routed, so there is no common mode failure going into the yard. When you get into the 345 kV yard, there are two buses which can feed either of these sources, which are buses A and B, which are connected to the entire grid system of upstate New York.

MR. ROSENTHAL: So there's at least one more transformer.

MR. JULKA: That's right.

MR. ROSENTHAL: Every transformer is going to be so much of a dB loss in the impulse.

MR. JULKA: Yes. There is at least one transformer there.

MR. ROSENTHAL: At least one more.

MR. JULKA: Yes.

MR. CRANDALL: There's a 345-to-115 step-down at Scriba.

MR. JULKA: We have another level transformer back there, too.

MR. CRANDALL: We can provide a drawing, a configuration of that.

MR. ROSENTHAL: We'll be walking away, I'm sure, with the actual electrical drawings you're going to share with us.

MR. JULKA: This was just to give you an overview of how the systems are tied in the plant itself.

This is the overall sketch. Are there any other questions on this? If not, I can go on to the next one, which is the UPS tie-ins, how they are tied in.

MR. ROSENTHAL: At some point are we going to get traces, I guess from an oscilloscope, of what the buses saw.

MR. JULKA: Yes. I can give a brief description, but I do have my report. I can give copies of it later on; I did not make copies for this meeting.

MR. ROSENTHAL: Well, if you compare -- Can you just verbalize for a minute and qualitatively tell us?

MR. JULKA: Sure.

Do you see the middle phase on the main transformer at the top? There was a fault in that

transformer. The root cause, Harold and his people will determine why that happened, but the electrical protection system, we assume that fault did happen.

We had differentials across that transformer itself, which operated and cleared that fault. At the same time, we have a backup protection which covers the generator and the main transformers together, and that also operated and sent a redundant signal, although it was needed, to trip.

At the time of the fault, we cleared the fault. From the starting of the event to when all the buses were transferred, the total time was about 12 cycles. From the clearing of the fault to the restoration of the power, it was 6 cycles.

Now, at the time of the fault, the B voltage collapsed, because the fault was on the B line. The voltage that the Scriba oscillograph showed was approximately 80 kV. I just want to reemphasize that the charts we are looking at -- to determine all this, the main purpose of these charts is to really look at the events as it happened and not really the magnitudes of the voltages and currents. When I say 80 kV, that's our best approximation of what that is.

MR. FIRLIT: This is Joe Firlit.

I'd like a clarification on the cycles. It took 12 cycles for our differential relays to take off the

transformer; is that correct?

MR. JULKA: No. It took us 12 cycles from the initiation of the fault to when the power was restored.

MR. FIRLIT: To when the power was restored. Okay.

MR. SYLVIA: Is this transfer from station service to reserve?

MR. JULKA: Right. From the initiation of the fault.

MR. FIRLIT: How does the six cycles fit in there?

MR. JULKA: From the disconnection of that bus from the faulted source to the transfer was six cycles.

MR. FIRLIT: Was six cycles.

MR. JULKA: It took six cycles to clear the fault, six cycles to connect to the new source.

MR. FIRLIT: Okay. So that's where you're getting your total of 12 cycles.

MR. JULKA: Right.

MR. FIRLIT: I understand that now.

MR. JULKA: Our design is that, if normal power is lost for any reason, we take the 13.8 kV switch gear 001 and switch gear 003 and correspondingly transfer to the corresponding reserve transformers, because reserve transformers are, again, three-winding transformers with the tertiary wiring feeding the safety-related buses, and the

other winding is there for the 13.8. It's used for normal start-up and also for fast transfer.

Our oscillograph did show that, after that 12 cycles, we picked up the load on both buses, and all the relaying schemes operated as they were designed to operate, and all the load was transferred over as designed.

Given that six cycle time, we did probably see that from the initiation of the fault to the disconnection of the fault at six cycles there was a dip in the B phase voltage because B went to ground so that probably ran through the system but again it should not be a problem for a system to handle that because faults like that do happen and electrical systems are designed to take care of that.

As far as the protection schemes are concerned I feel very pleased to see that all the protection worked as it was designed.

MR. ROSENTHAL: So if you have a scrub trace of some sort in the switch yard and are there any other qualitative, quantitative traces that we will be able to look at in this lower down, or is that it?

MR. McCORMICK: We have additional monitoring on the lower buses.

MR. CONWAY: John Conway.

The additional monitoring that we have available is via the G-TARS computer which lost power during the

event. Therefore, that data is not retrievable.

MR. ASHE: Frank Ashe, NRC. You seem to be suggesting that the differential was the actual guy that cleared the fault. Could you take us through that and show us how you determined that?

MR. JULKA: The differential when the targets came in and they operated the knock-out relay which initiates the fast transfer.

MR. ASHE: Okay, when the target came in, though, that's not for a fact?

MR. JULKA: I guess when the target comes in, that's when the relay operates.

MR. ASHE: I know that but you wouldn't be there looking at it at the time at which it came in so how do you know that it was the first guy to initiate it? Couldn't you have initiated something --

MR. JULKA: We went through all the targets which came in. We made a list of every target which came in in the plant. The differential came in on the transformer. Differential came in on the overall protection scheme but they are coordinated so the differential of the transformer will go first.

If the unit takes you out first, then the differential of the main transformer will not go after that because your trip has already occurred. You know, the

sequence of events has to occur in the way the differential across the main transformer is set for a lower value. The differential across the transformer is set just to operate on the transformer fault so it is set for a lot lower value as opposed to the overall unit differential which is set for a lot higher burns. It's looking for more than just the transformer itself. It's looking for generator and the transformer so it is looking for overall protection scheme as opposed to just the transformer currents, so the transformer differential really has to operate first before the unit can operate.

That just isolates us. You know, we have separate differentials across the unit generator. If there is a fault in the unit generator they should operate first before the unit would go, overall differential scheme.

From there we concluded that, yes, unit differential based on the settings did go first and it was followed by the -- this happened all within a few cycles so the overall differential went and took out the lockout relays and generator overcurrent relays came in. They took out the lockout relay on the 345-kV. The ground overcurrent relays came in, so we have in the plant four protection schemes and every one of them operated, which they are supposed to.

MR. SYLVIA: Ralph, I have a question.

Differential is differential between the main transformer and generator?

MR. JULKA: We have one differential across the two windings of the transformer.

MR. SYLVIA: Okay, that's across the transformer?

MR. JULKA: Right.

MR. SYLVIA: Do we also have a differential between the transformer and the generator?

MR. JULKA: That's right.

MR. SYLVIA: Is that from CTs or PTs? Is that voltage or is that some combination?

MR. JULKA: It's mostly CTs, current. They are connected. What it's looking for is current going in the same as current going out. If it's not it's going to trip you for any reason.

We have one across the transformer, one across the generator and one across the overall.

MR. SYLVIA: And by the lockout relays you know it was differential? What lockout relays?

MR. JULKA: Those picked up. Corresponding lockout relays were picked up and lockout relays stay in that position unless they are reset.

MR. FIRLIT: You have targets, don't you, that little red targets that come on?

MR. JULKA: Yes. Targets come on the differentials

and the lockouts stay in that position unless we reset them manually.

MR. ASHE: Frank Ashe, NRC. The way you're arriving at that, and you correct me if I am wrong, is through your knowledge of the inherent characteristics of your design. After the fact, looking at the relays to see that the target was tripped is not going to tell you which one tripped first. I think you are using the design information to know that the differential would have actuated before some other thing based on the actual inherent characteristics of the design. Is it fair to say that?

MR. JULKA: Yes.

MR. ASHE: Okay. Rather than something that I go to avoid and actually look at. Just looking at a trip target and a relay is not going to tell me it actuated before overcurrent actuated because all the targets are going to be tripped, so how do I know which one?

Unless I was right there at the time, which I doubt that anybody was, then I wouldn't no.

MR. JULKA: Two differentials is hard too, but an overcurrent it's timed so overcurrent will come later.

MR. ASHE: So what you are saying the differential actuated basically because of your inherent design characteristics. You know it's going to be the

differential.

MR. JULKA: Yes, by design.

MR. ASHE: Right, by design.

MR. JULKA: Yes. If you have a fault in the generator you should disconnect the generator first so the differential on the generator should operate first. Differentials work very fast, very fast acting relays. Overcurrent relays are slow acting.

MR. ROSENTHAL: Can you share that list of flags and targets with us?

MR. JULKA: Yes, I have a complete list of every target which came in. I can give a copy to you.

MR. McCORMICK: And the calibration and the time settings that go with that, so that you can follow up on that, so that data is available and will be provided.

MR. IBARRA: This is J. Ibarra. Can you tell me the core protection schemes now?

MR. JULKA: Okay. They are called unit alternate protection I, unit alternate protection II and generator protection and one is generator backup protection.

We have two lockout relays in each one of those protection schemes so there is a redundancy within the redundancy.

MR. McCORMICK: Okay, any further questions on the general feeds to the station? We'll provide as

indicated the relay scheme and the calibration data to support the deductions we've made so for in terms of how the relay scheme worked and what it meant to us.

A key point of information I think for everyone here is to show the relationship of the various uninterruptible power supplies to the normal station feeds and I would like to get that discussion brought forward next. Anil?

MR. JULKA: I am going to pass out another handout.

MR. ROSENTHAL: Good.

MR. JULKA: Now for those, if you want to get into the details, I do have the bigger size drawings and they are highlighted showing how the systems tied in, but this is -- for information. If you want, I have fresh copies I've highlighted which are the station drawings.

MR. ROSENTHAL: Right. You will provide those.

MR. JULKA: You can have these, yes. They are highlighted.

MR. ROSENTHAL: And then you and Frank can separately meet on that and that would not be a transcribed meeting. We'll get the actual plant drawings highlighted. Thank you.

MR. McCORMICK: Now we are going to discuss the 109 UPS's and how they are both safety-related and non-

safety related and how they are tied to the various bus configurations within the plant.

MR. SYLVIA: While doing that could you also indicate which ones are the Exide and which ones are the other manufacturer and the name of the other manufacturer.

MR. JULKA: Okay. On this drawing we should go from the left, UPS 1-D, 1-C, 1-A, 1-B, and 1-G and 1-H. These are all Exide units.

UPS's 3-A and 3-B are Elgar, E-l-g-a-r and those are 10 kVA units, small units.

MR. SYLVIA: Could you repeat? 3-A, 3-B and --

MR. JULKA: 3-A and 3-B are Elgar and they are 10 kVA units.

UPS 1-H is 5 kVA.

Bob, do you want to correct me on that? 5 kVA?

MR. CRANDALL: That is correct.

MR. JULKA: And UPS 1-D, 1-C, 1-A, 1-B and 1-G are all 75 kVA units.

1-H is a different design as opposed to the other five, although they are all exide.

Now one key thing to notice is I guess they were all fed from different -- UPS 1-B was fed from switchgear 001, which is the left half of our distribution system and all others were fed from switchgear 003 except for UPS-3-A.

The normal source is shown on the top. The

alternate source is shown at the bottom.

At the bottom I have a single line for Class 1-E UPS's 2-A and 2-B. They were tied in separately to the Class 1-E switchgear so they had no relationship to the other supplies whatsoever. They are fed from our normal 115 kV offsite source which was not really impacted by this fault.

MR. JULKA: They are the Elgar also.

MR. ROSENTHAL: How big are they?

MR. JULKA: Those are 25 kVA units.

MR. FIRLIT: So we have a total of ten UPS systems.

MR. JULKA: Yes.

MR. SYLVIA: Excuse me, what are the other two again?

MR. JULKA: Elgar.

MR. SYLVIA: What are they supplying?

MR. JULKA: At the bottom.

MR. SYLVIA: Okay, and they are the Elgar too?

MR. JULKA: They are the Elgar. The reason all these four are Elgars, 3-A and 3-B were brought to the same requirement as the safety related UPS's although they are used in non-safety systems. These are for the RPS and the scram solenoids -- RPS logic.

MR. ROSENTHAL: I'm sorry, can you just repeat

that sentence?

MR. JULKA: These were the UPS 3-A and 3-B were brought to the same requirements as the Class 1 UPS's so they were bought from the same manufacturer. The 2's and the 3's are similar design.

Now going back to the loads, typically --

MR. ROSENTHAL: I'm sorry.

MR. JULKA: Go ahead.

MR. ROSENTHAL: Just to close out it so that we don't have to revisit, 3-A, 3-B were brought to the same standards as 2-A, 2-B because it had the scram solenoids?

MR. JULKA: It's the RPS logic.

MR. ROSENTHAL: It had RPS logic sitting on it.

MR. JULKA: Right.

MR. ROSENTHAL: And do those 3-A, 3-B have a QA, QC preventive maintenance, et cetera program commensurate, I recognize it is non-1-E, but a program commensurate with the importance that you place on that?

MR. CRANDALL: And let me clarify that too. All four were purchased non-1-E -- or all purchased Class 1-E and then we have since upon installation downgraded 3-A and 3-B to non-safety related and the design is such that there are what are called electrical protection assemblies on the output of 3-A and 3-B.

For that reason, they fall under the same criteria

as the non-safety related. They are under the same PM type of programs and everything because of the EPAs. The EPAs protect the scram solenoids for us.

MR. JULKA: Let me clarify that. They were purchased to the same requirements, same QA requirements at the time of procurement. I think that is the key.

MR. CONWAY: This is John Conway. Once or twice there were statements here about scram solenoids I want to clarify.

The scram solenoids are not fed from an uninterruptible power supply, use the logic itself.

MR. ROSENTHAL: I'm sorry. They come up from the generator sets?

MR. JULKA: That is correct.

MR. ROSENTHAL: Which is in turn fed from non-1-E, just AC power.

MR. JULKA: UPS 1-D and 1-C mainly feed the essential lighting in the plant and some communication, Gaitronics.

UPS 1-A and 1-B feed the control room circuits. 1-G feeds the computer. 1-H is strictly an isolated system for the stack.

Is that right, Bob?

MR. CRANDALL: Yes -- monitor system, single load.

MR. JULKA: And we went over 3-A and 3-B for the

RPS logic. 2-A and 2-B feed the safety-related system in the plant.

3-A, 3-B, 2-A and 2-B and 1-H, they were not impacted by this scenario.

MR. CRANDALL: Just to clarify, this is Bob Crandall, 2-A and 2-B saw a bump on their maintenance supply -- that we know, because there was an alarm for sink loss, so there was a bump, though non-impacting.

MR. SYLVIA: I have a question. Maintenance supply being the ultimate supply --

MR. CRANDALL: There's three common terms and maybe we should clarify it at this point.

The term "bypass," the term "maintenance," and the term "alternate" are all synonymous. When you are talking UPS, different people use different terms.d

MR. ROSENTHAL: You said that a 2-A and 2-B -- you picked up an alarm. Is there a quantitative answer?

MR. CRANDALL: We went out of sync. The UPS went out of synchronization with its maintenance supply. We don't know what period, whether that's you know when we transferred our station loads to the offsite or prior to that but we also got some undervoltage targets on the Class 1-E, 4160 buses.

MR. ROSENTHAL: So can you quantify then, you know, the undervoltage target comes in when it's three volts

off, 20 volts off? I mean, you know -- or later?

MR. CRANDALL: I don't know.

MR. ROSENTHAL: But we will be able to do that?

MR. JULKA: I can clarify that. When that fault happened the entire 345 kV system went down in that and particular phase and that impact was felt at FitzPatrick Nine Mile I and the entire upstate New York grid system.

The 115 kV system, the B phase, did go down a little bit on that time. It did pick up the targets on the switchgear 101 and switchgear 103 but it was for only a few cycles that it did not initiate any other action.

We have done the voltage relays on this switchgear 101 and switchgear 103 buses which are set at I am going to say approximately because I don't have the right number here, approximately 92 percent voltage for 30 seconds. At that time we disconnect the system if that condition persists.

Then the second line of protection on the undervoltage is also there, which is approximately 80 percent and that's for 3 seconds, so we have two lines of protection which will -- targets may come in but they do not initiated any action because of the time delay involved in those actions.

MR. ROSENTHAL: I'm sorry, if you didn't peg the target for the 80 percent, three second, if you did not then

you believe that the perturbation was less than that?

MR. JULKA: That's right.

MR. ROSENTHAL: Okay, but you did pick the target on 92 percent 30-second?

MR. JULKA: Target? Target, yes -- but it didn't time but we know it reached that voltage.

MR. ROSENTHAL: 92 percent, for some time less than 30 seconds, yes?

MR. JULKA: Less than six cycles, yes.

MR. CONWAY: Did both sets of undervoltage schemes, targets indicate for an actuation?

MR. JULKA: No.

MR. CONWAY: Just the fire and lighting?

MR. JULKA: Yes.

MR. CRANDALL: That was the same throughout all three divisions?

MR. JULKA: All three divisions.

MR. CRANDALL: That's 50 milliseconds. There's plenty of time for the UPS to sense that little bump and it locks in an alarm so we had some idea that there was something there but it didn't affect them at all.

MR. ROSENTHAL: Okay. I am not arguing that UPS 2A or 2B had a hard time fulfilling its safety function which clearly it kept up but rather trying to quantify what is going on here.

I think it will be useful to people chasing ground faults and just other stuff to bring it all out.

MR. McCORMICK: Okay. Do any of you have any other --

MR. ASHE: Frank Ashe, NRC. Where was the 345?

MR. JULKA: It's out in the switch yard. It's about a half a mile away.

MR. ASHE: Okay, because I think what all this is coming down to is the 345 fault did back into the 115 some kind of way and that's why you saw it on the safety buses a little bit.

Is it fair to say that?

MR. JULKA: Yes. It resulted in the entire upstate New York system, so I'm sure every other plant in the --

MR. ASHE: Do you believe that that's the explanation as to why, since its impact obviously having gone that distance would be far less severe than that being seen by the AC sources feeding into the non-class 1E inverters? Do you really feel that is the reason why you didn't lose the Class 1E inverters?

MR. JULKA: Well, I think that we are still investigating why we lost the inverters. By normal design we should not have lost the inverters. Faults like this do happen in the industry and I guess the main, the electrical

system should be designed to handle these faults and I think our protection schemes did handle this fault -- I guess that is the intent of the inverters, to keep operating under these changes.

MR. ASHE: What we're trying to come up with here is why -- maybe I should ask this directly really.

Why do you feel that you lost the non-Class 1E inverters at the same time you got evidence that clearly suggests that Class 1E inverters saw something as a result of this fault but yet they stayed all on. You didn't lost those.

What was the difference?

MR. JULKA: I guess we don't know.

MR. ASHE: It's still under investigation?

MR. JULKA: Right, so as far as I am concerned that is the only piece of the puzzle which still needs to be solved is why those converters failed.

MR. SYLVIA: I have a question on something you just said.

When you made the statement that you should not have lost the non-1E converters, were you thinking that the normal supply should not have opened or just generally a broader statement?

MR. JULKA: No, what I am saying is on faults like this we disconnect the faulted power supply at the 345 line.

The intent was to fast transfer to switchgears to go to a regular source and the UPS's should have hung in.

MR. SYLVIA: And there should have been no transfer, even to one of those, the alternate --

MR. JULKA: That's right.

MR. SYLVIA: The breakers should have stayed closed, the normal supply breakers.

MR. JULKA: Yes.

MR. McCORMICK: I think in the next group that will discuss this, Ralph, we'll get into the logic of what those inverters should have done given the interruption that we had with respect to the line fall.

We have the Exide folks and we also have our system engineer to walk us through the control logic of what should have happened as we think the design should have operated and then we also are prepared to talk a little bit about our experience so far with these devices through other transients that have taken place.

I think that's appropriate, unless there are other questions.

MR. ASHE: I have one question.

Is there any definitive information, like strip chart recorders or monitoring equipment, in which the magnitude of voltages occurring attendant to the fault could be somewhat assessed between the non-class-1E buses and the

class 1-E buses? It appears as though the class-1E buses -- the effects of a fault there appear to be far less severe, just due to the design arrangement and so forth. But is there any definitive information, like monitor or whatever you might have had, that really backs that up?

MR. JULKA: The same oscillograph charts from where we made this conclusion.

MR. ASHE: But do you monitor the secondary side or the 115 line?

MR. JULKA: We do -- no.

MR. ASHE: The 4160 aspects.

MR. CONWAY: Not with the oscillograph.

MR. JULKA: No.

MR. FIRLIT: This is Joe Firlit.

We talked about the oscillographs in our station. How about in the substation at Scriba? Do we have oscillographs in there that have a time delay on it to record continuously, like 60 cycles or something like that, so we could go back and look at those oscillograph traces?

MR. JULKA: I think the oscillographs we are talking about are the Scribe oscillographs.

MR. FIRLIT: Oh, is that right.

MR. JULKA: The plant one was not working.

MR. FIRLIT: Okay.

MR. SYLVIA: The normal supply breaker, is it

within the cabinet of the UPS, or is it a separate breaker?

MR. JULKA: Yes. For the UPS, it's within. It's got an output, input, and alternate. Every breaker is within the cabinet itself.

MR. SYLVIA: Controlled by the control circuit, and so forth.

MR. JULKA: Part of the UPS, yes.

MR. FIRLIT: In terms of mechanics here, we do have coffee out here for people, and there is some banana bread, so just help yourself.

This meeting will go longer than two hours, in my projection.

MR. JULKA: I think the key thing I wanted to emphasize is that faults like this do happen in the electrical system off and on. In my lifetime, I have seen four or five of these faults, and I think we have to go from there and make sure the system operates properly.

As to the UPS, in our judgement at this point, that is the only open piece of the puzzle, on the UPS, which we have the Exide folks here for, to resolve that, why that did not transfer. Other than that, I think we are pleased with our system, how it operated.

MR. McCORMICK: Okay. Are there any questions on the material covered so far?

[No response.]

MR. McCORMICK: We have been at it about an hour. We're at a point where there is a logical transition to get into the workings of the UPS systems. Perhaps if we take a five-minute break, make sure we're comfortable, and convene here in five minutes. Work that as precisely as possible, please.

[Recess.]

MR. McCORMICK: I'd like to convene what I'll refer to as phase 2 of our meeting, which gets down to the details of the UPS control logic and design and gets into some of the more important things relative to our needs to agree on a troubleshooting plan and to use the input from our technical experts who have come to help us out from Exide and to understand just what took place here.

I will ask Bob Crandall, our system engineer, to lead this part of the discussion and to introduce, as appropriate, the input from the Exide organization.

MR. CRANDALL: This is Bob Crandall.

We're going to split this into the logic, and then I will do the history and maintenance. I don't want to get into it very deeply, but I want to hand out something, just so everybody that may be looking back at it down the road can get a little concept of where we are different in some of the units. What this is is a packet.

[Document distributed.]

MR. CRANDALL: I hesitate to use the word "schematic," because it's on a really basic level, hand-drawn kind of stuff. There's nothing false in it, but obviously it's much more complex than this.

The first page is the Exide UPS's. One thing I just want to illustrate, more to get the other one out of the way, is that 1-H is the last page, and I want to just show just how drastically different that is and why it's not part of the discussion, why we're not concerned about it. It's because it's not even close. That question has come up a lot of times. It's not even close.

Okay.

MR. McCORMICK: Are you going to walk us through that logic?

MR. CRANDALL: Yes. I'll give you a real basic on what we're talking here.

Two sources of power in: the AC input three-phase is from our normal supplies, non-safety-related; it's 575 three-phase. It comes into the unit. That AC-to-DC converter is just that. It's like a battery charger in there that converts it to DC. We have our plant batteries connected to it through CB-2. CB-1 and CB-2 are both within the box of the UPS. That battery is a backup: if the DC voltage on that bus between the AC-to-DC converter and the inverter drops, then the batteries take over. It is not a

transfer type thing.

MR. ASHE: Frank Ashe, NRC. Excuse me one minute.

The AC input three-phase that you showed there upstream of CB-1, what's the magnitude of the voltage there?

MR. CRANDALL: It's 575. That's a delta input, by the way; it's not a grounded reference, I'm saying. We don't bring a ground into the unit from the AC input.

We convert down to 140 volts DC. We call it DC link. Then the inverter converts that back to 120-208 three-phase Y. That's a grounded output.

On the bottom is our maintenance supply, alternate supply, bypass supply -- those are all the same terms. Then 575 feeds into a transformer that transforms that to 120-208. That 120-208 goes through a regulator that really corrects for voltage, keeps it plus or minus 2 percent, and sends 120-208 to the -- towards the UPS; I'll leave it that way.

The way this device works: We're normally on AC, with the DC available. CB-1 and CB-2 are closed. When we're on UPS power, CB-3 is closed, feeding the critical bus, whether it's the computer, lighting, whatever that happens to be. There are a number of trips, a number of parameters, that the UPS monitors. One thing it does is, it looks at the output of the maintenance supply. If the maintenance supply is within certain parameters for

frequency and voltage -- and example of that is 60 plus or minus a half cycle -- if that maintenance supply is within those parameters, the UPS will adjust itself to exactly duplicate that frequency, so it's in synch. If the maintenance supply goes outside of those parameters, the UPS will run on its own internal clock at 60 cycles. That's a constant referencing back and forth.

MR. ROSENTHAL: Excuse me. That's both frequency and phase angle?

MR. CRANDALL: Yes. The zero crossings are looked at as well. It's not just the frequency; you're right. There are deadnuts on.

Exide, you can correct me if I'm in any way, shape, or form not saying that precise.

MR. MACHILEK: No, you're okay.

MR. CRANDALL: The situation we were in: We were in a normal configuration. As I say, we had AC, DC available. We had CB-3 closed. CB-4 was open, which was normal. When we have any type of off or trip to the UPS transfer bypass, the way the transfer takes place is this: First the static switch gates on, makes a connection between the maintenance supply and the critical bus. We're totally in synch, so that's not a problem. Then CB-3 will open; then CB-4 will close.

That particular transfer of power from UPS to

maintenance takes place in less than 4 milliseconds. We have seen that in a 1 to 2 millisecond range.

The tracers we took. Extremely rapid.

Things that can cause that: As I say, there are certain parameters, high voltage on the output, low voltage on the output, over-temperature, logic trips, things like that. When we get a trip of the UPS, what occurs is, CB-1, CB-2 both trip; the logic tells CB-3 to open; and, if the maintenance supply is in synch, it will tell CB-4 to close.

MR. MACHILEK: This is Rudi Machilek.

If I may substitute the comment that, in case of a transfer, the command to gate the static switch and the command to close the CB-4 bypass breaker occur simultaneously. The function of the static switch is solely to overcome the time it takes for the mechanical circuit breaker, CB-4, to close, which may take about 30 to 50 milliseconds. The static switch would gate within about 120 microseconds, so the function of the static switch is solely to overcome the time it takes for the mechanically breaker to close.

I also want to go on record that the synchronizing between the UPS output and the bypass source is done on phase A-B. That means we are comparing phase A-B of the inverter output to the voltage A-B on the bypass. The reason that I like to emphasize is that phase B is the one

which suffered a disturbance, and that would, of course, cause the transfer command to be not there.

Even if the UPS would say, Go to bypass, it would not do it.

MR. McCORMICK: Let me understand. Phase A-B?

MR. MACHILEK: Voltage A-B. On a three-phase system, the phase-to-phase voltages are A-B, B-C, and C-A, as compared to phase-to-neutral voltages, which would be A, B, C, neutral. We are using that one phase for the purpose of confirming that the frequency is identical, that the phase coincident it within about 7 degrees, and that the voltage difference between the two sources is no more than 10 percent apart. We call it a delta-V or the difference in the voltages, by magnitude.

MR. SYLVIA: Can I ask you a question about this? We're talking about synchronizing and how they have to be together in order for the maintenance supply to close in.

MR. CRANDALL: Correct.

MR. SYLVIA: If a transfer is taking place and, say, it starts with CB-1 opening and all of that goes to zero, what's the significance of the synchronizing if, on a transfer, your normal supply has gone away, it's zero?

MR. CRANDALL: Let me attack it from the other end, and maybe that will better explain it. Don't take the numbers -- Rudi, you can throw in the exact numbers for me

if you wish.

What we're talking about is an example where we get an under-voltage for some reason on the output of the UPS: inverter is failing or something like that. What occurs very rapidly is, we're normally at 120; we droop down to, say, 116, and it's crashing. It's still at 116, let's say, and before it actually has tripped the UPS, it has already given the command to transfer, and the transfer is already done, and then the UPS trips. Rather than, the UPS has tripped, and now it's going to transfer, it has really transferred, and then the UPS goes away. Do you follow what I'm saying?

The wave shape isn't broken at all. It's merely a small ripple on it.

MR. SYLVIA: This storage battery really wouldn't have the capacity to carry load for any period of time; it's just to keep the voltage steady.

MR. CRANDALL: No. That has the ability to carry it for two hours.

MR. SYLVIA: Oh, two hours. Well, why is it so important that this transfer take place really fast.

MR. CONWAY: John Conway.

Let's clarify the difference between the battery carrying the critical load and the battery just carrying the logic load in the UPS. Which battery are you talking about?

MR. ROSENTHAL: The storage battery shows on this diagram.

MR. SYLVIA: That's the station battery.

MR. CRANDALL: The design basis for that is to be able to supply all of the UPS's on a particular battery, or all of their loads, for two hours with no AC power to the plant. They have that capability.

MR. ROSENTHAL: How big is battery 1A?

MR. CRANDALL: It's 5100 amp-hours.

MR. SYLVIA: So that's not a problem. Why wouldn't the system be able to just run the battery for a while?

MR. CRANDALL: One thing we do know occurred: We didn't have a failure of the UPS to go to battery; we had a trip of the UPS. A signal was generated, though we haven't identified where that came from -- we're looking in some areas -- but we do know that the UPS got a trip signal that told logically CB-1 and CB-2 to trip and CB-3 to open. It would go to the battery if we had a loss of power into the UPS, and that's not what caused it to fail.

MR. ROSENTHAL: How do you know that? You said that you got a logic signal to CB-1, -2, and -3.

MR. CRANDALL: From the investigation with the operators and the things that I recorded when I went down there. There were indications locked on -- and it's in the

package; I can give you a little bit -- that tell us exactly what those alarms were, and we had standing in what's called a module trip, which is a signal that tells those breakers to trip, tells the UPS to go away.

MR. ROSENTHAL: Not necessarily at this meeting, but at some point, Frank's going to have to get into the details enough to confirm that.

MR. CRANDALL: Certainly.

MR. MACHILEK: Before we go into a failure mode of the system, maybe it would be educational for one of us to describe the system, how it should work, and how it was intended to work, and, of course, to everybody's surprise, it did not do so.

In its normal operation, the AC input, of course, is there. Also, the battery is there. Both sources, as you see on the connection between the converter and the inverter, simply running in parallel, are trying to provide power to the inverter. Now, which one of the two sources is contributing the band switch when it is there, and which one has the higher DC voltage at this particular moment?

If the AC input would go away, such as was the case when the transformer failed, the battery simply keeps supplying DC to the inverter, and the inverter would not know that anything happened, because the inverter cannot differentiate if the DC comes from the battery or comes from

the rectifier.

The intended operation was that the critical load on the output of the UPS would not have seen anything, either, because the inverter would have continued running, and, last, not least, that was the purpose of purchasing, installing the UPS, to achieve that.

In case of a difficulty -- let's say the UPS, due to an internal problem, decides to quit at an inopportune moment -- it would give a command to the input circuit breaker, CB-1; the battery breaker, CB-2; the output breaker, CB-3, to open, and simultaneously give a command to CB-4 and the static switch to conduct. The voltage on the output of an inverter does not suddenly cease; it decays. During that decay period, which needs only 120 microseconds, of course we can effect the transfer. Now, if the transfer conditions are not given -- in other words, if the frequency should be not matching, if the phase coincidence should not be within 7 degrees, or if the voltage would be more than 10 percent apart, our system would give a transfer-prevent signal, which means it says, No, you cannot go to bypass, because the bypass is not of sufficient quality to maintain the load.

If we would transfer out of synch, you would get a phase hop or a rapid frequency, with a slew rate which computer systems and electronic systems simply cannot take.

Since the critical load is so, no power is better than bad power; because, if you could accept bad power, you wouldn't have the UPS. Therefore we do not transfer to raw power if that power is not of sufficient quality to supply the load successfully.

This would be the normal operation of the system. If we go to the scenario which happened, we can only fall back on what was reported, which was that --

MR. FIRLIT: Before you go into that phase, I still want to understand the normal sequence, okay?

MR. MACHILEK: Okay.

MR. FIRLIT: You said, if I understand it correctly -- I just need to understand it -- that the system is designed so that, if you have a fault, you trip CB-1, you trip CB-2, and you open up CB-3.

MR. MACHILEK: You give a command, yes.

MR. FIRLIT: What is the purpose, then, of having that storage battery there, if you automatically take it out of the circuit?

MR. MACHILEK: No, no. This is only taking place if the UPS suffers an internal fault.

MR. CRANDALL: To protect the UPS.

MR. ROSENTHAL: The purpose of having a UPS at all is, if there is a loss at the bus, 575 volt, three-phase, external to the UPS, if that's a fault --

MR. MACHILEK: -- then the output is maintained.

MR. ROSENTHAL: -- then you'll go back onto a battery and support the output. That's the function of --

MR. MACHILEK: -- the function of the UPS.

MR. ROSENTHAL: In fact, the whole maintenance supply connection need not be to perform its primary function, but all of this stuff is provided they don't have an internal fault within the box.

MR. MACHILEK: Yes.

MR. ROSENTHAL: Frank Ashe tells me that it is common practice to have such an arrangement on non-1E buses such as this, providing computers et cetera, including the bypass.

MR. MACHILEK: Yes.

MR. ROSENTHAL: But on 1E uninterruptable power supplies, it's common practice to have a bypass, but that it be a manual bypass.

MR. ASHE: Frank Ashe, NRC.

I don't think that's quite what I was trying to convey. On the non-class-1E inverters, I think, a point here is being missed. That is, a UPS is intended as an uninterruptable power supply. That means it stays on line for whatever goes wrong, and it provides power. All this business about transfers and fast transfers -- I think the key issue that's being missed here is, you're trying to

continually power your downstream loads, regardless of what's going on upstream.

That's the bottom line. To get back to what Jack has stated, in this area of power plants this kind of design if in fact it works is considered desirable from an operational viewpoint because you always power the necessary controllers to keep you up or alive. If something is going wrong per se on the 575 AC three-phase input it won't reflect back down to the 208 and everything that is being powered on the 208 goes smoothly and in fact the plant continues to operate even though something is going wrong -- something may be going wrong in 575.

The point I'd like to correct, I don't believe I said it's common practice for Class 1E inverters not to have static transfer switches. Some Class 1E converters will in fact have static transfer switches but there are cases in which 1E converters do not have static transfer switches.

MR. SYLVIA: Is the part about the fact that that's out is due to a failure of the UPS itself correct?

MR. MACHILEK: No, sir. I was referring to a failure of the UPS such as the failure of the transformer, a failure of the basic mechanism of the box to perform its function.

MR. SYLVIA: But that's not true --

MR. MACHILEK: -- reason for the bypass --

MR. SYLVIA: Let me finish. Maybe I can get you to understand my question a little bit better. Seems to me if you're worried about some external problem you just disconnect and let the battery do it.

MR. CRANDALL: That we do. If there is a transient occurring on the AC input the unit is designed not to trip. It won't trip. There is no sensing actually in the unit for -- there is no trip sensing on the AC input.

It will sense if it is outside its parameters and it does just what you said. The charger will shut itself down and will go on batteries and it will sustain for however long it takes for that to come back.

Where we're talking the trip we are talking about a ground in the inverter section for example and we blow a fuse. We don't want to lose our output so we send a trip signal to the inverter to protect it at the same time we transfer to maintenance.

Another key thing that I wanted to just clarify that Rudy was talking about too though, it is true we don't want to lose the output but we have got to quantify loss.

To a computer system 105 volts, 100 volts is still a loss so in a case where we have a transient or some bad voltage on the maintenance supply we don't want to go to it because a bad voltage on the maintenance supply can actually do damage to the equipment we are protecting so therefore in

some cases it is better to lose it than to send something down there we don't want and damage it.

That is why that protection is there not to go there.

MR. SYLVIA: Thank you.

MR. McCORMICK: The line feed, main feed, normal feed I guess to each of these -- the alternate feed for example, if the normal feed is bus 001, is the alternate feed 003?

MR. CRANDALL: No. Not necessarily.

MR. McCORMICK: But it would be a feed that was affected by the --

MR. CRANDALL: Both were affected.

MR. McCORMICK: Both were affected by the same fault, by the initiating fault.

MR. CRANDALL: I can hand this out but we'll go into it later.

MR. McCORMICK: Well, if you're going into it later, but I just want to get on my mind that when we go looking at the alternate feed in some cases it is the same for at least the opposite bus, all of which would have been experiencing the same transient.

MR. CRANDALL: That's true and that isn't per se a factor because again we are saying that if that bus has bad voltage, transients or whatever not acceptable then we shut

down the charger and we go on DC anyway. We don't want to go main.

MR. LEWIS: My name is Warren Lewis. I wanted to make a comment.

One of the things that hasn't really been said clearly -- it's been kind of circled around -- is that when a UPS makes a transfer it makes a make before break transfer.

The two supplies, the maintenance supply and the inverter supply, are briefly bridged. Then one disconnects. It's a hand lock, so on that basis that's where you get the uninterruptible power system.

Now the comment that Rudy has made is you never want to make a handoff if the supply you are attempting to hand off is worse than the one that you are already on and that comment was made that on a bus, on a maintenance bus, experiencing a serious surge or something like this and you make a very fast subcycle transfer to it, it can damage your sensitive loads so it is better usually by decision to lose the loads than to damage them.

Now the question that came up is why do you have the input breaker tripping, the DC source breaker tripping, and the output breakers all tripping on UPS?

The answer to that is that's an unusual condition. The only time you would normally do something like that is

if someone as an example saw a UPS on fire and you push an emergency "off" button and then you disconnect the input and output so that the key here is you must also disconnect the DC because the DC could feed the fire if you had it or whatever the arc-ing is or the problem that you are dealing with.

Normally you never disconnect all breakers unless it is a catastrophe.

Now what you have got in this situation is the breakers being tripped and should not have been tripped int he quantity that they were tripped. In other words, why trip the DC? Because it got a signal that told it to trip that it probably shouldn't have gotten, so the name of the game here is they may have wanted to disconnect a bypass line or refused to go to a bypass line but there is no reason to disconnect all power unless something went wrong. That is the real understanding. The battery should have maintained the load unless it was disconnected and it is normally never disconnected unless there is some major problem or the fear is that the battery will feed energy to a fault that would then be self-sustaining until the battery depleted.

MR. McCORMICK: And there is logic within this device that will do that?

MR. LEWIS: Yes, sir, there is.

MR. McCORMICK: And we will be able to understand what it looks at in order to make that decision?

MR. LEWIS: Yes, sir.

MR. McCORMICK: And we will be able to understand what it looks at in order to make that decision?

MR. LEWIS: Yes.

MR. McCORMICK: You will be able to get through that.

MR. LEWIS: Yes, you will be able to see what logic commands would normally be developed to cause things to trip. You would also notice that there are things that will not cause things to trip but you can always generate a false signal if something goes wrong.

MR. CRANDALL: Why don't I do this, because we are at that point maybe. I don't have enough for everybody.

[Documents distributed.]

MR. CRANDALL: Certainly we can make more copies. I definitely would like Frank to have a copy of that.

On the very last page of this tells you what those trips are.

I am not intending to go through this. There's some things referenced in there that I think are good information to give you the basis.

So Attachment 6 are -- those are the trips that protect the UPS from that failure.

MR. McCORMICK: The trips.

MR. SYLVIA: Bob, do any of these cause the output to transfer to the maintenance supply?

MR. CRANDALL: Those are the things we are talking about. Every one of these will cause CB1 and CB2 to open, CB3 to --

MR. McCORMICK: They all do it?

MR. CRANDALL: -- CB1, CB2 to trip and CB 3 to open, every one of those. It will literally take the UPS out of service.

MR. McCORMICK: And prevent CB-4 from closing?

MR. CRANDALL: No. It put a permissive, a signal to tell CB4 to close.

In the scenario we have, our maintenance supply was out of spec so that permissive to allow CB4 to close wasn't received, okay?

You can consider it as two contacts in series if you will. One of them is the signal we have to close the contact to tell CB4 to close but if the contact isn't closed it says it's in spec, then it's not going to happen.

MR. McCORMICK: How much power will the static switch carry? That doesn't look to be interrupted by anything.

MR. CRANDALL: It's logically turned on and off. It is not in their --

MR. McCORMICK: So it's logically turned on, okay.
MR. CRANDALL: Sustained, it's a dated on and dated off -- yes?
MR. IBARRA: Jose Ibarra. That diode that we are seeing here downstream of the storage battery, was that good?
MR. CRANDALL: Yes. We have put UPS 1C in part of our testing. We removed the AC supply from it and put that unit on DC.
That unit is running at -- it's over 90 percent loaded and it handled that fine, without a problem.
Another thing I was going to hand out a little later and you can look at, during our startup testing we tested all of those things, timed all of those things and verified that all of that does work exactly the way we are describing it.
MR. FIRLIT: Are you going to be prepared today to tell us why the wiring circuits decided to trip BC1, CB2 and CB3?
MR. JULKA: Exide has something --
MR. CRANDALL: Right, but we are hoping to get to, work to that. With not having this understanding it's hard to really even discuss it.
MR. JULKA: Do you want to go through that at this point?

MR. FIRLIT: No. Continue on. I just want to make sure that -- I don't know understand why all three of those -- he explained, you know, why it's designed that way and the example of the fire was a good example but I'd still like to know what inside there told all three breakers to trip because normally you would think that you just took out the storage battery as one alternative power supply if you did that.

MR. CRANDALL: I guess the question I would like ask at this point before we actually broach that, it's clear or is it clear to everyone how the mechanism of the trip works, not how it worked in the case we had but any of those will send the trip and how that works. We lose both breakers and we attempt to go -- that's clear, correct, so when we start getting into the scenario type we don't lose everybody.

MR. ROSENTHAL: And you just repeat again why you believe that CB1, 2, and 3 were given a demand signal to open by the logic as distinct from an overcurrent condition or something else existing. What is the bases for that statement?

MR. CRANDALL: And that's what we are going to get into. We had a module trip alarm and in that report I gave you it tells you exactly what we found on those units. I wasn't intending to go through that but you can read that

later.

It tells you all the alarms we got. The units had a module trip on, which says when you have a module trip that is the initiation to trip the unit. CB1, CG1 trip, CB3 opens.

We had that alarm so we know we got a trip of the unit. We don't know from where.

MR. ROSENTHAL: And some time Tuesday morning people went down all five UPS's, observed a module trip alarm and reported it back to the TSC or the EOF where people were collecting this sort of information.

MR. CRANDALL: We found when we went down to recover the unit found that alarm on four units -- one unit did not have it. That one unit is the unit that operations tried to recover. We have separate operators and it is their belief that alarm, and I say this guardedly, probably was there. We do not have one who can say absolutely that alarm, that module trip alarm, was there.

MR. ROSENTHAL: On which one?

MR. CRANDALL: On 1D, which the one they tried to recover. It is the normal practice that as you attempt to recover that, you reset those alarms though, so we have a pretty comfortable feeling that that was there and based on the other four, it's --

MR. SYLVIA: Bob, I've got a question about the

design logic.

You all have explained how we were conducting this maintenance supply -- what I don't understand is if this is going down, something is going down in the environment and you have to close in this maintenance supply to the output to bypass all of that, why do you have such stringent synchronization requirements? You know that's going down already.

MR. CRANDALL: Again, you can only put it in perspective, I guess.

Let me do this and again this is just as a reference, not to get all totally in.

This is our startup test and when you start -- just look at the last page or next to last and I don't think you can understand that until you can get a concept of the speed that we are talking about where Amil said six cycles, which is a blink of an eye. Nobody knows anything happened. That is an eternity to a UPS. Look at the -- let's see, I'll pick the worst case -- the very last page of this.

This is a trace. I apologize again. I don't have a lot on me.

What this is and what we did with this particular unit during startup, this is fully loaded 100 percent. We loaded the AC breaker. We then opened the DC breaker and what you are seeing here in the middle here, now each line

is one millisecond, all right? That is 1000th of a second.

You are seeing the transfer, you are seeing the output of the UPS go away, the static switch gate on and go on maintenance, so I think from that you can get an idea what I am talking about.

This thing is absolutely perfectly in sync absolute. I mean it's dead nuts-on so that the output doesn't even know anything happened.

MR. SYLVIA: It's so fast it can detect something going wrong as still check synchronization before it trips in.

MR. CRANDALL: Yes, before the output really goes anywhere where it would cause any problem at all. It has already detected that little bit of going down before it is actually --

MR. SYLVIA: And the speed with which it works, that makes sense.

MR. CRANDALL: Just to correct a little of what you said, the check to go to maintenance is a continuous, so it's not a case of it checks it. It is either there or isn't kind of is what I am saying. If it is not there it won't go. If it is there, it will.

MR. McCORMICK: But if maintenance and normal are going bad together, there has to be a second level. They are both going down together. They could be in sync together

failing but now there has to be a second level check to say that I want to go anyway --

MR. CRANDALL: Except I want to qualify that too. If maintenance and AC are going bad the unit should go on DC. See, what we have or would appear to have is we had -- and I am just doing this for illustration, this is not what we had
-- if you have two failures at the same time, which the theory is it's not going to happen that the UPS has a bus fault in it at the same time the maintenance goes, then you lose it, we don't try to protect against something like that. You would -- the theory is that if something is going wrong in the UPS you don't have a simultaneous failure on your maintenance. It will protect it against simultaneous problems on the AC because it is making an assumption that everything is working in the UPS.

MR. McCORMICK: DC should have just fed in as we said?

MR. CRANDALL: Yes. The phenomenon that we had was that we got initiation from the fault. We know it is from the transformer. We got an initiation into the logic of the UPS that told it something was wrong and tripped.

MR. MACHILEK: Bob, may I make a suggestion?

MR. CRANDALL: Yes.

MR. MACHILEK: The presence of the bypass, the

static switch in the bypass breaker, really had no bearing on any of the happenings during the incident.

In judging what happened we can disregard that the static switch in the bypass breaker is even there.

These two elements are only there if there is a physical breakdown of a component within the UPS such if your car breaks, if your transmission breaks, it doesn't go nowhere. In this period you know we are talking about a failure of the UPS.

Normally -- let's assume for a moment that the static switch in the bypass breaker CB4 would not be there and we go into the scenario of the transformer fault or what should have happened is that AC to DC converter would have phased bad which means it would have controlled itself not to accept that input because it was no good. It would have, seems to have put out DC, and the battery simply would have taken over and then would have kept running.

You would as of today not even know that there was a transformer fault, okay? There was no reason to transfer. There was no reason to do anything whatsoever now.

We have to look now what happened to the UPS equipment. Something within the equipment broke, to put it bluntly, okay? Not physically apart mechanically but seems to work. If that happens we are giving a command to the UPS module to switch itself off from all power, input, output

and battery. That means that we say any power present within the box, within the confinement of the UPS the equipment would be or could be dangerous, cause a fire for instance or maintain one or if a fuse blows within the switching of the circuitry of course you have to shut down because in a sense you would short circuit the battery internally, okay?

There are many reasons for doing that.

What happened is exactly that. That means the AC input went away. Normally the UPS would have gone on battery, except internally a fault occurred which prevented the continuation of operation of the UPS equipment

Unfortunately at the same time the bypass was not there so we could not transfer to it but that is really academic.

MR. CONWAY: Rudi, when you use the term "a fault internal" you mean some kind of a malfunction?

MR. MACHILEK: Some kind of --

MR. CONWAY: Some kind of interruption, not necessarily an electrical fault.

MR. MACHILEK: A malfunction. Let's say if the logic for instance now quits to do what it is supposed to do, then of course you lose the brain of the whole thing and it shuts down on you, okay?

MR. ROSENTHAL: With normal design operations, if my input is 575, three-phase and I drop to 10 percent

voltage for a few cycles, and then restore on the input, what would I expect to happen?

MR. MACHILEK: You would have to drop it further than that, because our normal operating range is plus 10, minus 15 percent. If you dropped the input voltage below 15 percent, then the charge at the rectifier would phase back -- it means it would no longer accept your power and quit to operate -- which causes the output of the rectifier to go to zero, but this doesn't matter, because the battery would supply power to the inverter and simply continues maintaining the output power from the inverter.

MR. FIRLIT: In that case, you're saying that the battery power from the storage batteries would take precedence over the maintenance voltage?

MR. CRANDALL: Yes.

MR. MACHILEK: Oh, yes, definitely. Please consider for a moment that there is no maintenance circuit at all. The maintenance circuit is what it says it should be: to be used for maintenance. That means, if you want to work on the equipment, if you want to have preventative maintenance or whatever, you would go to the maintenance bypass. Under normal operation, you only go to maintenance bypass if you have a physical breakdown of the UPS equipment as such.

MR. LEWIS: This is Warren Lewis.

Or, if you have lost the rectifier input to the UPS, you're running on batteries, and then the battery gets depleted. Rather than shutting the inverter down, you then go to the maintenance bypass, because that keeps your loads up.

You could, for example, have a burned out breaker on the input to the rectifier, which then would not affect the maintenance bypass line but would deplete the battery. So, at the end of the battery period, at some point when the battery voltage goes down, you make a maintenance transformer to keep the loads up -- transfer.

MR. SYLVIA: When we were talking about this synchronization circuit, did I hear someone say that the design concept was that, if you couldn't maintain this high quality of voltage, you would be better off not to have any?

MR. CRANDALL: Yes. That's the theory behind it. That's why -- I guess you could say there is a number of theories. One is the transfer itself, also, so that you don't transfer out of phase and actually send one heck of a shot; but a lot of the equipment we're protecting we don't want to send low voltage to, or any type of transient as well.

Computer systems don't do real well with transients, for example.

MR. LEWIS: This is Warren Lewis again.

One of the reasons the tight synchronization is maintained is that, again, if you initiate a static transfer, it's make before break. If you were 90 degrees out of phase and initiated a make-before-break transfer, that would vaporize the static switch, and everything would go down. That's the reason that's done.

MR. SYLVIA: And all of it's based on the idea that, if you can't maintain the quality, you're better off with -- If you can't maintain this high quality of UPS supply, you're better off to trip the unit.

MR. CRANDALL: Yes. And if the maintenance supply still has that acceptable quality, it will put it to that. If it doesn't, it won't.

MR. LEWIS: It's not quite like that. What is really happening here is that the inverter and DC operation is not only preserving continuity of power, which is where the name "uninterruptable power source" comes from, but it is also providing power of very high quality, because it is buffering the load from disturbances on the AC line. Now, if the idea is that, if you can't maintain pure power and it would therefore be better to lose the loads, by logical extension you would say we would have no maintenance bypass, because a maintenance bypass would by definition be of less quality than an inverter. It's not an iron-clad rule.

The rule is that the bypass line will be excellent

power for computer loads, except statistically it will have disturbances on it. Therefore, the name of the game is, what are the odds that you would have a UPS inverter failure that would force you to the maintenance bypass at the same time statistically the maintenance bypass would have poor quality power. That's kind of low probability. The idea is that you do force the transfer; the UPS goes down; allow your critical loads to operate on what might be referred to as raw utility power -- on the statistical basis that you're not going to take disturbances on that line for the brief period of time that you may be doing this.

If you're concerned about that then people go to redundant operations, where they have a second UPS to feed the maintenance backup line, so you're transferring between UPS's.

And it gets worse than that, but you don't want to get into that.

MR. McCORMICK: Have we talked about this so-called regulator here? Does this have a factor in it at all? I see a transformer to regulator on the maintenance supply.

MR. CRANDALL: In this particular case, we don't feel it does.

MR. ROSENTHAL: Except as we may get into the issue of tracing ground faults.

MR. CRANDALL: Yes. The ground itself going through there, it may be, but where we're talking quality of power and those kinds of things, I don't think it's an issue.

MR. McCORMICK: Can we go off the record for a second?

[Discussion off the record.]

MR. ROSENTHAL: Without going into the detailed maintenance history and prior events, et cetera, have there been situations in which AC power to the UPS was lost and the UPS went on DC as designed?

MR. CRANDALL: Oh, many times. Our loss-of-power tests.

MR. ROSENTHAL: When was the last time? Do you have a feel for it? A few months ago? Years ago?

MR. CRANDALL: He's saying the last time we actually lost AC power to one of the buses.

MR. FIRLIT: When was the last time we lost offsite power? We had that in Boltman.

VOICE: That didn't affect us.

MR. CONWAY: When was the last time you opened CB-1?

VOICE: I haven't done that before.

MR. CRANDALL: I can't come up with a time.

MR. ROSENTHAL: Okay.

MR. CRANDALL: It's not a singular event, I guess, is the best way I can describe that, though. There have been multiple times where we've lost a bus for one reason or another. They have also at times administratively put them on DC because they were going to do an evolution in the plant that they felt they wanted them on DC for.

MR. ROSENTHAL: Okay.

MR. CRANDALL: We have confidence in the DC part of that.

MR. ROSENTHAL: I want to wrap before we get into the logic.

I'm understanding that the ground straps, ground fault, some grounding-related activity was done within the last year, two years?

MR. CRANDALL: Yes.

MR. ROSENTHAL: I'm thinking in terms of change analysis from the last it was tried until now.

MR. CRANDALL: Each unit -- and I'm going to take exception to 1H, because 1H was installed exactly the way the vendor sent it to us, and it was installed grounded. The other nine units all came in grounded. VAE, which was Stone & Webster at that time, specified that they would be ungrounded, and that's the way the installation draws them for. We removed the grounds from those nine units as part of the installation and ran that way until -- I can get

dates -- about a year ago.

MR. FIRLIT: Stone & Webster recommended that we remove the grounds when the manufacturer had recommended that we ground that equipment?

MR. CRANDALL: Yes. The specification was actually out as "shall be ungrounded."

MR. FIRLIT: But something much have reversed that decision later that said, No, go back and ground it. Is that correct?

MR. CRANDALL: From what we were seeing from failures in the field, we were seeing hits on the computer and unexplained things. We had problems with maintainability and that electricians would go out and read voltages and panels, and they would read 30 volts to ground and 20 volts to ground and open a circuit, thinking there was bad voltage there, when in actuality we had problems with references. We were also concerned someone could go in a panel and read no voltage to ground and get across it and get hurt.

MR. FIRLIT: If I was to go to another nuclear power plant that has this equipment -- and I hope we're not the only one in the United States that has this equipment -- would I find their system grounded or ungrounded?

MR. CRANDALL: Most I talked to are grounded. When engineering went into this, we asked the question --

system engineering -- because of the inconsistencies. We were seeing some logic types of things that were not explainable, that appeared to be some noise types of things, on the loads as well as the UPS systems. When engineering got with the vendors, it's my understanding they got the word. In my talking to them, both Elgar and Exide said, What do you mean you're running ungrounded? Why? So it was their recommendations to put those grounds back on. What we saw was a lot more stable units from that.

MR. FIRLIT: Are we going to also find out today whether or not any other nuclear power plant in the United States has ever had failures of the UPS systems? If they did, has this information ever been transmitted to the other users of the Exide system?

MR. CRANDALL: We know that at Yankee Rowe they had a similar event. We haven't been able -- They have had a problem. We have not been able to tie it together. We're still looking at a lot of that. We have some things out on Notepad.

Before I answer your question, I'd like Warren to answer the question on grounding, because he is here because he is a grounding expert.

MR. LEWIS: Warren Lewis.

Because this is a generating station, an electrical utility, the National Electrical Code contains

with it an exemption for conductors and things that are under the exclusive controls of utilities. In a way, perhaps, somebody could say that they could choose in some cases to not follow the National Electrical Code, and there may be some argument that could be raised to say, Well, we don't want to do it that way, but, in order to not follow the National Electrical Code, which is a safety-based document, one would have to have one hell of a good argument to want to do it a different way.

Having said that, let me mention that the grounding issue that we're talking about here is thoroughly and accurately covered in the National Electrical Code. There are two sections which are offered within the code, section 250-5 and section 250-26. The first one I mentioned describes AC systems required to be grounded, and the second one describes the methods of grounding for systems which are to be grounded.

What you're dealing with here is an inverter output and a maintenance bypass, a 208-volt Y-120 volts. Both of these systems, because they have a neutral involved, or a midpoint, if you want to think of it that way, or common -- if you ground that neutral -- and ground by definition in this case is to connect a conductor between that terminal and the metal framing closure of the equipment, making it common to the green-wire safety

grounding system, and also running a connection to building structural steel and an earth-grounding mat kind of thing for a grounding electrode -- that kind of constitutes the term grounding. If you do ground that neutral terminal, you then limit the voltage from any phase to ground to 150 volts or less on a 208-volt Y. The NEC is structured to state that it is mandatory that any circuit that can be grounded to limit its voltage to 150 volts or less to ground must be solidly grounded -- i.e., not with a resistor, not with an inductor, but with a solid strap. We do have a grounding requirement.

I'm stressing because the manufacturer, Exide, provided the equipment in conformance with the National Electrical Code by providing the equipment in grounded fashion, with its Y output grounded. Then the equipment was installed, and the strap was removed, and the bypass circuit was not grounded, so you had the bypass and the inverter floating.

Now, in the NEC, the purpose for this grounding is described up in the early sections, the 90 sections, of the code -- pardon me: section 250. The purpose of grounding is to limit the voltage to ground between any conductor and, in the case of a phase or line being shorted to ground, to allow current to flow through the fault of sufficient magnitude to trip the old current device in a prompt

fashion.

Now, if the floating system had been installed and you had experienced a short circuit from a phased frame, there would have been no circuit breaker trip; there would have been no fuse blow. Instead, you would have had the whole AC system go up in voltage on the neutral point, and then you would then have a dangerous situation as defined by the National Electrical Code.

Also, if you had a floating AC system, you have a system which is in fact grounded by stray reactances, meaning the capacitance of the wiring through the system to the metal conduit, as an example, and then the inductances of all the wiring in the conduit. What happens under these conditions, with these small amounts of reactances: If you get any kind of electrical disturbance -- some non-sinusoidal impulse, something hits it -- they will oscillate and ring and create disturbances between any line and ground and neutral and ground.

Now, electronic loads are quite sensitive to noise of this type on the lines, so it is quite reasonable that you had unreliable operation of your sensitive loads.

In addition to that, the manufacturers of the load equipment almost universally -- and definitely if the load equipment is listed by a product safety laboratory such as UL -- have designed the equipment to only operate properly

if it's looking back into a correctly National Electrical Code-grounded input power circuit. Therefore, if the power circuit feeding the load equipment does not meet the NEC -- i.e., for grounding or whatever, the load equipment is not operating within its design parameters -- it should therefore be considered to be subject to unreliability.

If this line voltage to ground is not controlled and it becomes high because of a lightning impulse of something that sights this, you can get voltage breakdowns, things like this which are quite dangerous.

You do have the requirement to ground, which is why I found it amazing that the grounding was eliminated during the initial installation. Now, having decided to ground in order to meet the code, there's a basic decision that has to be made. You have two Y sources: you have the bypass sources and you have the inverter source. Now, which one shall you choose to ground?

The National Electrical Code does not give you advice in this matter, because it is not a safety question as to which you choose to ground, but it is normal practice in the industry to ground the AC supply that is designated as the prime supply for the sensitive load. This is the basic reason you will find that the Exide equipment came in with the grounding strap installed: it was to minimize the voltage difference that could appear during normal

operation -- and I stress the words "normal operation" -- between neutral and ground on the inverter output.

Now, that means that the bypass supply would normally be the supply elected to be not jumpered to ground, but it doesn't mean the bypass supply is ungrounded, because you have a four-wire Y in each case, and the neutrals are not switched. Therefore, the neutrals are brought together. They take the Y from the bypass and the Y from the inverter and physically tie the two neutral conductors together by a solid connection. That's called a solidly interconnected AC system.

On that solid interconnection, the inverter is normally the neutral terminal that gets grounded, so the bypass supply sees its ground by looking at the ground on the inverter winding. What we now have installed here is the opposite. We have a situation where the loads see their ground normally by looking at the bypass transformer ground, but the normal operation of the system is on the inverter, so it would be considered normal or recommended practice -- say, IEEE-recommended practice, for example -- to exchange power between the sensitive loads and the inverter with the inverter being the grounded source. Then, in a maintenance bypass operation, this being considered an abnormal operation of short time period, to then allow the system to operate on the maintenance bypass and seek ground back to

the inverter point.

There were two things that have occurred here that have some bearing on your problem: the initial decision to remove the grounding and operate ungrounded, which was strange and didn't conform with the code, and then the second decision, which was basically correct, to ground, but, for reason of judgement -- which I do not understand -- someone chose what would be the nonstandard system to ground out of the two systems.

If you have some questions, I'd be glad to try to answer them.

MR. CRANDALL: That's how it came from Exide --

MR. SYLVIA: So when we grounded it, we didn't ground it like it was grounded when they came from the manufacturer.

MR. CRANDALL: Yes, we did. We grounded it just like it was. We re-grounded it as it was.

MR. SYLVIA: So that your question about why was it grounded this way goes back to the manufacturer then.

MR. LEWIS: My understanding is that by physical inspection I see the bypass transformer is the one grounded from its neutral to ground. I can't say that I saw a grounding jumper in the Exide unit from the Exide neutral to ground.

MR. SYLVIA: Are you saying that we didn't ground

it like it probably came from the factory?

MR. CRANDALL: Well, my understanding is that --

MR. MACHILEK: I have to inject here, please, for reasons of proprietary information that is supposed to come from. The equipment was ordered by specifications to be ungrounded. I have the specification with me if you want to observe it.

MR. CRANDALL: That is correct. They came ungrounded --

MR. MACHILEK: It was not shipped by the factory contrary to --

MR. LEWIS: I will withdraw my comments on that because I was operating on the basis of what I heard yesterday and what I know is the normal practice for the company but I was not aware of the special order.

MR. SYLVIA: Let me make sure I am clear now, okay? We ordered it ungrounded but it actually came into the plant grounded?

MR. CRANDALL: That's not what he just said.

MR. MACHILEK: It was ordered ungrounded. It was shipped and delivered ungrounded but the installer should have, would have had to ground it in order to meet the electrical requirements.

MR. CRANDALL: Let me rephrase it. What he is saying is correct but what we are saying is correct too and

maybe I need to qualify that.

The maintenance supply that was purchased through Exide was not Exide's. It's Heavy Duty. The equipment came in grounded through Heavy Duty's equipment so he's right.

Exide sent it as specified, meaning the UPS was ungrounded. The ground was in the heavy duty equipment. We lifted that but the one thing I want to go with here is -- and the only reason I wanted Warren to come back in, we have confidence that the ground itself is correct, that it needs to be grounded. We don't in any way, shape or form feel that that is a problem that we even want to address to remove it because that is worse because of the problems that we get in through our loads downstream.

Any filtering that is on those loads would not work if we removed that ground.

I just want you to know that we have done something --

MR. JULKA: There was a question I think we meant to Dr. Warren separately but the way we have grounded it, it was done on a modification in '88 time frame.

The way we have grounded it is the way I think 90 percent of the nuclear plants in the U.S. have those grounded. I think we need to talk separately about the grounding practices but it's no different than any other plant.

MR. SYLVIA: I want to understand what Warren said. He also said that normally the inverter circuit should be grounded and the maintenance supply should be grounded and they should be connected between the two.

MR. LEWIS: No, that's not correct. If I understand your question, you never ground both AC systems that you are going to connect on a UPS. You only ground one system. The word "ground" means in this case to take the neutral terminal and place a jumper between it and building steel, framework, things like this.

You only have one jumper that you are allowed to put in so you have to choose the AC system to place the jumper in.

It's IEEE recommended practice and normal practice in the industry to place the jumper in the inverter supply as opposed to place the jumper in the bypass supply but remember both neutrals are tied together by a splice so the neutrals are made common.

If you visualize two Y's common on the neutral, we're simply saying where do you place the jumper, in the supply A or supply B? We always choose the supply which is the inverter because that would be normal operation and the idea would be to minimize voltage difference between ground an neutral during normal operation.

This installation appears to have the jumper in

the maintenance bypass transformer as opposed to the inverter.

MR. FIRLIT: But there is a hard wire line between the neutral of the inverter to the neutral of the maintenance supply and the maintenance supply neutral is the one that's grounded?

MR. LEWIS: That's my understanding.

MR. FIRLIT: Okay. I didn't understand that, okay.

MR. SYLVIA: Is that a significant fact as to which one you ground as long as the neutrals are tied together?

MR. LEWIS: It's a significant fact if you ask the question does it have to do with continuity of power questions or quality of power questions.

If it is the former, for continuity of power, it is of negligible concern. If it is for quality of power it is of significant concern because if you use a power line analyzer to look at power quality to compare it to what electronic loads will tolerate or not tolerate, you find again if you are on whichever supply is the one grounded will have the least noise and disturbance on it while you are connected to it, so the idea is to have the inverter to be the best power quality so you ground it, and you look at it with the analyzer and it looks good but the bypass line,

when you transfer to it, will then on occasion have a little more noise but people tend to accept that, that it would not be a good idea to have the bypass line with a good ground to neutral noise situation with the inverter to have a poor neutral to ground noise because 99.9 percent of the time your computer would not get the quality of power it desires.

MR. SYLVIA: So that doesn't have anything to do with tripping off the end.

MR. LEWIS: I hesitate to say it does not because the B phase as I understand it did involve ground fault which therefore did involve the injection of current into the safety building, grounding system. Therefore any connection into that grounding system could be viewed as a noise injection or return point and it could have a bearing but I can't say it did.

MR. SYLVIA: Any grounding could but not necessarily how we grounded it, is that right?

MR. LEWIS: I understand that question. Let me put it this way. Since we are at a disadvantage that we could not reconstruct this problem by restoring the plant and then going out and grounding Phase B again to see what happens, it could have been that if the inverter had been the grounded supply that the event might not have caused this.

On the other hand, it might have had no bearing on

it but by experience I think you would have had less opportunity for a problem of any kind of this nature if the ground had been in the inverter, but I would not be prepared to say definitely.

MR. SYLVIA: Then the question I have is do we have any idea why Stone & Webster specified ungrounded system.

MR. CRANDALL: Nothing I can come up with from any of the documentation. You know, nothing written down. Our verbal communications to Boston were that they wanted to limit the ground current or any potential for ground current on a load-related fault from being reflected back to the UPS?

MR. FIRLIT: If you took both units and you grounded both of them, okay, because the grounds may be physically different from the standpoint that they may not be grounded at the same reference, then I could see why there would be a difference but if you are hard wired from one system over the other system electrically it doesn't know really where it is grounded. It's grounded, so you really are tying physically the two systems together with a ground.

There is where I have trouble understanding why one would be different from the other in terms of a reference. They are both grounded.

If you are saying because I have a hard wire and that wire is 50 foot long or 100 foot long and I've got some losses from that ground to the other -- you know, I am having trouble understanding if they are hard-wired why that reference. To me it doesn't make any difference whether you are in the cabin or the other one.

MR. LEWIS: I do understand your question.

The situation is such that with a heavy conductor connecting the two together and having limited length, say 10 or 15 feet, you can stand there and see the two supplies nearly adjacent to one another, so the question is what difference does it make if you have the ground at one end of the heavy conductor or at the other?

It makes very little difference from a safety standpoint, which is why the national electrical code provides no information in that area.

The safety situation is such that you are dealing with high currents at low frequencies. You are dealing at the fundamental power frequency and some harmonics thereof.

The impedance of the wire, which is what the electrical code, it's only value if you will is very low at the power frequency and fundamentals thereof, so 10 or 15 feet worth of heavy wire makes no difference.

On the other hand, if you begin to deal in terms of impulses, i.e., noise, electrical noise which affects

electronic equipment and causes it to malfunction, you are then talking about disturbances in the hundreds of kilohertz into the megahertz range.

In these frequencies wires in excess of several inches long become significant. One can develop very large voltage drops on impulse conditions from one end to the other of a wire due not to its resistance but its inductance.

The length of the wire has a tremendous effect upon the inductance of the wire which is a magnetic function. Therefore we try to minimize the inductive reactance in the wire and the reason for this is because from an electronic standpoint we are worried about developing impulses due to the LDI over DT effect. The fast rates of current change on inductance produce big transient voltages so you could have large impulse voltages just by having one ground as opposed to the other ground.

The question is do you want those impulses which will occur to occur during normal operation on the inverter or to take the chance that they are not going to get you when you are on the bypass temporarily.

MR. CRANDALL: I'd like to interject. I'm not questioning anything Warren's saying -- it's all legitimate -- but I think we're splitting some hairs of how much effect. What I would suggest is that, yes, maybe we can

look at how much this might have affected it one way or the other and whether. What I'd like to do is go on more with where we might have been hit by some of those things, if we can. I understand how everybody is trying to understand.

MR. IBARRA: Just one question: When are we going to know for sure how it's grounded? Can we determine that right away?

MR. JULKA: It is grounded at the transformer on the drawings.

MR. IBARRA: Okay.

MR. LEWIS: I got on the floor and looked down there and saw the wire going up into the transformer, but I didn't take the cover off.

MR. CRANDALL: The 5 Exides are grounded at the maintenance supply transformer. The 3-series is grounded at the maintenance supply transformer. The 2-series are grounded on the output of the UPS.

MR. FIRLIT: I appreciate your comment, but, by the same token, we don't know what really caused that logic to lock out CB-1, CB-2, and CB-3, and I think we ought to pull that thread until we find out an answer, because what we're going to get involved with later on is what Stone & Webster recommended in terms of ungrounded systems and why we grounded on the other system when that's not the preferred way to ground. I think those are salient points

that have to be brought out, and they've just got to be discussed here.

MR. CRANDALL: I'm not questioning whether they should be brought out. I'm just wondering whether we need to get into the design differences and all of that in order to totally understand. That's what I was questioning.

MR. MACHILEK: Please let me make one more comment so not to create the wrong impression that Stone & Webster may have done something wrong. The method of grounding which my colleague, Warren, is describing here is only valid if you have one transformer solely operating one UPS. If you have one building input transformer which is supplying four or five UPS systems then obviously you cannot ground at the UPS systems points, because it would generate more different grounds.

Therefore, the safe way to specify grounding if you don't know what the systems are going to look like is to specify ungrounded UPS, for the sole reason that you can ground at the UPS, if it's appropriate, and you do not ground if it's not appropriate, such as if you have more than one UPS system working off the same transformer or if you have essential loads which require a grounding of the transformer on the building entrance at other sections of the electrical code.

I'm just saying that, from Stone & Webster's point

of view, which are systems designers', the safe way would be to order the equipment ungrounded and leave it up to the installer or the systems engineer who is responsible for the actual system then to decide whether to do it.

MR. LEWIS: Let me make a comment that I agree with Rudi on what he has said. I avoided getting into a discussion of the various ways of grounding based upon exceptions and if you have this and if you have that. I wanted to only address myself to what you have here.

The key to understanding -- Rudi is correct -- is that there are many times when the National Electrical Code would require what we call the maintenance source to be the grounded source and the inverter to be the one connected to it, but that was not what you had here. The thing that I would say is that the electrical installer follows the blue-line drawings. If the blue-line drawings do not show instructions to ground and a grounding symbol and a wire size and so on and so forth, he isn't going to add a ground wire where he was not instructed to install one.

It really goes back to the drawing that the installers followed. If the drawing showed no ground symbol, then the question is, who prepared the drawing, who approved the drawing, and what was their reasoning process for rejecting the National Electrical Code at that point.

MR. TSOMBARIS: This is Steve Tsombaris, from

Stone & Webster.

If I may interject one thing: As Bob described, there was an EDCRS that shows how the system is grounded today, and it was in that configuration that the system was grounded when the disturbance occurred. As a result of the disturbance, we observed certain things, including a module trip.

Two things, basically, happened. One thing that we noticed was that we lost voltage on phase B as a result of the dip. We know on the other two phases the voltage stayed pretty much what it was prior to the fault. We also know that, during a ground fault, arcs may be present, and we know that there will be ground faults into the ground grade. It's likely that a combination of the voltage dip or some ground currents could cause the unit to malfunction, resulting in a trip, the unit shutting down.

Knowing what the grounding system was, knowing what the voltage was, given those two things, I think we can now go ahead and try to evaluate how these changes in the system affect the UPS. I think, talking about grounding and how it could be or how it was ordered or whether the grounding that is recommended by NEC for getting good-quality power during normal operation as opposed to during a disturbance -- that's various scenarios that may or may not be applicable, or may be studied, but later on.

I think Exide could probably look in terms of the unit and tell us how the disturbance would affect the logic. Having that as a starting point, we can go ahead and exhaust the possibilities that could be present and, hopefully, lead to a logical conclusion as to what happened.

MR. CRANDALL: Can you go at this point into the differences between the Exide and the Elgar.

MR. TSOMBARIS: One of the things --

MR. SYLVIA: Along the lines of the point you're making, we want to be as thorough as possible, and we just don't want to take any chances. Many of us are hearing this for the first time; we don't know as much as you know. You'll just have to have some patience with us.

MR. TSOMBARIS: Absolutely. What I was saying is that I heard a lot of talking about grounding, and I think Bob can demonstrate how the system was grounded, so we can then attack our problem the way it's grounded. The fact that ten years ago it was other than ground is not relevant today.

There were some reasons for it, but I'm not in a position to discuss it at this point.

What Bob has asked me to do: One of the things we did was look at the difference between the UPS's made by Elgar and the UPS's made by Exide, which were supplied normal power from the same buses. I have a few sketches to

pass out.

[Documents distributed.]

MR. McCORMICK: Are you comfortable proceeding as we're going?

MR. ROSENTHAL: The original intent of introducing the grounding thing was just to set up the thing that's done, to do what's called a change analysis. You knew it was working at one time, and then the plant has been modified, or the equipment was modified subsequently, so we know that it would be -- Were there other modifications to the UPS in the last two years?

MR. CRANDALL: No.

MR. ROSENTHAL: No. Okay. Then you'll be able to provide some experience. Let's restrict those hopes to maybe the last two years.

MR. CRANDALL: The point we're making with the grounding may be viable. What we're trying to do is see if it has an effect, and then we'll look and see if maybe the change contributed to this.

MR. ROSENTHAL: There weren't any substantive changes?

MR. CRANDALL: No.

MR. McCORMICK: We'll be able to document, by virtue of mod paper, what we did to return this system to a grounded state when that was done in '89 or at the last

refueling outage, so we'll have that mod paper, where it was put in, and so forth, to document it.

MR. CRANDALL: You have that right, Frank? Or do you need that?

MR. IBARRA: Jose Ibarra.

That's just what you provided, right?

MR. CRANDALL: Yes. I think you've already -- If not, I'll get it for you. Let me know if you need it.

MR. McCORMICK: I have a bit of housekeeping, one item. We have a new expert in the room; Dr. Chang Chiu has arrived, and I just wanted to introduce him and indicate that he will be part of the discussion from here on.

Also, Richard Hackman of failure prevention.

Now, Exide, do you have anything more that you want to bring to the discussion of the relays and the breakers? I just don't want to get off on this path until Exide finishes their presentation.

MR. CRANDALL: Marty, part of the analysis we're going through with Exide, though, I think might only make sense if you see the difference. We're not saying extensively, but --

MR. ROSENTHAL: How much time do you want?

MR. CRANDALL: Let me put it this way: We're looking at how grounding can affect the logic of the Exide, and we have found an isolation of the grounding for the

Elgar units. We just think that should be on the table first, because that is a definite difference.

MR. McCORMICK: All right. Let's introduce that difference, and then we'll move back to Exide.

MR. TSOMBARIS: This is the Elgar unit, and this is the Exide unit.

[Documents distributed.]

MR. McCORMICK: This is the Elgar you just passed out, and that's the Exide.

This is Exide coming through now.

MR. TSOMBARIS: There is a note at the bottom of the page.

MR. McCORMICK: Okay.

MR. TSOMBARIS: Trying to see what would cause all those breakers to open, we thought perhaps the logic that controls all those things may be the source of the problem. I think we mentioned that before. We looked at the power supply that drives the logic on the Elgar units and the Exide units.

If you were to look at the first sketch, that serves the Elgar unit, you would notice at the breaker CB-1 there is a tap there that goes to power supply, and that goes to the rectifier logic. Then, right after the battery, there is another power supply, which is a DC-to-DC power supply, which goes to the inverter logic. That's

highlighted with yellow here.

Now, all the other components are basically the same in the three units, except that DC-to-DC power supply -- The Elgar unit has a DC-to-DC power supply that feeds the inverter logic, while the Exide unit has an AC-to-AC power supply unit that feeds the same logic. This feed comes upstream from breaker CB-4.

I have another highlighted that shows CB-4. Here is the bypass source. There is a tap here that Exide uses to pick up control power for the inverter unit. Now, the control power eventually is plus or minus 20 volts DC. The AC is converted to plus or minus 20 volts DC. On the Elgar unit, the 125 volt DC is converted to 25 volts DC. Actually, they have a couple other voltages, lower, for different functions.

That is a difference. What that difference says is that, on the Elgar unit, there is no connection between the AC system and the power supply that feeds the inverter logic.

MR. CRANDALL: So the logic would not be affected by disturbances on the AC.

MR. TSOMBARIS: By the disturbance.

MR. CRANDALL: Thank you.

MR. TSOMBARIS: At this point I would like to turn it over to Rudi, who could then --

MR. CRANDALL: Can I just make one comment?

The Exide unit being off of the AC, it could be affected by that AC disturbance.

MR. TSOMBARIS: Well, originally, yes.

MR. McCORMICK: It also looks as though the supply is taken off the bypass source, which is the source that's grounded.

MR. CRANDALL: Exactly. Correct.

MR. McCORMICK: So the ground that we were talking about earlier is on the bypass source.

MR. CRANDALL: And prior to CB-4, so it doesn't matter whether CB-4 is open or closed.

MR. TSOMBARIS: And we will also see that we're cutting off phase B for that power.

MR. CRANDALL: Which had the disturbance.

MR. TSOMBARIS: Which had the disturbance.

MR. ROSENTHAL: Why don't we stop now? Rudi, I don't mean to be rude to you, but, rather, I think that the next session is going to last at least an hour. Rather than having people pop up and down while you're talking, I think it would be more courteous is we all took a five-minute break, refreshed our heads, and then we're going to turn the floor over to you and listen well.

[Recess.]

MR. CRANDALL: I think we're at the point where we

now want to go into our Exide people.

MR. McCORMICK: Roy, are you ready now to give us your estimate of what you think took place and what you think needs to be done to verify or proceed in an orderly fashion if we have to check anything out?

MR. MACHILEK: The information which we received in order to analyze the problem was faxed to us on August 14 at 4 o'clock in the afternoon --

MR. McCORMICK: Roy, could you hold up a minute? We've lost Frank.

[Pause.]

MR. McCORMICK: Frank, the whole meeting's waiting for you.

[Pause.]

MR. McCORMICK: Okay. We're ready to resume. Roy? Or Rudi. I'm sorry.

MR. MACHILEK: I started to explain that we received an account of the happenings on August 14, 16:05, by fax, and immediately started to analyze the situation from the information received. The information says basically that a scenario happened; an upstream transformer was lost; and all five of our UPS systems shut down. The one thing which was striking -- that all five UPS systems shut down at the same moment -- meant that something had to happen which was common to all five systems. If such a

commonality would not exist, of course, each one of the inverters, if they would have all gone down at the same time, would have had differences of why, the indications, the alarms, and so on.

We started to look for some commonality, and the only documented commonality was that, besides each one of the UPS system was shutting down rapidly; that means it received a command to shut down -- not a fluke, not a transient, not anything but a solid command for the modules to say, Shut down. That fact is documented by the presence of a lamp, which is stored, which says that the module tripped. That lamp can only be lit if there was a legitimate, hard, enduring signal telling the UPS module to do so. Simply a smaller flick of a transient or anything like this would not have accomplished that. It would not have latched on that lamp.

We suspected that we had problems with maintaining the logic, specifically the logic power.

MR. MACHILEK: The problem with that conclusion was the fact that if logic power loss was causing an UPS shutdown there was also another lamp which had to precede the one which says shutdown which power supply failure, logic failure, which also is a latched-on lamp.

So the proper sequence of getting to an UPS shutdown is to first have a latch on the lamp indicating the

reason for the shutdown, which can be any one of I believe ten different sources which are listed in the UPS failure report on the last page, Attachment No. 6. There are 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 -- 10 probable causes for generating an UPS shutdown.

Now the problem with our system, well, let's say the way the system is designed that whichever of those ten sources is telling the UPS to shut down does so by lighting a lamp over a static latch and that lamp stays on, it's latched on until an operator would come and reset that latch.

That latched lamp signal then is forwarded to a summary gate which tells the UPS to shut down. That means any one of those ten lamps is summed in a gate which resides in one signal which goes to the trip lamp and the trip circuit and says shut down. Now --

MR. ASHE: Excuse me. Frank Ashe, NRC. When you say shut down, what you mean is all breakers open up --

MR. MACHILEK: All breakers open up.

MR. ASHE: Inverters--

MR. MACHILEK: Completely dead.

MR. McCORMICK: That's CB1, CB2 and CB3 open up.

MR. MACHILEK: That is correct.

MR. McCORMICK: And CB4?

MR. MACHILEK: CB4? Forget it. You lost the UPS,

okay?

MR. ROSENTHAL: CB4 is locked out.

MR. MACHILEK: CB4 couldn't because there was no voltage there. We lost Phase B so the bypass source was not available.

MR. CRANDALL: The maintenance supply was out of sync. We didn't have a permissive to close CB4 so it would not have closed.

MR. MACHILEK: What happened was in six cycles now, okay? That means during the six cycles by losing the Phase B -- C or was it B? B.

MR. McCORMICK: But doesn't the same logic for CB1, CB2, CH3, and the decision not to let CB4 close all come from the same --

MR. MACHILEK: It all comes from the control circuit of the UPS.

MR. ABBOTT: CB4 also does?

MR. MACHILEK: Yes, sir. The command to close, the actual power to close is taken from the bypass.

MR. McCORMICK: So the command to have CB1, 2, and 3 open up and 4 not close --

MR. MACHILEK: No. It also tells the 4 to close but there is another circuit which is the transfer control which says no, you cannot do it, so you would get an opening command for CB1, CB2, CB3, a gate in command to the static

switch and it goes in command to CB4, except those last two commands they are blocked by the transfer control saying bypass is not good so you cannot go there.

MR. McCORMICK: Then there is something else then. There is another transfer control not in this logic panel that would prevent CB4 from closing?

MR. MACHILEK: Yes, sir. There is.

MR. CRANDALL: Suffice to say that the one problem that he is getting into is the trip. The CB4 worked her design exactly the way it was supposed to.

MR. MACHILEK: It is included in the little block which says static switch control 834.

MR. McCORMICK: That helps me because I couldn't figure out what it was doing.

MR. CRANDALL: It wasn't supposed to close. We didn't have sync.

MR. MACHILEK: Under a normal situation, if the bypass supply would have been of acceptable quality CB4 would have closed and the static switch would have gated of course and you would have had a transfer of power to bypass and your load would not have had an interruption, okay?

MR. McCORMICK: Once it makes a decision not to close it is locked out. The power was recovered and when the disturbance cleared, it would not go back and see.

MR. MACHILEK: No, sir, no. Everything locks up.

Now the UPS, the problem with the report we received was that the initiating lamp, one of those ten lamps which we had the latch in in order to tell the trip to function, none of these lamps was reported to have been lit.

Maybe we thought you know it was an oversight so we went back and reassured that none of these lamps were lit and we have been assured that enough people looked at it and said no, there was no lamp.

MR. CRANDALL: That analysis is based on interviews with five separate operators, some of them more than once, going down to the unit.

They are telling us to the best of their knowledge there was no lights there and then we have one unit, G, that no one reset a single thing and it also did not have a light so we have relative assurance from all of that that none of these lights were on in any unit. It is not absolute 100 percent but I mean as best as a memory can be on five guys.

MR. MACHILEK: So -- after we were reassured that was a correct condition, we thought we knew why lost the logic which I will explain to you in a second but we could not explain the absence of any one of the initiating commands. Therefore we were searching for what possibly could generate such a condition.

The only thing we could come up with was that there may have been a ground disturbance introduced, signal

injected, which logically cannot be reasoned out, and for that reason we of course you know went to the foremost expert on grounding. Mr. Warren brought him in from the West Coast and said, hey, you know I discussed the matter with him on the phone and of course he said, gee, you know without seeing the installation I can't tell you anything, so he came and looked at the installation with the sole reason to tell me not what should have been done -- you know, we had a little, maybe a straighter discussion before, but the reason for having Mr. Warren here is to tell us if there was a possibility to inject a signal into all five models at the same time, which would wipe out all the lights which had to be lit in order to get the trip.

We decided yesterday that to search academically for that reason is moot because we will never find out. The prime concern or the prime problem was that the UPS was shutting down. If there was a light or no light is really, if you excuse me to say that, academic, okay? It is of great interest of course because we have no explanation of why that happened but basically we feel that the UPS should not have shut down in the first place, okay?

If there was a command to shut down, we elected to assume that there was a light and we don't question that there wasn't, please, okay -- we do not question the fact that there was no lights stored. We have to assume there

was.

Why do we have to assume that? Because any test you would run right now to induce a shutdown of the module would first generate such a light.

MR. MACHILEK: There is no break or malfunction that we can prove here in order to duplicate that situation.

MR. McCORMICK: Do we know -- I don't guess the same light would be defective in every panel but it would seem to me that --

MR. MACHILEK: Right now if you go out to the UPS modules and you would introduce a condition which ends up in a shutdown you will get the initiating light.

MR. McCORMICK: On every one of these lights?

MR. CRANDALL: On Attachment 6 we have done the DCUV, the ACUV, the ACOV. We have given it a logic failure and in each case the light came on and the unit tripped as specified and it transferred to maintenance.

MR. McCORMICK: Frequency failure?

MR. CRANDALL: Frequency failure we did not.

MR. CHIU: Is it possible you have some kind of disturbance or transient but were not triggering any of the ten trips, but the signal going to the board and causing the logic to be scrambled?

MR. MACHILEK: It is not.

MR. CHIU: It is not possible?

MR. MACHILEK: That is not possible.

MR. ROSENTHAL: You know that you generated a module trip alarm.

MR. MACHILEK: In that actual module trip it did do it.

MR. CRANDALL: Right. That is based on the actual indications found.

MR. ROSENTHAL: We know that? We believe that?

MR. FIRLIT: I think that's a better characterization.

MR. ROSENTHAL: Okay. If we believe that we have a module trip --

MR. MACHILEK: Yes, sir.

MR. ROSENTHAL: So that trip then is CB1, 2, 3.

MR. CRANDALL: There is a light for a module trip and that was on four of the five units.

MR. MACHILEK: -- the modules tripped and we lost power, otherwise we wouldn't be here right now.

MR. ROSENTHAL: Do you have a sense of how long in duration and of what quantity a signal you have to provide to the module trip unit?

Are we talking about microseconds, milliseconds, many volts, little volts?

MR. ZUG: Microseconds.

MR. MACHILEK: Yes. Mr. Bill Zug, he is the

Director of Engineering. He has those figures.

MR. ROSENTHAL: So you believe that how many volts? Repeating a little TTL, sir?

MR. ZUG: C-MOS logic takes between 3 and 7 volts.

MR. MACHILEK: So it's you know between 3 and 7 volts for some milliseconds is a good healthy signal -- microseconds is a good healthy signal in terms of logic, you know, to latch. We have to latch --

MR. ZUG: It called an RS type latch.

MR. MACHILEK: So you know that, and we are talking about five different systems here, okay.

MR. FIRLIT: Can we back up just a second?

MR. MACHILEK: Yes.

MR. CRANDALL: Might I just interject by the way, I mean we know the ground grid disturbance was there and you may not realize that also hit fire panels so we know it was of sufficient magnitude to do these kinds of things.

MR. ROSENTHAL: Just repeat what you said for me?

MR. CRANDALL: There were some disturbances noted on some fire panels that are a solid state device within the plant as well. What I am saying is, you know, we have been looking for other things that can give us some pointers too, commonalities, and that would give us one also that would give a sense not of magnitude but a sense that we could be in those magnitudes of disturbances on the grounds.

MR. ASHE: Excuse me, if we could just back up for a second. You showed us these ten trip alarms.

MR. CRANDALL: Yes, sir.

MR. ASHE: I thought what you said and I thought it was significant was that before the logic unit trips these lights happened to light and the reason you know that is because the signal that lights these lights then goes on from that point in the circuitry to trip the unit.

MR. MACHILEK: Correct.

MR. ASHE: So the light has to be on one way before the unit can trip because the unit gets its signal from this lighting. Is that what you said?

MR. MACHILEK: Correct.

MR. ASHE: Okay.

MR. ROSENTHAL: By virtue of your design now.

MR. MACHILEK: Correct. There is a serious progression of action toward a trip.

MR. SYLVIA: If it did come on it didn't lock in.

MR. MACHILEK: No, the problem is that the latch which locks in initiates the lamps as well as gives the signal on to the next latch, which then is associated with the trip.

MR. SYLVIA: What's implied, it never got the signal.

MR. MACHILEK: You had ot have the signal in order

to generate the end result, yes, sir.

MR. McCORMICK: Could the light have been reset by an operator without resetting the trip lights?

MR. MACHILEK: You can only reset both lights, not one of the two by itself.

MR. McCORMICK: I just want to make the point -- you have got something going on here that we don't --

MR. MACHILEK: There is a reset button and if you reset, if you push that button you reset both lights.

MR. McCORMICK: But we do know we had the module trip light still on so we could not have introduced an operator in there and by doing something that would have changed the state.

MR. MACHILEK: Correct.

MR. ASHE: Is it possible by design that the signal is being sent to the trip unit at the same time it goes to the trip alone? Not possible?

MR. MACHILEK: It is the same signal which is causing both actions.

MR. CRANDALL: It's not parallel tasks. It's a series package.

MR. ASHE: That's what I am trying to get to.

It is a serial path. The light must be lit before the trip unit is signalled to trip. Must be there. Must have a signal --

MR. MACHILEK: It happens simultaneously.

MR. ASHE: I think you are saying a parallel task, not a series.

MR. MACHILEK: Yes. The lamp and the --

MR. ASHE: -- and the trip unit is signal at the same time.

MR. MACHILEK: What I meant by serial path is that one latch triggers the next latch which gets me the final lamp. See there is one latch with the initiating lamps. It triggers the second latch -- I'm sorry -- which triggers, they open which is the summary gate. I'm sorry, not to mislead you here.

MR. SYLVIA: So it's parallel?

MR. MACHILEK: The lamp and the signal should be considered parallel.

MR. BERTSCH: But the latch is one. There's only one latch.

MR. ZUG: This is Bill Zug. We are dealing here in technicalities. If you send a signal that is being fed through logic gates, what you call parallel and what you call series, it is the same signal that branches off. The output of the latch goes through a buffer gate to light the lamp. That same signal is then processed over two additional gates to trip the unit.

Now if you are dealing in hair-splitting

nanoseconds, it's series but it is the same initiating signal.

MR. McCORMICK: And it doesn't have to go through one to get to the other.

MR. ZUG: That is correct.

MR. ASHE: That's the point. So have you investigated response times? The answer is no, right? Because you think it is ten to the minus nine and the light didn't light --

MR. BERTSCH: It's one latch though. It's one latch that lights both lights.

In order for the light to be latched in it's only one latch that would latch both lights. It's not two separate -- one latch for here and one latch for here.

MR. ASHE: When you say latch what are you talking about? What do you mean? A transistor? An operational amplifier?

MR. ZUG: It is a logic gate that is called an RS latch. It is a device 4044. When you give it a signal it sends the output low. If you give it a reset signal in the same chip, it sends the output back high.

MR. ASHE: Suppose it loses power in between? What happens?

MR. ZUG: It unlatches and the default state is power high and if that would have happened you would not

have either lamp. Neither is shut down.

Now the question was asked if we know that by design. Yes, we know that by design but also the physical evidence is that there was a latch set because only after the reset button was pushed on all five units did the trip lamp go out so there is the physical evidence that a latch was in fact latch.

MR. McCORMICK: So the particular trip light that we can't find was not a factor in the actual tripping. We didn't -- by design one of these should have gone on but it didn't have to go in order to do the module trip. That is the way I'm saying it.

MR. CRANDALL: Let me put something in perspective a little bit too because what's been very difficult for the team is to go right out there and find the actual smoke and what we have been really --

MR. FIRLIT: Time out, time out. Let's have one conversation at this table here, okay? One at a time.

Go ahead.

MR. CRANDALL: What we have been really digging for is the anomaly between finding this target so to speak that gave us the trip and that has been absolutely totally unexplainable by any of the design.

The trouble is we know what happened so what I would like to put in perspective is the fact that we do know

we got a trip.

We do know we didn't get a normal trip of what these things are listed because they all latch and most of those we have checked but we did get a trip in the circuitry.

We have been unable to and I am not sure whether we ever will be able to explain precisely how that happened but we have been able to make some concrete decisions so to speak that we know that signal came into that board.

The direction we are going to is how can that get into the board and we are sort of saying that maybe we don't want to beat it to death as to why we didn't get the light. Maybe that is not as big a deal.

It's going to be uncomfortable that we are not going to be able to explain that but what we want to address is -- we want to go back and look how can that come into the board and in essence say we are not going to be able to find that little piece, if everybody is comfortable with that.

MR. CHIU: Can I make a comment? Isn't it true what we right now assume, we have to have a signal going to the board and the board will generate all the actuation for the breakers. Will there be a possibility of spurious actuation?

We never had a signal going to the board.

The board itself through some other environment --

MR. CRANDALL: There's three signals that were generated off the board in order for this to happen.

Is that right, Rudi?

MR. MACHILEK: Yes.

MR. CRANDALL: Two signals had to be generated off the board so we know it came from the board. We know that so we know something came into the board but not any of these ten.

Is that answering your question?

MR. CHIU: No. My question is, right now we are assuming none of the ten actuation signals go into the board. Then the board will generate the three --

MR. CRANDALL: No, we're saying not. We are saying we note one of the ten did not go to the board.

We know that.

Part of that is based on a failure of five units when we have a confidence level that those trips do indeed work.

So we know it's not the ten; we know there is a trip; we know it went into the board.

MR. McCORMICK: Is there a test that we can perform on each of these trips to check that they will work?

MR. CRANDALL: We have done it on most.

MR. McCORMICK: Is there a test we can perform for each one?

MR. CRANDALL: There are some we would prefer not to. I was going to get that in the troubleshooting. The DC overvoltage we would prefer not to do that, because that can cause damage in filter units and things like that.

MR. McCORMICK: Okay.

MR. CRANDALL: I'm not saying that's not valid that could be addressed, and maybe we need to do that, but we --

MR. McCORMICK: Let's go back to Rudi.

MR. CRANDALL: I just want to put in perspective -- and I don't want to get off on a tangent of this -- Like Rudi said, we're analytically saying we didn't have a light, but we're saying to ourselves, Okay, we're assuming an 11th light that doesn't exist must have done something, and we're not getting off on that lack of light.

MR. McCORMICK: Okay.

Rudi, go ahead.

MR. MACHILEK: What is of main concern is, why did the units trip? Why was a trip signal initiated in the first place? The trip signal which was stored -- we have a lamp which says we had a logic failing. That means the failure in the module was not in the power circuit, but it was in the logic circuit.

Investigating that, where it possibly could come from, we established that the way we are generating logic

power under certain conditions can lead to a momentary loss of logic power. That momentary loss of logic power, of course, would shut the module down, would give you a lamp indication which says, logic problem, and would give you a trip. Since that is the only common denominator for all five modules, resulting in the same result in all five, we pretty much thought it was a certainty that the problem had to be in that portion of the equipment.

We started to investigate what the possible scenario would be to cause that loss. We do have a mini-UPS system within the UPS, in order to generate logic power. That consists of two power supplies, a plus and a minus 20 volt power supply, which works in parallel with a small control battery supplying battery power to the logic. The AC supply to the two power supplies can come from either of two AC sources: either the bypass source, which is the maintenance bypass, or the output of the inverter itself.

MR. CRANDALL: Excuse me one second. Just so everybody is up, he's talking right in here, on this drawing.

Sorry. Go ahead.

MR. MACHILEK: At the time of shipment of those units, the standard procedure at Exide Electronics was to have the bypass source as being the preferred source for the power supplies generating the DC control power. If the

bypass source would go away, if it would cease to exist suddenly, a relay would switch over to the other supply, which is the inverter output, and would continue power to the power supplies. The little switching transient would be made up by the battery, which is in parallel with the output of the AC, DC power supplies.

Now, we demonstrated yesterday to ourselves that such a loss of bypass power in fact was reaching the logic power over to the other source, without an interruption to the output. Can that be confirmed?

MR. CRANDALL: With a correction, sort of. We proved that, with the unit on-line, maintenance power available, that logic is on maintenance power.

MR. MACHILEK: Yes. And it would shut down --

MR. CRANDALL: And it's on the B phase. That should be pointed out. It's a single phase, 120 volts on the B phase.

MR. McCORMICK: But you did prove that it would switch.

MR. CRANDALL: We did prove.

MR. ROSENTHAL: Last night you stood there and turned off the bypass supply, and you observed K-5 in quotes relay the armature move.

MR. MACHILEK: Yes, sir.

MR. CRANDALL: No. I want to get that specific.

Not CB-4. The input power into the maintenance supply.

MR. ROSENTHAL: I said K-5.

MR. CRANDALL: You said we opened CB-4.

MR. ROSENTHAL: No. I'm sorry. You opened up an upstream breaker on the other side of the regulating transformer.

MR. CRANDALL: Okay. I misunderstood that.

MR. ROSENTHAL: Right?

MR. CRANDALL: Yes. We shut off the maintenance supply.

MR. ROSENTHAL: And you observed this K-5.

MR. CRANDALL: Yes.

MR. MACHILEK: K-5 was switching over to the inverter output as being the AC supply to the power supplies.

MR. ROSENTHAL: Do we have a drawing that shows where K-5 is?

MR. CRANDALL: It's really right there.

MR. MACHILEK: It is in the block which says Logic Power and relay panel 8-1, in the middle of the box.

MR. CRANDALL: We have that on a UPS drawing that we gave you, but we didn't bring it with us, I don't think, the specifics.

MR. MACHILEK: This is really the way it was designed, and it does in fact operate this way. What we

suspect does not operate so well: If the bypass would not suddenly cease to exist, but would greatly reduce itself in the amplitude -- which it did, because unfortunately the supply power to the power supplies comes from phase B neutral, and B was the phase, unfortunately, which was affected by the scenario on the input power transformer.

If that voltage would, let's say, have dropped to 40 percent or so, which was reported it did, that relay not necessarily would switch. It could, in chatter, resist to switch over to the other supply, which of course could lead to a momentary loss of the output of the power supplies, in case the battery would not be able to carry through.

The point is now, is the battery able to, or is the battery not able to, carry through. We suspect that the battery of that little mini-UPS is in a condition where it cannot sustain logic power through that scenario.

MR. SYLVIA: Can you test these batteries?

MR. CRANDALL: In the one unit we have tested that battery, it is dead.

MR. ROSENTHAL: Which one is that?

MR. CRANDALL: 1C, UPS 1C. We haven't gotten into the other four to check, but 1C's battery is dead. We do know that.

MR. ASHE: Wouldn't you like to qualify that? Dead -- you mean degrading.

MR. CRANDALL: It's .06 volts out of 20, I think it is. It's dead.

[Laughter.]

MR. ASHE: All right.

MR. ROSENTHAL: It's a little nicad battery, about -- how big?

MR. CRANDALL: It's a series of them. They're little D cells combined together.

MR. McCORMICK: D cell batteries?

MR. CRANDALL: Nicad, yes, 48 of these things.

MR. ROSENTHAL: And you know that that battery is dead because --

MR. CRANDALL: We tested it.

MR. ROSENTHAL: When?

MR. CRANDALL: We opened up logic power --

MR. ROSENTHAL: Tuesday, Wednesday, Thursday?

MR. CRANDALL: The first day we were out there, which I think was Wednesday or Thursday. I'm not sure which day; I'd have to look. The days are running together.

MR. ROSENTHAL: You go out there, and you physically remove the battery, and you hold it to a voltmeter?

MR. CRANDALL: If you look on the drawing, there is, I think, CB-1 -- A27 CB-1 -- that connects it.

MR. ROSENTHAL: Right.

MR. CRANDALL: Down below, there is a switch or a breaker that ties this to the maintenance supply.

Right here. We opened the S1 switch. We went on maintenance power, had the unit down. Under that condition, the maintenance supply is feeding the power supplies. We opened the S1 switch to take that AC away, and the battery should have sustained it. The lights went out. We then proceeded to check across the bus and got .06.

MR. BERTSCH: I think one was .06. The other one was maybe half a volt.

MR. CRANDALL: It's effectively zero.

MR. BERTSCH: It's nothing.

MR. SYLVIA: Do we know how long that battery had been in there?

MR. CRANDALL: They were replaced during startup.

MR. ROSENTHAL: When was that?

MR. CRANDALL: It was about six years ago.

MR. ROSENTHAL: And the batteries are not part of a specific -- Are the batteries part of a PM program?

MR. CRANDALL: We do not have the program written, though we wrote a DER, and I think I gave that to Frank.

MR. ROSENTHAL: So for the last six years the batteries have not been --

MR. CRANDALL: No, they haven't been.

MR. ROSENTHAL: I'm sure in the future they will

be.

MR. CRANDALL: We just flew some in last night.

MR. SYLVIA: What is the recommended replacement time?

MR. CRANDALL: My understanding was five years. I have not put my hand on a piece of paper for that.

MR. SYLVIA: It's not in the manual?

MR. CRANDALL: No.

MR. McCORMICK: What do you mean, not in the manual?

MR. CRANDALL: I didn't find it in the manual.

MR. JULKA: We have to check that.

VOICE: It's four years.

MR. CRANDALL: He's saying it's four years.

MR. MACHILEK: The basic problem is that it is four years at 77 degree F.

MR. ROSENTHAL: Keep going. How hot do you think it is in there? If you put your hand on that panel outside, it is hot.

MR. MACHILEK: I would say the inside temperature should hover around 120 degree F.

MR. CRANDALL: When you're saying 77 degrees, are you saying the environment of the batteries, or you're saying the ambient?

MR. MACHILEK: The environment around the battery.

MR. CRANDALL: But we know that's not going to be 77 in there, right? Ever.

MR. ASHE: You're operating beyond that.

MR. JULKA: It may have to be two or three years.

MR. ASHE: It would be shortened.

MR. CRANDALL: Okay.

MR. ROSENTHAL: At first I thought we might have maintenance which wasn't a direct contributor to the event but simply would be life-shortening on stuff. It now may be very germane. Is there any way to get a thermocouple or a means of measuring the internal temperature of the --

MR. CRANDALL: I think we have those.

MR. ROSENTHAL: With the doors closed and fans running.

MR. CRANDALL: What we have done numerous times -- I've got to make sure I can put my hands on the numbers, and we don't have it on every unit; C and D are the ones that are hot.

MR. ROSENTHAL: Okay.

MR. CRANDALL: We have done comparisons where we've taken a surface pyrometer. It's difficult at best to put a thermometer in there, to secure it, because of the nature of the equipment, so the way we have done it is, everybody ready, open the door, stick the surface pyrometer on, and take a reading on the surface of the inverter legs,

which is a relative indication of the heat in the box. We have some numbers that give us some --

MR. BERTSCH: But that's on the surface of the metal, which is actually part of the heat sink for the SCRs. The batteries are located further back, but they're actually a little cooler, because they're in an open area.

MR. ROSENTHAL: When I stand and face the front of the inverter, on the upper left I see a whole bunch of logic cards. Is that the area in which the battery is located?

MR. CRANDALL: No. The batteries are in the back section at the top, just underneath the grating.

MR. ROSENTHAL: And the SCRs are two, three feet down from that.

MR. CRANDALL: About a foot below, or so.

MR. BERTSCH: They're also in front. The batteries are mounted physically on the back, and the SCRs are further in the front; you've got a capacitor bank in between them.

MR. MACHILEK: The only significance of it is, whatever temperature it is, it is not 77 degree F. Therefore, we should not expect five-year life. How much less -- [Pause]

MR. McCORMICK: Okay.

MR. MACHILEK: So far this was our conjecture of the probable scenario. The proof of the pudding is in

showing it, and we suggested a test sequence yesterday to prove the point. If it bears out, then we do have a remedy.

About three years ago, the 827 was redesigned to have redundant power supplies on it. That means instead of having one plus-minus 20 power supply pair, it has two. One power supply pair is supplied from the inverter output; the other power supply input is coming from the maintenance bypass. We have a diode option of the DC output of the two power supplies; therefore, any switching or any switching transient is eliminated.

MR. CONWAY: Therefore, that relay potentially chattering on a degraded condition is eliminated.

MR. MACHILEK: No more relay.

MR. CONWAY: No more relay.

MR. JULKA: Do we know what type of relay this is?

MR. ZUG: It is actually a small contactor. The manufacturer escapes me at the moment.

MR. JULKA: I was more interested in the drop-out voltage for that relay.

MR. MACHILEK: We'll find out. That's why I was suggesting to reduce the voltage on the bypass input to see at which point it starts chattering and establish what we have going there.

MR. ASHE: By the way, there should be something pointed out here: That task was not completed yesterday

because of other problems. However, I would assume you plan to continue to test.

MR. MACHILEK: Yes. We had hoped that we could test before that meeting. It would have maybe shortened the discussion time by two hours.

MR. ASHE: But right now, at least, there has been no change in the thinking.

MR. MACHILEK: No, sir. The tests are --

MR. ASHE: So as soon as this inverter becomes available again, you're going to try --

MR. MACHILEK: As soon as we get permission to get at it, yes, sir, we'll do so.

MR. McCORMICK: That will be one of the things we hope to conclude, that we could go ahead and fix whatever.

MR. MACHILEK: I talked to the factor last night, and there is a new version of the 827 power supply pan on the way. It should be at the Syracuse airport this afternoon or tomorrow morning.

In case the test bears out what our conjecture is here, we can repeat the test with the new power supply and show that the same scenario would not cause a shutdown of the modules.

MR. FIRLIT: Am I to understand that we have uninterruptable power supplies that, if the battery voltage that supplies the logic circuit there gets below a certain

level, takes out the whole system, then, in one transfer?

MR. MACHILEK: If you --

MR. FIRLIT: What I'm trying to figure out is, is that battery a cause of why we didn't transfer? That's what I'm trying to figure out. I have not figured that out yet.

MR. MACHILEK: Not why it didn't transfer. Why you did shut down the module.

MR. CRANDALL: But specifically to this particular --

MR. FIRLIT: It caused a problem. That's what I'm getting at.

MR. SYLVIA: You mean there's no light that tells you when the battery's going bad or anything like that? There's just a word in the book that says, should be replaced?

MR. CRANDALL: Can I interject? We're saying the battery is definitely the concern here, but it's not that the battery is bad and therefore, any time it's bad, we'll have the problem. It's the battery bad with this kind of transient coming in on the power supply.

MR. McCORMICK: The question is, there's no monitor across that to tell you it's bad before you get into this problem.

MR. CRANDALL: Strictly through a preventive maintenance program, which is what we are instituting on

these units.

MR. LEWIS: It was mentioned that this supply picked off at phase B. If, for example, it had been picked off at phase C, by chance, you might never have seen this problem. It's things adding up together that makes it.

MR. MACHILEK: Or if the transformer failure would have been on phase C or A, we would not have seen it, either.

MR. CRANDALL: It's very possible that the --

MR. SYLVIA: Batteries that are supposed to last four years could go bad in six months.

MR. ROSENTHAL: I'm not defending the PM program; we need the PM program. But if it's that critical --

MR. CRANDALL: That's what I'm saying. That's what I'm trying to point out. I don't think it has the critical -- In the scenario we're in, yes, it's critical, but in a normal mode of transfer it is not.

MR. ASHE: At this point I don't think you can actually prove it's that critical. I really don't. You don't have anything to provide that it's that critical, nothing. Have I missed a point someplace? Is it critical even to the situation that we had?

MR. SYLVIA: No.

MR. ASHE: You can't prove the battery is that critical, even in this kind of transient. You can't prove

that right now. You have no information.

MR. McCORMICK: Chattering may be enough.

MR. ASHE: May be. May be. I'm saying prove it, not may be. We want to take the uncertainty out of it. You're going to make it repetitive; you're going to duplicate it. But right now, you can't do that.

MR. CRANDALL: We don't know if all five batteries are bad in all five units, either.

MR. McCORMICK: Do all five have the battery?

MR. CRANDALL: No. That's the key to those two, by the way. Elgars use the DC-to-DC converter; they do not rely on AC. That's why I asked Steve to go into that first. A DC-to-DC converter is not susceptible to transients on AC.

MR. IBARRA: This is Jose Ibarra.

In the technical manuals that are delivered when the UPS is delivered -- does that manual itself address that battery and whatever has to be done to keep those units operating on a regular basis?

MR. CRANDALL: Steve just showed it to me. When I made the comment that I couldn't find it, I was looking for it when we were doing the PM. It says nothing about it in the troubleshoot section. It's a note. I'll read it, just for the record.

It talks of the A27A1 card and there is a parentheses: The control battery discharge sensing is

located on the A27A1 card. These batteries should be replaced at four year intervals.

It is in as a note in the paragraph.

MR. FIRLIT: Okay, I go back to the gentleman there that says with this product we don't really know whether or not the battery played a key role or not so I don't know, I could surmise that the battery deteriorated over a six year period but I can't -- I don't know if that's what caused the battery to be low or if something in this transient zapped that battery to make it low.

MR. McCORMICK: Obviously it's probably been working a little above its temperature -- but as Ralph said it could have been for all we know that battery. There is no indicator on the front of the panel. You are kind of in the blind. It could fail first but I don't think we were doing anything to mitigate the potential for it being a failure, we've got a number of things going.

Do you have a trouble-shooting plan? Is there a trouble-shooting plan that can get us through from where we are now to find out --

MR. MACHILEK: We submitted the test sequence yesterday.

MR. McCORMICK: And has the NRC reviewed that, would agree to that?

MR. ASHE: That's been modified because we had a

little problem as you are well aware with the impurity that was in the test so I would assume that this plan is going to be modified, right?

MR. ROSENTHAL: Not yet. Wait a second, wait a second. I'm sorry -- I thought you said "the plant."

MR. ASHE: The plan. This test plan -- p-l-a-n.

MR. ROSENTHAL: P-l-a-n-t will not be modified -- yet!

[Laughter.]

MR. ROSENTHAL: We agreed with what you said yesterday. When it went down we witnessed, we were going through this thing, this other failure. Now we have this meeting here.

Yes, today we have to agree to some test plan. We want to review what we heard this morning, review what you are saying now or as modified.

MR. McCORMICK: We need to fix what broke last night.

MR. ROSENTHAL: We know that.

MR. CRANDALL: What I would like to present is to the degree that we are able to is to present to the NRC whatever, in whatever format, whether it is in this meeting, another meeting or whatever, the overall plan of how we want to attack the overall troubleshooting with knowing that we are going to have to get deeper in, Frank and I or whoever.

Troubleshoot plans are going to change as we go along.

MR. McCORMICK: Yes. Are you willing to entertain that now?

MR. ROSENTHAL: That troubleshooting plan? Today? Yes, I mean within the hour, surely, or less.

MR. ASHE: Could I just comment on that, please? In terms of a plan and I am just asking now, we would like to keep modifications to a minimum so we can try to duplicate it, if at all possible so if the unit went down, we're not only going to replace it, we are going to change the state of it, and now I am not sure what they are doing here anymore.

If we keep changing it we are not going to be able to duplicate what we had when we had the failure.

MR. CRANDALL: I would want to reduplicate the failure on at least the second unit before I started to look at --

MR. ROSENTHAL: Okay.

MR. CRANDALL: That's my opinion but again I think those, on that level, you know maybe that is not at the level we're at. The specifics of that may be on your or my level is what I am thinking and it may be the plan to go through it. The overall should be here.

MR. ASHE: We're on that second aspect there

because the other four as I understand it are frozen and so they should be basically the same state and this particular one you know we had a problem with yesterday so I wasn't aware of that aspect of your plan, okay, about duplicating the same test on a second unit.

MR. SYLVIA: How are we going to duplicate the failure?

MR. ASHE: Well, we are talking a narrow base, a very restrictive test here on the logic to attempt to see if--

MR. MACHILEK: If our scenario is demonstratable.

MR. SYLVIA: I guess I don't know enough about it to know whether that is any good or not.

Does this narrow or the bounds of this test really tell us that we are duplicating what happened, starting with the transformer failure or are you just duplicating that if the battery fails the logic won't work.

MR. MACHILEK: No, you would have to rely on our ability to analyze the circuitry which we designed to respond to a certain --

MR. CRANDALL: I think it's a scenario that probably we can try and go out and if we get lucky we will be able to reproduce it but I think we are going into it with the probabilities are probably against that. We have got to try it and have some hopes we can do it.

If we can't then we need to sit down and based on what we are seeing then you know deduce some things.

MR. LEWIS: Warren Lewis. You can reduce the voltage and reproduce the chatter but you can't reproduce the transient that accompanied it through the grounding system so what the hope is if you can say finding trouble is something you are hoping for, you are hoping that a simple reduction in voltage will reveal the problem.

If a simple reduction in voltage doesn't reveal the problem that doesn't mean that you can declare that this is an invalid test. It is a test which is incomplete. You can't say there is no problem. You may still be right on the right track, let's put it that way.

MR. ROSENTHAL: Before we get into the troubleshooting today and I guess I am working off this Drawing C-110-611-234, let me ask just a simple question.

K5, is that normally energized or normally de-energized/

MR. MACHILEK: Normally energized.

MR. LEWIS: From the bypass line.

MR. ROSENTHAL: And these contacts are shown on this drawing in DN.

MR. MACHILEK: De-energized.

MR. ROSENTHAL: So you plug it into the B Phase. You would close K5. You would align Power Supply 1 and 2 to

get roughly 110 volts AC and then Power Supply 1 and 2 put out plus or minus 20 volts with the batteries in parallel with those two power supplies.

MR. MACHILEK: Correct.

MR. ROSENTHAL: That's what I am reading.

MR. MACHILEK: Correct.

MR. ROSENTHAL: Okay. What is the CB1, contacts 1 and 2, on the output of the battery?

MR. MACHILEK: That is the battery breaker, the breaker which disconnects the battery for purposes of testing, replacement or whatever.

MR. ROSENTHAL: Okay, now you went out and you measured a battery and you said that it is one volt and that is in parallel with which battery?

MR. CRANDALL: The way we did it was we put the unit on maintenance supply. We opened the S1 which took power from the maintenance away. We left CB1 closed and read the logic voltage.

MR. LEWIS: Under load.

MR. CRANDALL: Under load, that's true. It was under load.

MR. McCORMICK: Why would that not be a part --

MR. CRANDALL: No, it was an open circuit. It had load on it, which could drag it down. It may not be dead open-circuited. There we are talking about a degree of

degradation, I guess.

For safety reasons I chose really not to have somebody go way up inside.

MR. ROSENTHAL: I'm sorry. He might as well see, too.

MR. JULKA: This is the AC source.

MR. ROSENTHAL: This is the AC. This is now closed.

MR. JULKA: Right. This is closed.

MR. ROSENTHAL: Because this is energized. This is now closed. Into this power supply is -- the output of the power supply is here. Here's the battery, with this closed, in parallel.

MR. JULKA: That's right.

MR. ROSENTHAL: Okay.

Then you open this, and you measure the voltage here.

MR. McCORMICK: This is now handling whatever load is on there.

MR. ROSENTHAL: ES-2 is dead.

And you still have all the cards.

MR. McCORMICK: Yes.

MR. ROSENTHAL: And you reviewed this?

MR. ASHE: Yes. I think we understand that aspect of it. It was good for you to take the time to go through

it like that.

MR. ROSENTHAL: Before we get into the tests, can somebody go -- Maybe, Frank, you're better to verbalize. Okay. Please pick up.

As I understand it, what we've said this morning is that there was a logical disturbance on the B phase of this power plant. Five uninterruptable power supplies tripped out. I need an adjective now that they were probably tripped out because of a larger failure, that breakers were demanded to open.

MR. ASHE: I wouldn't call it a failure. I would characterize it as a logic signal which caused the breakers to open.

MR. ROSENTHAL: Do we know that? What adjective do we want to use? We think that CB-1, 2, 3, times five units, were demanded to open.

MR. ASHE: I would still say logic signal.

MR. CRANDALL: We know that.

MR. ROSENTHAL: You say that we know that.

MR. ASHE: We know that.

MR. CRANDALL: We do know that, because our modules tripped alike.

MR. ASHE: Right.

MR. ROSENTHAL: So we know that.

MR. ASHE: Yes. That's known. That part is

known.

MR. ROSENTHAL: So, then, we know that it was some command signal that we're now tracing down.

MR. ASHE: Right.

MR. ROSENTHAL: The reason I'm trying to get this out is, I don't want to be sitting here with this crew three days from now, saying, Ah ha; we did so much testing; this all fell apart; now we're going to go back into the heavy power said of this. We really think we're on the control side of this, the logic of this.

MR. ASHE: This discussion has been centered on the control logic power supply.

MR. ROSENTHAL: Do you concur?

MR. ASHE: Yes.

Obviously, this man knows more about his unit than I do, or let's hope so.

[Laughter.]

MR. ROSENTHAL: I just want to get a little summary going.

Now we're off the logic --

MR. ASHE: The principal focus has been the logic power supply area. It appears -- it may be -- it is possible that degradation in the batteries, in this area, may have been a contributing factor or cause to generating the trip unit signal which isolated all of these UPS's.

MR. ROSENTHAL: Let me back up. We agree that we had a trip unit --

MR. ASHE: Is there anybody here that disagrees with his statement? If somebody disagrees with that, we want to hear?

MR. CHIU: Will you restate his statement?

MR. ASHE: His statement says that we know -- not think, or it is not maybe -- that the logic unit trip signal was sent to isolate the inverters.

MR. LEWIS: I disagree.

MR. ASHE: You disagree. We do not know that.

MR. LEWIS: Wait. I disagree with a word.

MR. ASHE: Okay.

MR. LEWIS: The logic signal was erroneously sent.

MR. ASHE: Okay.

MR. LEWIS: And this is important, because it differentiates between a failure of logic and so on and so forth. The second thing was that we had a phase B failure, but we had a phase B-to-ground failure, so we had two conditions: fault on B, current injected into the grounding system.

MR. ASHE: Wait a minute. That part is different from what he said. Let's go back to your word. Would you agree an erroneous trip signal was sent?

MR. LEWIS: Yes.

MR. ASHE: Okay.

Does everybody agree with that, then?

MR. TSOMBARIS: No. I think it was a trip signal that was sent. I don't think it was erroneous.

MR. ASHE: Okay.

MR. ROSENTHAL: Moving on --

MR. ASHE: I think we should get -- It was my understand that everybody was in agreement that some signal was sent from the trip unit. Now, you call it erroneous, call it this, call it that, or what have you. Call it whatever you want to call it, but the trip unit sent the signal.

MR. TSOMBARIS: And I think the unit performed the way it was supposed to, given the signal it received. The signal it received, given what it was, it tripped the unit, which it was supposed to do.

MR. ASHE: Well, we're getting into semantics. I think I understand.

MR. McCORMICK: If the trip signal was sent, I don't know how the word "erroneous" is in there.

MR. ASHE: Well, it's a semantic problem here. I understand what you mean by erroneous. In my line of thinking, the module either sent a signal, or it didn't -- for whatever reason you can think of, and there can probably be a thousand. It sent a signal or it didn't.

If I've got the wrong understanding, then we need to back up and get the right understanding.

MR. MACHILEK: The module did exactly what it was designed to do. We don't like what it did.

MR. ROSENTHAL: So the module tripped, changed state.

MR. MACHILEK: Yes, sir.

MR. ROSENTHAL: At the other end of the logic, you have sensors, and to date we don't believe that any of those conditions were detected in those things. Somebody had better verbalize better than me.

MR. ASHE: I think we aren't able to clearly establish why the logic sent that signal. Is that wrong wording?

MR. ROSENTHAL: No.

MR. MACHILEK: We did not have any visual indication of which of the signals initiated the trip, yes.

MR. SYLVIA: Let me ask you another way. By design, if the logic signal existed due to the batteries being dead, would we have gotten the logic fail light? We still should have gotten the light?

MR. MACHILEK: Oh, yes. The logic fail says you have a problem in the logic. Now, what problem in the logic: we would have to resort to the lamp switch, but it didn't light.

MR. SYLVIA: To me, just from a pure logic point of view, you haven't said the battery caused the failure; you're saying it's a good possibility, so you want to do this test. But the fact that we didn't get the light causes me to doubt that.

MR. MACHILEK: Well, we cannot duplicate not getting the light.

MR. McCORMICK: I don't know that we want to say the battery caused the failure; it could have prevented it.

MR. ROSENTHAL: No, you don't know that. I was just trying to narrow it down at least to cards from the whole plant, and the troubleshooting is going to determine this. One can come up with alternates in terms of ground faults; we could go in there with a small RF generator and see if that causes changes in logic states -- I mean, there are things that can be progressively done, but at least we're focused on the card level and a sub-unit of this thing.

MR. FIRLIT: Where I'm lacking with the battery is, If the logic circuit got a signal -- we all agreed that was some kind of a signal that got in there -- and I heard a statement saying that the circuit did the job it was supposed to do. If it did the job that it was supposed to do, how does the battery fit into it? It would have tripped either way; you've got a trip signal to pop all those

breakers.

MR. CRANDALL: Maybe I can word it.

The module got a trip signal from somewhere, and it is likely that the power supply, being connected to the AC, is the avenue that that transient entered the unit, and that disturbance affected the power supply such that that trip signal was generated.

MR. TSOMBARIS: Can I say something? Maybe that will help understanding.

One of the reasons the UPS shut down itself is, If the control power supply drops. I think you can correct me if I'm wrong. Normally it's plus or minus 20 volts. If, for some reason, that voltage drops below a certain value, that in itself would generate a trip signal. Is that true?

MR. ZUG: Yes.

This is Bill Zug.

The power supply voltages, both the plus 20 and the minus 20 volts, are being supervised by a circuit. If that voltage drops below 16.5 volts, a trip signal is generated. Now, the probable scenario is that, in the reduction of the phase B power supply voltage, to what appears to be 40 percent of normal, there was insufficient voltage on the power supply to hold up the 20 volts. Additionally, due to a degraded -- let me use the word "degraded" -- battery, it could not substitute and hold up

the voltage, so a decrease in that voltage to below 16.5 volts would have generated that trip signal.

The only thing that is not consistent is that there should have been a lamp on the protection board that would have said, Power supply failed. The only thing in this scenario that doesn't fit is the absence of the lamp. However -- and this was pointed out before -- a latch was set, because it had to be unstored, and the pushing on the reset button, the unstoring, cleared the trip lamp.

MR. ROSENTHAL: On the C UPS --

MR. ZUG: Yes.

MR. ROSENTHAL: -- but not on the other UPS.

MR. ZUG: All the trip lamps were cleared by pushing the reset button, except on --

MR. CONWAY: G.

MR. ZUG: Was it G?

MR. CONWAY: Right.

MR. ZUG: -- except G, which most likely was reset, because the operator tried to restart the unit. The only way you can restart the unit is by resetting the alarm. I think there is conclusive evidence that that was the case.

MR. ABBOTT: That was the D-delta unit.

MR. CONWAY: Yes.

MR. ZUG: UPS 1D, as in dog.

MR. SYLVIA: So there is no load on these small

batteries normally?

MR. ZUG: Normally there's no load on these batteries, because the power supplies -- the DC power supplies -- provide logic power. The battery just floats, in the same way as the main battery floats on its battery charger, simply providing a maintenance charge, to prevent self-discharging.

MR. SYLVIA: How much load do they have to carry when they are called on to do something?

MR. ZUG: Under normal operation, approximately 5 amps on the positive supply, approximately 3.5 amps on the negative supply. Under non-operating conditions, it's less than one half amp.

MR. SYLVIA: So for this battery to have caused a problem, we have these batteries in five units that were supposed to last four years, but it has been, what, six years?

MR. CRANDALL: Yes.

MR. SYLVIA: With no load on any of them, and they all went bad to the same degree that caused them to fail when the load was put on them. That's what we believe.

MR. ZUG: Yes.

MR. CRANDALL: That scenario -- I disagree. I agree there is a failure related to the power supply. That maybe contributed to a lower degraded battery. It is

conceivable that, with a good battery and the transient we got, the relay could still have chattered with a good battery and maybe caused the same thing.

MR. SYLVIA: Yes. I said with the battery, Bob. I didn't say with the idea of the failure. If these batteries caused the problem, the logic that I went through would have to be improved.

MR. CRANDALL: Well, see, we've proved that batteries being bad alone don't cause the problem, because we've gone through and done all these trips, and it works fine. Nothing locks up. It transfers over; everything works good. The batteries could be contributing.

MR. SYLVIA: We're going to get the new batteries to prove or disprove the point about whether or not the batteries did it.

MR. CRANDALL: We can go through and try the test and hopefully prove something.

MR. CHIU: One thing we want to consider in your test: If you have a short on capacitor, or of a power supply -- capacitor holding up with DC power, but if you have -- For example, right now we're hypothesizing a microsecond of AC power transient. Somehow, DC power would be dropped. The one possibility there is somehow trigger the capacitor -- that is one possibility -- short it out. It has happened in the industry several times now.

If we shorted out, we can also drain the DC power supply at the same time. Then, after the transient, maybe the spurious thing disappears. Now we don't have the evidence. So it may be of less consequence on the effect. But we need to factor into that --

MR. CRANDALL: Sure. I don't want to focus on the battery. I want to keep with what we know.

MR. CONWAY: John Conway.

I don't think we know -- or maybe we can show -- that we're talking about a 40 percent decrease on the B phase -- or a 60 percent decrease on the B phase voltage. Don't we have indications that the voltage did not degrade that far, or can we not disprove that, that the voltage in fact went that low on the in-house 600 volt power board?

MR. JULKA: Six cycles for that period and six cycles previously, the whole system would go down on the B phase. It was effectively shorted.

The phase was effectively shorted. Again, what I'm saying is based on the Scriba oscilloscope. At that time, system was still connected.

MR. CONWAY: Throughout the plant?

MR. JULKA: Throughout the plant.

MR. CONWAY: Even at the lower voltage.

MR. JULKA: Right. We disconnected six cycles later. During the six cycles, it was connected. Like I

said before, the approximately value of phase B voltage was estimated to be around 80 kV. Normally it should be 220 kV to ground on a 345 phase-to-phase system.

Since the system was still connected, the system saw the same thing. The proper transformations in the transformers and everything else down the line.

MR. McCORMICK: Okay.

Does Exide have anything more that they want to bring to this discussion at this point?

MR. MACHILEK: No. At this point we want to maintain the suggested test sequence.

MR. McCORMICK: Can you draw any conclusions or make any recommendations until you get the results of that test?

MR. MACHILEK: No, sir.

MR. McCORMICK: Okay.

In order to proceed on that test on the C unit, we have to make certain repairs to problems that occurred last night.

MR. MACHILEK: Something broke. It had nothing to do with what we were doing. We lost a chip or something.

MR. McCORMICK: I would expect that all tests would still be -- It would be appropriate to continue all testing on the C unit, which is the only one that we haven't done anything to to change it from the state that it was at

the end of the day Tuesday.

MR. MACHILEK: Well, it has not really changed the state of what the unit was.

MR. McCORMICK: Do we know hat we have to do to the C unit to put it back into its state?

MR. BERTSCH: High confidence, yes.

MR. ASHE: Back up. Do you really know, or do you think you know? You think you know.

MR. BERTSCH: I think I know. It's just a matter of pulling two cards and checking a couple of chips.

MR. ASHE: Oh, okay. All right.

MR. BERTSCH: Put a scope in there and look and see what we've got for voltages.

MR. ASHE: Okay. So actually you're just planning to remove cards and put on a scope and try to check some things.

MR. BERTSCH: Replace the chips.

MR. ASHE: When you replace the card, you do the whole card, or do you just --

MR. BERTSCH: No, I'm just going to replace the chips.

MR. ASHE: Okay.

Has this happened before? Is that why you've got such high confidence in this?

MR. BERTSCH: Yes.

MR. ASHE: Okay.

MR. SYLVIA: Are you using the scope or electronic voltmeters to check that voltage, or are you using a Simpson's meter?

MR. BERTSCH: No, we don't use Simpson's for this. It's all either a scope or digital voltmeters.

MR. SYLVIA: Okay.

Does the fact that the battery was really dead and we didn't get this trip and transfer tell us anything?

MR. CRANDALL: We don't have enough information yet.

MR. SYLVIA: Well, we said if the battery was less than 16 volts, we're supposed to get this logic power supply failure on these ten things. If we get that, we're supposed to get a trip of the UPS, and it's supposed to switch over to the maintenance.

MR. CRANDALL: The total power supply battery and power supplies have to go below 16 volts.

MR. SYLVIA: But when we took it out, it was dead.

MR. CRANDALL: Right. What I'm saying is, the trip is not monitoring the battery; it's monitoring the whole logic bus, which is normally fed by power supplies which hold it above.

MR. SYLVIA: Oh. So the battery could be bad without this working.

MR. CRANDALL: We'd never know.

MR. LEWIS: Until you call on it to do its thing, you don't know it's dead.

MR. CRANDALL: It could have been bad a month after it went in.

MR. ZUG: It's like you don't know if you have a bad car battery until you try to start your car.

MR. ASHE: Unless the cells shorted out. Then you'll know.

MR. CRANDALL: We also only know we have one bad battery.

MR. ASHE: Without a signal, starting the circuit's fine.

MR. ROSENTHAL: I'm reluctant to -- At this point I think that you ought to be doing the troubleshooting on the C and not start on the other uninterruptable power supplies. I think we're in agreement on that.

MR. McCORMICK: That's correct.

MR. ROSENTHAL: We feel that we'll gain confidence, knowledge, et cetera. Based on what's learned about the C, when you then go and open up the next UPS, we'll be that much smarter. I think that we at this point should be doing things sequentially.

MR. CRANDALL: What I would like to do, because I think it would be worthwhile for the expediency, would be

to address to you what our overall plan is, accepting that you put hold points in, but I'd like the ability to say, This is the direction we're going, and you agree, and then Frank or whoever it has to be says, All right; you can go past this whole point to our next point -- rather than resitting down each time.

MR. ROSENTHAL: Fine. We will make ourselves available independent of the hours, et cetera.

MR. McCORMICK: Do you have a troubleshooting plan, or at least a sequence, of how you would propose to do that?

MR. CRANDALL: Yes. That's the logic we would like to take. I don't know if we want to address that here.

MR. ROSENTHAL: It's up to you.

MR. McCORMICK: I'd at least like to have it generally discussed -- we don't have to conclude -- at least have it handed out here so it's for the --

MR. FIRLIT: So I don't lose this thought: Is there any possibility that there are any batteries from the generic standpoint anyplace else in any control or logic circuit that we don't know about that's buried in a manual someplace that says that we ought to check this? Is somebody looking at that?

If you fix this problem, I'm not still going to be satisfied that you don't have a battery out there someplace

else. I certainly don't want to be in the horrible situation that something else happens there.

MR. McCORMICK: We'll certainly ask that question. We can't answer it here, but, if there is something.

MR. FIRLIT: Okay.

MR. McCORMICK: The question is, from where we sit right now, we want to at least initiate thought on the part of a system engineers as to whether there's another potential battery backup supply for some unit which could be sitting here and not in a PM program.

MR. BERTSCH: Yes.

MR. McCORMICK: There could be. We have to know where they are. As an aside.

MR. CONWAY: We'll talk. I'm not sure I follow you. You want me to find every place in the plant that might have another battery that needs to be replaced? Is that essentially what is being asked?

MR. FIRLIT: If we start up again, say that something else happens to our plant -- two weeks later we trip off -- and somebody says, Oh, there was a battery in this supply that said it should be changed out every two years, I want to rest assured before we start this plant up again that that doesn't happen again.

MR. CONWAY: I understand. That's the question.

MR. FIRLIT: Yes.

MR. CONWAY: I don't know how to make that happen.

MR. FIRLIT: Okay.

MR. McCORMICK: But we will make an attempt.

MR. CONWAY: Somebody is going to have to. That's a large effort -- I guess is what I'm saying.

MR. CRANDALL: What this is -- what we did is we looked at the units we wanted to attack first and what we're proposing to do because number one we have C and we agree with you, Jack, we want a complete C. We want to get a complete picture all the way around before we go on.

Our intent is to focus in on the specific troubleshooting plan for that which we'll handle specifically.

Overall, what I am looking for on this plan and that you agree and what we wish to do is to do one C, complete that to your satisfaction and ours and then continue on the same thing with 1A, looking at trips and set points, the batteries, similar to what we are doing at C, verify that we have consistency and then at that point go on to UPS 1B.

1B has a bad CB3. We want to first replacer CB3 because we can't do any trips without that being replaced and then continue on that same trip set point verification.

If we find the control circuit problem, whether we do that to the other units I would like to address at that

point.

MR. McCORMICK: You skipped 1A.

MR. CRANDALL: 1A I had second, I think.

MR. McCORMICK: A2. You are going to replace that breaker --

MR. CRANDALL: I'm sorry. Let me -- A we know we have a problem within its charger supply that we would repair first.

MR. McCORMICK: But we would do no testing.

MR. CRANDALL: Once that is repaired we would do the testing on it. We can't do testing without it. Again, on the lower level I think we can look at exactly what troubleshooting we do to repair that to make sure that we are not missing something -- if that's agreed. You know what I am saying?

MR. McCORMICK: So you want to perform the same tests that you scheduled on 1C on 1A after you change that breaker.

MR. CRANDALL: Breakers on B but same logic. Let me reiterate.

We are going to complete C, hold point on the other units. We then go to A, make its repair. There is a charger problem in there. Make that repair, then do the same test on A that we did on C, then go to 1B, make the breaker repair, do the same tests that we did on C and A.

MR. McCORMICK: That's what you call check-trip set points and record voltages?

MR. CRANDALL: Yes. In the description down there on the left is what we are intending as trips and set points.

MR. McCORMICK: And you want that statement under 1A. Do you troubleshoot the breaker? I am looking at your second page.

MR. CRANDALL: Our listings don't give it probably as well as it does on the little bubble chart there.

MR. McCORMICK: On your second page it was replace the breaker and check trip points and voltages on 1B. You didn't make that statement under 1A but you do want to propose that?

MR. CRANDALL: Yes. Again, we are taking exceptions to a couple tests that we feel would be destructive and probably not going to an area that is going to give us any good information, like the DC-OV. We don't want to stress out those DC caps. Again we handle that I think on a lower level. If you feel you want us to do that we'll come up with something.

Once we are done with those three units, our plan is to evaluate what we have got, the set points, what kind of data we received and there may be a high confidence level at that point that we have enough.

I would like to make the decision at that point, whether you want us to do the rest of those tests on the other two units.

I would like not to play with UPS 1G if I don't have to. I'm saying that upfront and not because I am trying to trick anybody or anything else. G is our plant computer. I don't want a failure on that unit or do much repairs on that unit if I don't have to.

UPS 1B is loaded. I don't have much confidence in how its logic works. I am actually concerned whether testing on it will give us the same reliability of testing on A, B and C and again I am just kind of putting that on the table upfront.

If you feel that you want us to do that, certainly we can. My plan at this point is not to do that because that actually may confuse the issue.

MR. McCORMICK: 1A and 1B do have plant impact, forward impact.

MR. CRANDALL: Yes, they do but those are already addressed in the repairs anyway.

There is repeatability in A and B.

MR. McCORMICK: I suppose what we can say is we'd like to offer this for consideration only and that we would ask that we could proceed for the troubleshooting on the C that we have -- and that would allow us to fix the cards

on the C, do that testing and then recycle back with A being probably the next one depending on how things come out.

MR. CRANDALL: I guess the point I would like to get at is a single point, clearance of ability to work, you know, rather than the overall quarantine, just, Frank, tell us to go and we can go. That's kind of the agreement I am trying to get to.

MR. ROSENTHAL: Frank?

MR. ASHE: Let me ask something here. It's very right here that 1D is what we got to show what the problem is and I can certainly understand that.

Is this another one that we can run this test without doing any repairs on it first?

MR. CRANDALL: We could do it on D. We could do it on G and if I had a choice I would do it on D prior.

MR. ASHE: -- settings, F, 1G. What about G?

MR. JULKA: Same design except it feeds the computers.

MR. ASHE: So you can do it on B, you say, without replacing the circuit breakers, is that --

MR. JULKA: Not B. D - "David," D as in David.

MR. CRANDALL: B we can do some things. We can't do the actual trans-- you know, we can't put it on line and transfer it off line. There are certain things we can't do with it until we replace the breaker.

MR. ASHE: Excuse me, I'm sorry. This test that you are going to run on C, if I understood you correctly earlier, what you said was, oh, I will -- the concern came up about changing the units. If we keep changing the units, then we are no longer going to be duplicating what we have and then I am not sure how valid the tests are and trying to relate that back to what really happened.

So you said, well, okay, I got to repair 1C so we'll make some modifications in that repair but before I really provide some confidence in that area what I thought you said you were going to duplicate that same test with another unit to see if you could duplicate it on another unit.

MR. CRANDALL: Yes, sir.

MR. ASHE: What unit is that going to be in?

MR. CRANDALL: I would like to go to A and duplicate that.

MR. ASHE: Before you repair it?

MR. CRANDALL: No, I can't. Unfortunately I can't because I can't get the engine running.

MR. ASHE: What I am trying to get to is can we duplicate this test we are going to do on 1C without having to repair the unit or something?

MR. CRANDALL: We might have to go to D to do that probably.

MR. CONWAY: The B, the Bravo UPS we're talking -- again I'm being too practical but just replacing the CB3 breaker is the only repair we are talking about doing there. It's not logic related. It really -- the way we we're working at it really should be done --

MR. ASHE: That's nice and all but there are things that occur in the installation as you well know that perhaps we can't always characterize by, you know, design kind of things.

MR. CRANDALL: I guess maybe that I have then and in that case we could do it on all three units and the theory would be that if we put an anomaly into A for example, it wouldn't be the same anomaly we would put in B.

MR. ASHE: What I'm trying to get to is to have further confidence in this test and then I think we can make more positive statements about the battery and the logic and all of that. That's what I was trying to get to, but without modifying or repairing the unit before you've done the tests.

MR. CRANDALL: The reason we've got confidence we can do it by repairing two of those, that the fault in 1A -- at this time and again I am saying we have got to look at that close as we go -- the fault in 1A is in the charger section. The charger section doesn't send trips to the module, and I understand, yes, there can be some things

that you end up inadvertently modifying to get you out of that, I know what you are saying, but we have got a high confidence that we are not in any way affecting that particular section of the unit.

MR. FIRLIT: Marty, can I make a suggestion that maybe you and you and the gentleman from the NRC work that out together, the details?

MR. McCORMICK: Yes. Well, all I'd like to get here today is get the C done and then we can move into the others and that's been the point.

MR. ASHE: Okay, and as I understand the 1C, the troubleshooting plan for 1C is you want to go in and pull two cards and take them to a bench and look at them through the oscilloscope and do some things.

MR. BERTSCH: No, we've got some on the extended board inside the unit to see what's bad. We have got to do the troubleshooting in the unit, then pull them out and repair them.

MR. ASHE: All right. Do we have anything in terms of a plan or procedure that you --

MR. BERTSCH: Not yet.

MR. ASHE: Okay.

MR. BERTSCH: That was late last night. I don't know, you haven't put them together yet, have you?

MR. CRANDALL: No.

MR. ASHE: Maybe we should leave that first because I think I generally understand what you are going to do --

MR. CRANDALL: No, we are going to clear -- the individual pieces we are going to clear between us. I am not questioning that. I am trying, what I am really intending to do is get us one level less than we are now and we have got the overall quarantine on all units and I just want to get it down a little lower so that we can expeditiously go through these things is what I am saying.

MR. McCORMICK: They'll work out with you, get your concurrence, go to the next thing.

MR. CRANDALL: And just get from our management as well the word back through that these are off quarantine if Bob and Frank say they are -- you know what I'm saying? I don't want to go all through these and have to go through a mechanism that we have got to get, you know --

MR. McCORMICK: We'll work that out, out of this room but the key player is Frank's authorization to go ahead of the troubleshooting plan. Once you have that, I'll take care of the rest of it.

MR. CRANDALL: Okay.

MR. McCORMICK: Let me just try and end this. Let me kind of try and pull this back now.

We owe you I think some other things which we'll

do off-line.

We owe you an operability history and a maintenance history, which we'll provide separately.

We owe you the PM routine monitoring and other operating procedures that go with both Class 1E and Class Non-1E UPS's. We'll provide that separate as a handout for review.

We will not be able to get Exide's formal report because they need the testing. However, we would expect from Exide with that testing in hand to have very appropriately for, provided their formal conclusions on what they think happened and corrective action.

Yes?

MR. ASHE: Before the test or after the test?

MR. McCORMICK: After the text.

MR. ASHE: Oh, okay.

MR. McCORMICK: I understood Rudi to say that he needs this information --

MR. ASHE: I'm sorry, I misunderstood.

MR. McCORMICK: But following that with that data in hand we are looking for paper to say here is what Exide's conclusion is, as soon as practical once you have the data in hand, with appropriate recommendations to fix, which also have to be cleared before we go into it.

Now on the closing bullet on the second page,

there is a series of other data which Jack has looked for and this involves other players, some of which are in the room and others are not, but we need to work out a contact arrangement for the main transformer, details to interface with that, with our experts. Howard Light is here, the AC-DC relay, if there is a need for any more data on that, and we have those. Some photographs have been taken and you have been given those and there will be others taken.

Another key thing is the plant lighting and we have the package of the plant lighting breakdown. That goes to Jose, and they can interchange that.

We're working on the UPS component loading, which won't be available until Monday, and we'll hand you that.

The sequence of events is ready and completed under Tomlinson.

MR. ROSENTHAL: He has been working with Jan Jensen on that.

MR. McCORMICK: And then a decision on the restoration of equipment, which will be at your --

MR. ROSENTHAL: We do have cameras with us, but it really is easier for me to use your photographer.

MR. McCORMICK: Okay.

MR. ROSENTHAL: If you look at the Vogtle report, you'll see some photographs throughout it. I'll work out a list with you, if you wouldn't mind.

MR. McCORMICK: Sure.

MR. ROSENTHAL: The photographer can take pictures of the office and the other stuff.

The AC-DC relaying and main transformer: We have a gentleman from Duke Power coming up to join us. We arranged it through INPO. He's due in tomorrow. Stoner. I would intend to ask him to look into that.

MR. McCORMICK: Mr. Light, you'll be available for that transformer discussion, which will be tomorrow or sometime; we'll work that out with you and Steve.

MR. ROSENTHAL: Let me just bet back to the troubleshooting plan in broad terms.

MR. McCORMICK: Okay.

MR. ROSENTHAL: You come up with hypotheses about what went wrong, you go into the 1C unit. If those hypotheses are borne out, then you proceed on to the next unit. They may not be, in which case everybody stops. Let's not interpret this as more of a work plan of what you do each day. I mean, yes, you do what you have on day 2, provided that day 1 worked out. I think everybody understands that.

MR. CRANDALL: Certainly. Yes.

MR. ASHE: Yes.

MR. CRANDALL: If we find the problem to everybody's satisfaction, there may be no reason to go try

and duplicate that, either, but I'd like to make that decision at that point, too.

MR. ASHE: Quite frankly, at this point I don't think this is a static thing. It's going to be changing as time goes on. It's not static at this point.

I don't know. Do I have the wrong idea?

MR. BERTSCH: No.

MR. ASHE: Okay.

MR. McCORMICK: I think I'm about ready to say we're done this meeting, unless someone has some other topics they feel ought to be covered. I've covered the main things I wanted to get done, and right now I'm leaving with what I think is the authorization to arrange to make the fix to the card in the C inverter, logic card or power supply; and then arrange in a formal fashion to proceed with the tests which the Exide people have proposed to us and perform that test. When we're ready to do that, we will get a-hold of the appropriate NRC personnel to be in attendance.

MR. ROSENTHAL: Right.

We'd like to attend as much of the actual troubleshooting as we can support, too.

MR. McCORMICK: We're proceeding with the B transformer work; all that's going ahead. And we will not move beyond what we already have agreed to -- the tests on the C and its repair -- although we have a schedule of how

we think we will proceed, assuming things go together.

I'm prepared to conclude this meeting unless there are some other main topics, and we can pick up the others as we go.

We're done.

MR. ROSENTHAL: This meeting is over.

[Whereupon, at 12:53 p.m., the meeting concluded.]

[illegible]

[illegible]

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: Information Exchange Meeting

DOCKET NUMBER:

PLACE OF PROCEEDING: Scriba, N.Y.

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.

Jon Hundley

JON HUNDLEY

Official Reporter
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