## 07-459A-91 ORIGINAL

## OFFICIAL TRANSCRIPT OF PROCEEDINGS

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Agency:	U.S. Nuclear Regulatory Commission Incident Investigation Team
Title:	Nine Mile Point Nuclear Power Plant Information Meeting
Docket No.	

LOCATION:	Bethesda	, Maryland					
DATE:	Tuesday,	September	3;	1991	PAGES:	1 -	175

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2	NUCLEAR REGULATORY COMMISSION
3	INCIDENT INVESTIGATION TEAM
4	Nine Mile Point Nuclear Power Plant
5	Information Meeting
6	Nuclear Regulatory Commission
7	The Woodmont Building
8	Room W-100
9	8120 Woodmont Avenue
10	Bethesda, Maryland ·
11	Tuesday, September 3, 1991
12	The meeting in the above-entitled matter convened,
13	pursuant to notice, in closed session at 9:30 a.m.
14	PARTICIPANTS:
15	JACK ROSENTHAL, NRT/ITT Team Leader
16	FRANK ASHE, NRT/ITT Team
17	JOSE IBARRA, NRC/IIT TEAM
18	WALTER JENSEN, NRC/IIT Team
19	MICHAEL JORDAN, NRC/IIT TEAM
20	JOHN KAUFFMAN, NRC/IIT Team
21	TOM POHIDA, NRC/ITT Team
22	JIM STONER, NRC/IIT Team
23	BILL VATTER, NRC/IIT Team
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1	RUDI MACHILEK, Exide Electronics
2	WAYMON RANSOM, Exide Electronics
3	KYLE TERRY, Niagara Mohawk
4	KERRY JOHNSON, Failure Prevention, Inc.
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2	[9:30 a.m.]
3	MR. JORDAN: Good morning, gentleman. My name is
4	Michael Jordan. I'm out of Region III with the NRC. It is
5	September 3, 1991. We're conducting an investigation of an
6	event that happened at Nine Mile Point on August 13, 1991.
7	MR. IBARRA: I'm Jose Ibarra and I'm part of the
8	IIT Team, Instrument and Controls.
9	MR. MACHILEK: I'm Rudi Machilek. I'm Director of
10	the Technical Group of the Technology Center.
11	MR. HESS: D.J. Hess, Director-Customer Support
12	Operations for Exide Electronics.
13	MR. RANSOM: Waymon Ransom, Customer Support
14	Engineer for the Western Region.
15	MR. GRADY: Michael Grady, Manager of Technical
16	Support.
17	MR. STONER: Jim Stoner, Consultant with the IIT
18	Team.
19	MR. ROSENTHAL: Jack Rosenthal. I'm the IIT Team
20	Leader. Sitting next to me is Frank Ashe, who I look at as
21	my central focus for this meeting.
22	MR. ASHE: Frank Ashe, IIT Team member from the
23	Office of Nuclear Reactor Regulations.
24	MR. TERRY: I'm Kyle Terry. I'm Vice President of
25	Nuclear Engineering for Niagra Mohawk.

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MR. JOHNSON: I'm Kerry Johnson, Vice President of
 Failure Prevention, Incorporated.

3 MR. POHIDA: Tom Pohida from Instrumentation and 4 Controls Branch, member of the IIT Team.

MR. ROSENTHAL: Rudi, I think that we really have 5 What we had related was that we wanted to 6 to rely on you. understand, truly understand the system, rather than 7 guessing and that the best thing to do is to do it top-down 8 on what's the system, what was its intent, how does it work, 9 and get progressively deeper into what makes this thing trip 10 11 a lot, what makes the thing run, with a lot of focus on the 12 A-13 card cage.

MR. MACHILEK: All right. Where do you want me to start? Basically, as you know, the uninterruptible power systems originally, if you go back in time, and I have to go back in time a little because we are talking about ten-yearold equipment that we're dealing with here.

Originally, the purpose of the UPS was an uninterruptible power supply, meaning that if your utility power went away, there was an alternate power source which takes its place. It carries you through a scenario where the utility goes away and then later on comes back again.

It also had some elements of power conditioning, which means that it took the spikes and the switching transients and so on out of the actual critical power supply

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1 which was supplied by the utility.

Later on, our customers and we in the industry found that the actual load which was connected to the critical bus was the subject of protection. That means the person who operated a piece of equipment which was powered by the UPS, his prime concern was the power on the terminals, actually where he was receiving power rather than what the UPS was doing or something else.

9 The explanation of UPS then became an 10 uninterruptible power system. If you really look at a UPS, 11 what it was supposed to prevent is if you have a power station, like an atomic power plant, the power is pretty 12 Normally, a failure in the power station itself, if 13 qood. 14 you're talking about generating stations of the old type, steam power plants, coal-fired and so on, there were rarely 15 incidents of losing the whole power supply; for instance, if 16 an atomic power plant goes down. 17

18 The operations were from the transmission of the 19 power from the generating plant to the actual users input, 20 and then the distribution of power down to the terminals of 21 the equipment which was supposed to be protected.

22 So our whole focus as time went on was to 23 safeguard the power not only from the standpoint of having a 24 power conversion module or a box sitting there, but 25 examining the whole system, recognizing the fact that all

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the maintenance and fail operations in a distribution system still exist, coming off the UPS like they did exist before coming off the power plant, except the scope was reduced to exclude all the transmissions and the outside elements from there.

What we did after that was to actually start 6 7 supplying uninterruptible power systems, meaning that we took responsibility for the design of the system from the 8 actual utility power input to a user's distribution system, 9 to include the supply circuitry to the UPS, the UPS itself, 10 its bypass circuitry, the maintenance of all those elements, 11 and then, of course, the coordination of the downstream 12 distribution to the actual user of the equipment. 13

14 The reason why I was saying all that is that at 15 the time ten years ago, whoever designed the system was not 16 designing an uninterruptible power system. Switchgear was 17 purchased, a UPS was purchased, and all kinds of 18 installation effects were done. On the end, you had 19 something there which was considered to be adequate at the 20 time.

The equipment was purchased as being best commercial grade. There was no special requirement for it in enhanced meantime between failure or availability. Usually, if we sell UPS systems or if they are specified by militaries or by nuclear power plants and so on, a percent

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availability of power is specified. For instance, 99.9
would be a 99.9 percent of the time you have to somewhat
guarantee that the power will be there. Six nines is about
it; 99.9999, which basically gives you 18 seconds of actual
power loss per year. So maybe every 15 years you can afford
to lose the power for a little noticeable time.

7 Of course, you will understand that in order to 8 achieve that, you have to go beyond the box, the actual 9 power converter. You have to examine the input switchgear, 10 the bypass switchgear, and, last but not least, the 11 downstream switchgear with it.

12 The high reliability equipment avoids two things. 13 Number one, single point failure mechanisms; that means any 14 circuit which would bring the whole system down, and the 15 system, we are talking only about the power conversion box 16 and the bypass circuitry, and the circuit which would be 17 vulnerable or which would cause by its failure as a single 18 point to bring the whole system down should be avoided.

19 Number two, in good UPS systems design, you do not 20 want to rely on anything to happen in the case of a 21 corrective emergency situation, which has not actually 22 happened already in operation. In other words, you do not 23 want to say if something happens, this relay has to switch 24 or that breaker has to change state or whatever.

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If you depend on that to happen, there's a certain

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If I may digress for a moment, if you would rob a 1 risk. bank and you run off to your getaway car, of course, you 2 wonder is it going to start or is it not going to start. On 3 the other hand, if it's already running, then the risk of 4 does it start or not start is falling away and it becomes a 5 6 certainty that the car is starting because it's already running. 7

In this spirit, we are usually avoiding -- and as 8 a matter of fact, the latest changes which are proposed to 9 10 be done in the A-27 was in that spirit, that if I have to switch the K-5 relay, for instance, why don't I only switch 11 it at the times where if it doesn't work, it wouldn't cause 12 me a load loss, that it would be an inconvenience and so on. 13 14 I'm just telling you where we are coming from in this 15 respect.

16 The fact that the A-27, for instance, the new one 17 or the one which was generated by the Navy, came from that kind of investigation. Somebody said, hey, what happens if 18 a power supply fails. You go to bypass. What if there is 19 no bypass? Usually you have to differentiate here between 20 one failure, does it survive the failure of one component, 21 does it survive the failure of two components that fail at 22 the same time and what is the probability of that, what if 23 there are three things happening at the same time, what is 24 the probability of that, because last, not least, all those 25

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1 questions can be answered with a big sign, which is dollars.

Of course, if you compete for an order; for instance, the equipment for the Nine Mile Plant, it's a complicated situation. They cannot give you a Cadillac if all you want to go is from here to there and you call it transportation. See what I mean?

7 So we have to understand here that the equipment 8 which was installed was not the highest scrutinized 9 equipment, such that it would go into high military or high-10 risk military installations or installations which specify 11 the percentage of availability and the quality which has to 12 be maintained to that end.

So from about 1972, we introduced the Series 3000, 13 which the new equipment that is the subject of our 14 discussion here is part of it. The Series 3000 was 15 developed, if you want, between 1968 and 1972. The first 16 system of that sort went into operation in the spring of 17 18 1972 at Philadelphia Electric in Philadelphia; not in the power plant itself, but in the office in the building they 19 It is still running. It is still there. 20 have downtown.

It is the system we have the longest in service, about 19 years now. I think if there's a question on what is the failure rate and what is the availability of power and how vulnerable is the equipment, I believe that installation would be the most indicative of that 3000

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1 circuitry.

The 3000 was improved. The problem was that it 2 3 used to be that the development time of a piece of apparatus was maybe one year and the lifetime of the design was maybe 4 5 ten vears. Now the design time is maybe two years and the lifetime is minus one year. That means as soon as you come 6 7 up with a piece of equipment, enough technology has been made available that you almost can say whatever new I'm 8 introducing is obsolete at the time, unless you don't know 9 about the other thing yet. 10

So in that spirit, we had a Series 250 and a Series 300, 315, a Mark I, a Mark I-and-a-half, a Mark Iand-three-quarters, and then a Mark II, and then we had -from then on it became a little erratic because customers had specific needs or specific circumstances and we went more into the design of systems rather than the power conversion module.

In that spirit, we made changes, improvements, if you want, to meet certain specific requirements. The Mark II design was actually the one where we entered the era of systems rather than supply and made changes in the circuitry which had nothing to do with improving the circuitry itself, but had something to do with the operations effect of what we were doing.

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For instance, some customers said if a module went

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to bypass that it should not come back automatically ever.
They wanted to go there and investigate what caused it and
fix it or do whatever. The other customers said, gee, I
don't really care about all that; if I have a glitch in the
power and the power restores to normal, I want to come back
and I don't want to have that much to do.

7 So we had two versions already. One had automatic re-transfer and the other had manual re-transfer. 8 The Mark II-U was a design which consolidated all the features which 9 were different for various customers into one universal 10 11 design. In other words, with the universal board, you can 12 select if you want to come back automatic and manual. You have all kinds of features in there which we don't advertise 13 14 to be selectable, but they are there to aid us to come up 15 with a board which meets everybody, and yet we can sell it 16 to you as a custom piece of equipment because we can adjust 17 it, but we don't have to make special production runs.

The reliability of the circuitry is better, of course, because it's done over and over the same thing. For instance, we came up with the Mark II-U selectable for 50 and 60 Hertz. So you can stick it into international units as well as domestic ones. You will never run it at 50 Hertz.

24 But if you want to test for clock failure, you can 25 actually switch a little switch and the inside of the unit

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gets programmed for 50 Hertz, and yet you have 60, the
 clock, of course, goes to hell, but the effects of it we can
 demonstrate.

In our design, anything failing in one module only 4 effects that one module. If you have a bypass, it will go 5 б If you have a parallel module, such as a to bypass. 7 redundant one, the redundant one will take over without any ill effects. We call it selective tripping. That means any 8 failure within the module only effects the module. It does 9 not effect the output bus. 10

If you do not have a redundant module which works with the one that you have on-line, then, of course, the utility has to take its place. So the utility in this case is the redundancy to the UPS. If the UPS fails, it will go to bypass, the bypass being the utility.

There is a misconception, of course, if you want a reasonable assumption that once you are in the power blend itself, that you'll never lose utility power or the utility power is highly, highly reliable there. The module itself was designed to have a meantime between failures of 20,000 hours.

In other words, every 20,000 hours, if you operate the equipment for an infinite amount of time, then, as an average, every 20,000 hours you would have a failure, which does not mean that you will not have a failure until 20,000

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1 hours have passed.

As you know, if you have a dice, the probability for infinite amount of throws is that you have each one, one to six, come up exactly at the same one-sixth of the time. Of course, if you only throw the dice ten times, you will find that distribution is not true. So we are talking about probabilities here. We're talking about MPTF.

So we have to expect that you may not have a 8 failure in five years, but you may have three in two months. 9 10 We don't know. It's the quality of the components and the 11 design intent is of that sort. So every 20,000 hours, if you want, as an average, for an infinite period of time, you 12 would have a need -- now, this 20,000 hours is only failures 13 of components which would actually effect the output of the 14 15 module itself.

16 If a meter goes bad or what have you, which has no 17 effect on the operation, we do not consider that a failure 18 in that sense. Now, if the UPS fails for an internal 19 component failure, blowing of fuses or a malfunction of 20 whatever sort, there is a mechanism in place where it shifts 21 the critical bus over to the alternate redundant source.

The redundant source can be a diesel plant which is already up. The redundant source can be a utility, such as in your case, or the redundant source can be another UPS which was running in parallel with the one you already have,

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and if one fails, the other one simply takes over and you
 wouldn't even know anything was going on.

Now, in case the UPS fails, the UPS module fails 3 itself and, as a second failure at the same time, the 4 utility isn't there either, then, of course, we're talking 5 about a double failure. The meantime between failures of 6 that to happen is calculated at 100,000 hours if the utility 7 has an MPTF for 3,000 hours. That means if the utility 8 9 doesn't fail more often than to generate 3,000 hours MPTF, then every 100,000 hours, if you operate the equipment an 10 11 infinite amount of time, you will have a load loss.

Why do I say that? Because if you have only one module and it quits and you have only one bypass and it's not there, then, of course, if the sky breaks, all the sparrows out there, you have nothing to work anymore.

Now, in the case of the incident, if I may refer to the incident, you'll know what happened here. We had that situation happen. The UPS tripped, became unavailable for the user and the bypass wasn't there either simply because its quality has to be a certain one in order to be labelled in existence. It's frequency has to be within half-a-Hertz.

Its voltage has to be at least within ten percent, plus or minus, of the mean voltage which the system is adjusted to. Of course, it has to be in sync with the

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output of the UPS module. If any one of these three conditions are not there, then the bypass is considered not available. The reason for that is if you would switch to such a bypass, let's say you're out of sync and you will switch anyway, you are suffering a phase hot.

That means instantaneously you would see a huge 6 change in frequency in an extremely short period of time, 7 where the FTD would be substantial. Any piece of equipment 8 downstream which is of the computer type which would be 9 sensitive to fast frequency changes would either have a data 10 problem, it's output would be unusable, or else it would 11 even be physically damaged, such as it was in the case if 12 you go back ten years when the equipment was not able to do 13 this kind of thing. 14

Now, most of the users say that no power is better 15 In other words, if I have no power, well, 16 than bad power. 17 equipment stops functioning and if I have bad power it gets Single phasing, for instance, if you lose one 18 damaged. phase, was considered a serious problem because you're 19 rotating all the motors and so on, drives, what have you, a 20 lot of the three-phase pieces of equipment suffered. 21

So a lot of installations do have protection, that the circuit breakers actually open if you lose a phase. What that would have done any good, of course, is because the power supplies would not have seen a reduction in

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voltage on Phase B when you had the incident. It would have
a seen a loss. We demonstrated it even was bad batteries on
the power supply and actual loss of the bypass power was not
detrimental.

5 It was a reduction in the voltage which really caused us to go down. We did not consider that in the 6 Tell you that plain and honest. A loss of voltage 7 design. 8 on one phase, a reduction of voltage on one phase was not considered in the design of the UPS. It was designed for a 9 loss of either one of the two supplies. If the UPS output 10 was lost, then, of course, you transfer. If you didn't have 11 a bypass at the time, bad luck, you go down. 12

It is designed to do that. If you lose both, if you lose the UPS module, you do not have a redundant one and your bypass is not available as defined, then you will lose your load. So in the design application of the UPS, it had to be considered that every 100,000 hours average over an infinite period of time, I will lose that load.

19 That simple. Now, the question is was that fact 20 considered in the application of the module and since it did 21 happen, why was everybody upset. You have to look at it 22 from that point of view. Yes, we had five units around in 23 there for roughly five years, so we have 25 equipment years 24 of operation. How many times did we go down? We did go 25 down once and the circumstance was really one that the

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1 equipment wasn't designed for.

2 Should it have been designed for -- well, a lot of should-it-have's we can discuss until we're blue in the face 3 4 here. MR. ROSENTHAL: Let me just interrupt. What is 5 hung on the UPS, on what loadings, etcetera, is a subject 6 for the IIT, but I don't consider it a subject for this 7 8 meeting. No, no. 9 MR. MACHILEK: 10 MR. ROSENTHAL: Just so we get agreement here. 11 MR. MACHILEK: I'm simply saying it in the 12 relationship of what can be expected. If you have four passengers, you cannot have a two-seater sports car. In 13 14 that relationship, I am simply saying that the severity of having that scenario happen, which was expected to happen 15 16 based on the design criteria of the system, needs to be taken into consideration here. 17 18 The only reason why I'm saying that, if we would only be having a 10,000 or a 15,000 hour operating here, 19 then we would be extremely disturbed here. 20 The only reason

I was making that dissertation was to say what is expected, and I believe this was the equation, what was the design criteria of the equipment, what is it expected to do.

Now, if the utility goes away, of course, the rectifier portion is not all that important of the UPS

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because you have a battery there as a redundant DC supply
 for the inverter to operate. So the actual loss,
 disturbance of the input to the UPS, number one, it's much
 broader.

5 You can risk a plus or minus three Hertz of 6 deviation in the frequency and the rectifier would still 7 run. You can have a plus-ten minus-fifteen percent voltage 8 deviation and you can actually have an actual outage, or if 9 the rectifier itself breaks, all those considerations are of 10 little concern to the inverter as long as the battery is 11 there.

If the battery is not there, and now we're talking 12 13 about two failures again, the UPS would go down. The same way the little UPS, which we consider the power supply, 14 15 which is basically of the same design as the large one, we have a little UPS within the big UPS. If you lose the 16 17 supply to an UPS and you lose your secondary or redundant power to it, which is the battery, the output goes bonkers. 18 19 It goes away.

This is the reason why you bought the UPS in the first place. You are well aware of that, that if the battery plant would go away and you have a power glitch, you've had it, you lose your load. Unfortunately, of course, the little UPS which is supplying the control power, which was at the time of the same design as the big one,

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1 doing the same job, suffers the same shortcomings.

All I want to say, that the normal operation of the UPS is utility power goes through the rectifier, it's been rectified, supplied to the inverter, the inverter inverts it and out comes the AC on the other end. The rectifier itself is redundant in the meaning that the battery power takes its place, not requiring a switching, though.

9 Normally, the battery is simply floating. It's in 10 parallel with the rectifier output and who supplies power to 11 the inverter simply determines who has the instantaneously 12 higher voltage at one particular moment. So whichever 13 voltage of the two, the battery or the rectifier is higher 14 in any one instant, this source will supply the power.

15 Of course, if one source fails, then -- now, you can lose your battery as long as the AC and still nothing 16 happens. If you can restore the battery power, of course, 17 18 you're in good shape again. I've seen instances where, for instance, auctioneering diodes, such as we have, were 19 paralleled with circuit breakers, that in case that one --20 now, an SCR fails always short, always meaning until one 21 22 fails open.

I've only had one diode open failure in the over
42 years I'm working with static power equipment, but it
happened one time. No matter if you work 60 years, your

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whole life on something, if it happens one time, that one
 time is considered a 100 percent of the failure. How come
 you did not consider that.

Of course, the question is why don't we have circuit breakers parallel to the auctioneering diodes. Well, we don't expect the auctioneering diode to fail open. Otherwise, you would have the parallel breaker, you get in a RAM, and we do have in a RAM that the auctioneering diode is, in fact, there and it's in good shape, it goes to the circuit breaker and you maintain power.

So what you expect, you design for. If you can afford to design for it depends now on the probability and if you want to spend the money. If it once happens in 60 years, do you want to really install it, maintain it, and do all these good things. Well a lot of people say no way, forget it.

But you only have one spare tire in your car. Why don't you have two? Well, how many times did you have a blowout on two tires at the same time? Never. None of us have, right? But it could happen, right?

So in that spirit, we have now the battery as a redundant power supply to the rectifier. Is it an absolute 100 percent true that you never lose DC power? No. You can only reduce probabilities, you cannot reduce the risk and son on.

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Now, once you have the inverter, unfortunately the
 inverter has to be -- I think we covered the basic
 operation. As long as you have AC and battery, you have an
 inverter, as long as you have a bypass, whatever happens,
 you go to bypass. So far, the load is not being effected by
 anything.

MR. ROSENTHAL: I follow the -- if you lose the 7 rectifier, you go on the battery, etcetera. As I understand 8 the design objective, it's that no single failure of the 9 battery or the rectifier will cause the normal UPS to go 10 down. On going to bypass on loss of the inverter, I think 11 we're going to have to -- that's a design objective, I take 12 it, but I think we want to see drawings and, as the morning 13 14 progresses, truly understand that.

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MR. MACHILEK: Okay.

MR. ROSENTHAL: You'll get to that. Go ahead.
You're doing terrific.

MR. MACHILEK: Now, as long as we understand that the loss of the rectifier portion, or half of the box, really, would bother us little if we confide in ourselves to the existence of single failures.

As far as the inverter is concerned, of course --23 yes, sir?

24 MR. ROSENTHAL: Sorry. There are signals from the 25 card cage to the SCRs on the rectifier side.

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Correct. There are three circuit 1 MR. MACHILEK: 2 boards, commonly known as A-30, A-1, 2 and 3, which control the rectifier. If you go back in time between 1972 and 3 1976, we had two card cages. One was in the rectifier, and 4 the rectifier was a separate cabinet, physically divided, 5 and you had an inverter at another card cage; of course, 6 7 constant cost reductions and looking to make the whole equipment to be smaller in footprint and so on. 8

Last, not least, the least amount of components 9 you use is the most reliable unit, because we have the 10 11 failure, MPTF is calculating by the count of equipment, of components. We combined the card cage into one and designed 12 the UPS that it behaves much like a three-phase generator 13 The only difference is that it has the absolutely 14 would. constant frequency on the output. The output frequency does 15 16 not change with loading at all.

17 It's just to explain the differences between a 18 three-phase generator. The impedance, of course, the output 19 impedance is higher, 16 to 18 percent versus maybe eight 20 percent in the generator. Other than that, it is phase-to-21 phase control, not as the static equipment was if you go 22 back in time prior to 1968.

23 So as far as we are now concerned, let's say the 24 AC goes away, the battery is powering the inverter. Now the 25 question is is the bypass power going away at the same time

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1 the input power to the UPS goes away or is it not.

If the bypass power and the UPS input power go away at the same time, then, in a sense, you do not really have redundant bypass power. You simply have a UPS sitting there without a bypass and you are back to your 20,000 hours MPTF, because the 100,000 hours we only realize by having the utility.

In order to overcome that, if you are a user, if 8 you are out in the plant somewhere taking utility power, you 9 would come from different substations. You would come from 10 11 -- if the two substations go together in the same high voltage line, of course, again, you can only go that far 12 13 until you make tradeoffs. If you have substations and you have cables coming in, of course, you try to have separate 14 cables. You have redundancy, as much as you can afford. 15

Let's take the case where the bypass power is coming from another source. You lose your source to the UPS. You go on battery. The other source is available. Then what happens is that you run on battery at the design which you had at the time ten years ago.

You run on battery until the battery was depleted, which would never happen in your case because you have a battery charger which is keeping the DC bus alive, unless the battery charger also is supplied by the same utility source which supplies the UPS in the first place. But let's

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1 not -- let's say the DC stays put.

2 Then you would simply run on battery. You would not have any need for the bypass source until the bypass 3 source comes back. That is the designed intent of it. 4 5 MR. ROSENTHAL: Let's stop this again. For now, let's assume that all the logic was up and running 6 throughout the entire event. Let's assume that. 7 8 MR. MACHILEK: Yes. MR. ROSENTHAL: We believe that on the normal and 9 10 on the maintenance supply, for sometime between six and nine 11 cycles, the voltage went to about -- somewhat more than half of its normal voltage, then went to zero for three cycles, 12 and then was back up after a total of 12 cycles. 13 14 I think that the relay time that we were looking at in the switchyard and in the plant are a little bit off 15 16 by a few cycles. So for six to nine cycles, you saw a degraded voltage on the normal input and on the maintenance 17 18 bus. Let's assume that the electronics power source is 19 20 good. 21 MR. MACHILEK: Logic power. 22 MR. ROSENTHAL: Yes. The logic power. What should I design the UPS to --23 24 MR. MACHILEK: To keep running. MR. ROSENTHAL: And it would --25

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MR. MACHILEK: The inverter would keep on
 supplying power from the battery.

3 MR. ROSENTHAL: From the 5100 battery. What would 4 the rectifier do for that small period of time.

5 MR. MACHILEK: Just sitting there being phased 6 off.

7 MR. ROSENTHAL: Phased off by the logic.

MR. MACHILEK: That's correct.

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9 MR. ROSENTHAL: Then when it saw the voltage good 10 again --

MR. MACHILEK: The voltage comes good again, it recognizes that fact, it waits for a little under ten seconds to make sure -- see, if you have a utility switching, sometimes it comes back suddenly and you have about -- you deal with the supplies of networks coming.

So it makes sure that the AC, in fact, is stable and is back. It synchronizes to it and then walks the load back up. It means it increases the load gradually over about three seconds or thereabouts.

The reason why that feature was put in is if you come from a diesel generator, because more often than not, if a utility fails, a diesel plant starts up and the diesel doesn't want to see a sudden in-rush or increase of power. So we are ramping the load up on the rectifier.

Once that has taken place, you are back into

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normal operation like you had before. Regardless of how
 short an outage or disturbance you have on the input, you
 end up with about 14 seconds non-availability of the
 rectifier.

5 So your large station battery will always see a 6 14-second discharge period, even if your disturbance was 7 only nine cycles or six cycles or whatever it is. But the 8 inverter simply doesn't care. It doesn't know. The logic 9 often cannot differentiate if the DC power is coming from 10 the rectifier or the battery.

It can only determine that DC is available within the window, as we call it, between the maximum and minimum battery voltage which exists on the DC link. So the inverter would sit there and run.

Now, since you lost your bypass power, the way the power supply input is configured on the units you have, the K-5 relay, the infamous K-5 would have switched over and would have put the logic on the inverter output. Now, that switch-over should or was, by design, done that the battery would not really be required to be there.

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MR. ROSENTHAL: The little battery.

22 MR. MACHILEK: The little battery, yes. That 23 means there is enough capacity in the power supplies to 24 switch you over, to carry you over. The battery, of course, 25 was there, still there, because we believed that the little

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UPS is powering the pickups. That's our philosophy.

Yes, we are the only ones in the industry which has a control power battery. The rest of our competition, if you should lose all the power, you do not know what happened simply because you would not have any light indication and, number two, we have enough power in the battery that if everything goes bad, it still has enough power to open all the circuit breakers.

9 So we believe and I believe very strongly today 10 that that battery is a very important feature; not for a 11 single component failure or a failure, but if you have a 12 more specific scenario which not one failure or two or 13 three, but simply accumulation of failures, you never want 14 to see. You don't want an aircraft to go down with 300 15 people on it, you know. It happens.

So in that spirit, I believe we do have -- we maintain the light indications, so if you come after this scenario, that you see or you can determine what happened. That feature failed during that event. That means on the end of the scenario, we did not realize the information we should have had. Namely, what caused the trip for the UPS.

When we got the first call of what happened, we never expected that the batteries were dead. That was not a consideration. We learned that after we got the site. But only in the investigations we did up to that point was

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1 considering that the battery was in good shape.

We tried to find a scenario, either a 2 multiplicity, happenings never seen before, to theorize of 3 how could we possibly, and there we go now into circuitry of 4 the A-21 board, how could we possibly get a lamp indication 5 б on the A-14, which is the meter panel, how can we possibly get no indication on the A-21, and that was really the focus 7 of our intent to find out what happened was -- to assume all 8 that. 9

When I talked to -- and I don't have a record of who was on the conference call, the very first one we got after the event, and people wanted to have a quick -- you know, what happened, tell me, tell me now, not tomorrow, not in half-an-hour, right now I want to know.

So we stuck our heads together. Well, we were on the conference call and we said, gee, in order to get a latch-to-latch and the lamp's not lit and the other lamp which comes on at the same time is, what possibly could cause it. So our first input was no way. The lamps had to be there, somebody had to push the button and reset it.

If you push that button, you reset all of the lights which were lit, reported lit, together with the ones which were reported not lit. They call come on at the same time, they all reset with the same button. So you cannot reset 15 lamps and have the other two lit. It doesn't work • • •

1 that way.

So we said, gee, you know, since the lamps on the A-14 were still lit and the lamps on the A-21 were not, the lamps had to go away somehow. How can the lamps go away? Well, the only -- component failures were ruled out. You cannot have the same component failures on five modules and five modules are doing the same thing at the same time.

8 So we just said, hey, you know, to have a chip 9 here or there or something went bad, forget it. There was 10 no repair required. That means all units went on-line by 11 simply being restarted.

Then Mr. Bill Zuke, I think some of you have 12 mentioned, he says, you know, Rudi, he said there is 13 something like an SCR latch-up, there is something which can 14 15 latch-up the logic without getting actually a signal to do We looked into that while we were still on the 16 so. 17 conference call and said, well, how can that happen; we have 18 a printer circuit board which is about 16-inches long or 19 thereabouts, there is a ribbon going from here to there, I 20 would have to have -- and I think the test showed ten volts, but we thought between five and six volts. I made that 21 22 statement on the phone.

If I had a voltage difference on that ribbon from here to here of at least five volts, we thought at the time, it could happen. But what would not have happened is that

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1 the latches would latch. You would have to have a trip and 2 you would have -- after the trip, the lamps would have gone 3 away and you wouldn't have known what was going on.

Let's say the SCR latch-up time was staying put. Then you had to switch down or off the controls, the control power supplies completely in order to get an outage. But there was no report of such a shutting down of the control modules, the control logic.

9 Matter of fact, it's not something you can easily overlook because, number one, you have to shut the module 10 down or, if it's already down, you have to wait for the DC 11 12 link to bleed off. If you restart the unit while the DC 13 link is still up, you'll probably have a combination So you wait for the DC to come down to about 30 14 failure. 15 volts. Then you can restart the unit.

16 So it's not something you can do in the haste of 17 going through a scenario and forget about it. So we took 18 the transcript and we searched it and there was no mention. 19 When we came to decide, we questioned the personnel, we said was the logic reset. Why do we have to reset the logic, we 20 pushed the reset button. I said, well, what did you do 21 22 after you pushed the reset button. Well, we started the unit back up and it came back up. 23

24 So there was no resetting taking place. For that 25 reason, we discarded the idea of the SCR latch-up of the

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gates, which is the trip signal and what gave you the lamps on the A-14. All this was going through in haste. We were still on the conference call. I said, gee, folks, I cannot really -- all I'm saying here is we're just trying to, off the top of our heads, find a scenario which could cause the peculiar -- if it would have been a commercial situation, we would have said you're all full of -- you know.

8 The lamps were there. You just didn't -- you know 9 -- you just reset it and then you thought, gee, God, I 10 should have done this and that. But this wasn't the case. 11 We were talking about reliable personnel, we were talking 12 about more than one team which looked at it, so we did not 13 consider -- we took as a fact that the A-21 lamps were not 14 there.

The only other way, if the SCR latch-up can be discarded now, is, well, what else is there peculiar to the lamps. They all power with five volts. The only five volts in the whole system is to power these lamps. It comes from a five-volt power supply on the A-21.

So if, on all five units, the five volts would have gone away and stayed away for the whole period of time three teams looked at it, and then after pushing the button, all of a sudden they were there again, we just -- not reasonably, with any academics and even practical reasoning, we could come to a conclusion that that would be a

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1 possibility.

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2 So this is where we were. My statement, and I 3 think it's on the transcript of the last meeting, was, 4 folks, I have to consider it academic, it doesn't really do 5 me any good to search for it for another ten years because 6 we will never find out.

7 There is no way I know of, and if there are any 8 experts elsewhere which can look at it, you're never too old 9 to learn. But what I have to my command in the development 10 lab in the Systems Test Department, I just can't do it for 11 you. If I cannot duplicate a failure, no explanation would 12 suffice. Show me, don't tell me, and I cannot do that.

For that reason, I suggest that to -- I don't know to what extent there is a need for explanation of the incident down to an understanding. This is where we ended up, that I said, you know, at this point, I say to myself let the powers to be and the experts will look into that some more.

All I was interested now is in how can I help you to improve the situation, not to prevent a scenario like this and give you a guarantee in writing and my paycheck, although it's not that big, but simply say what could we have or what would we do, what can I do today to help you, us, in order to improve the situation.

What I said to myself, well, the philosophy of an

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UPS, as I explained at the beginning of my dissertation
 here, is not to ask for something to work which doesn't work
 before an incident, but take the risk away.

For that reason, I was suggesting the change of 4 5 the A-27 board to say let me -- you always have to start on the bypass because the inverter isn't there. . So if we say 6 7 inverter preferred, it was a bad choice of words. You have to have the preferred supply to be the bypass or some 8 others, like -- the other ones, you have to use a DC 9 converter off the battery. But it has to be other than the 10 11 output of the UPS.

Now, the battery supply in the commercial systems is not that reliable that we can work off the DC to power our power supplies. In your case, different story. So what Is ay to myself, if that K-5 would switch right away after the inverter is brought up and becomes available, you've got to switch at one time or the other.

Either you stay on bypass and you switch when you need it or you go and switch right away, then you stay there. This was the reason why I suggested the change, that the K-5 were not working would be -- the importance of it would diminish; again, not as a single point failure, together with a dead battery, two failures you've got to have, two or three.

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You've got to lose the power for a reason, the

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transformer failed, you had a bad battery, and to decide why to switch at that period of time. So I can take that risk away. I can say, okay, I have the getaway car running, ready.

5 Now, you would have detected the bad battery 6 because if you started up the unit and you wanted to go from 7 bypass to UPS, you may or may not. Chances are that you 8 would not have to take the -- unfortunately, the problem is 9 that you cannot detect the battery, you cannot measure a 10 dead battery unless you discharge it.

11 The open circuit voltage can stay up to roughly 12 two volts per cell, even on a very poor battery. You have 13 to put some load to it and see how fast the battery voltage 14 collapses.

Normally, we are doing that twice a year. In our 15 commercial contracted maintenance procedures, we go in twice 16 a year, every six months. We go on maintenance bypass. 17 18 That means we switch the load actually around the whole UPS and go through and check out everything. So we never had in 19 20 the past a battery which wasn't load tested either twice a year or at least once a year, because some customers 21 objected to the twice a year for the simple reason that they 22 did not want to come off the UPS twice a year. 23

They said once a year we have a general maintenance period. Some during a long weekend, they had

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 There was always some window where we could go in.

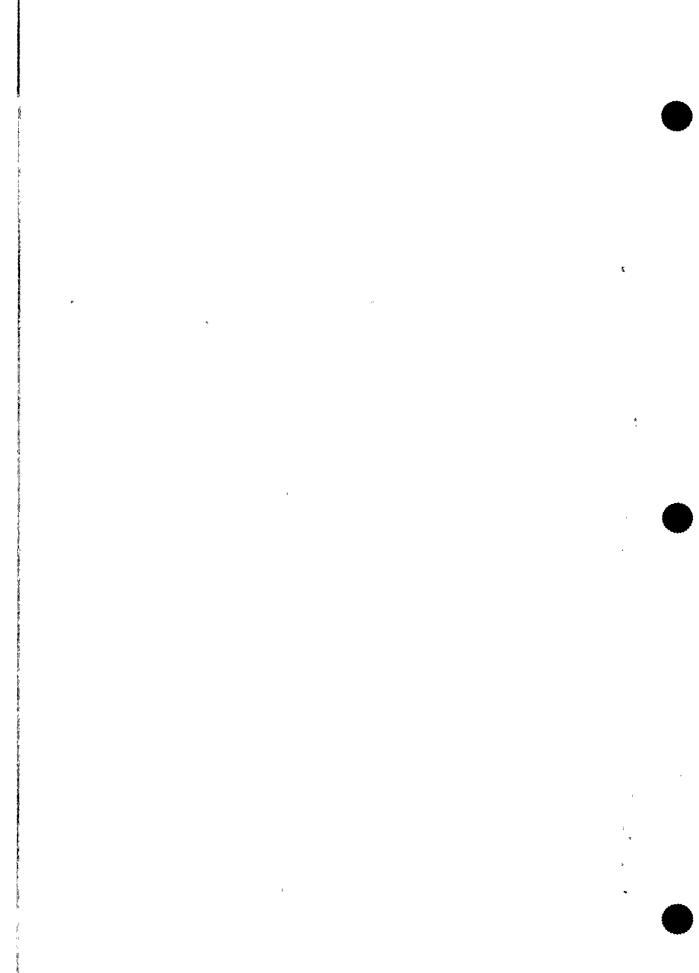
We never could at these installations -- and customers get over-confident. Nothing has happened to them for three years to say, well, why should I shut down twice a year. This is basically the way that the situation is still.

Now, can you design -- okay. As far as what you 8 see in the manual was already describing the Navy style, 9 unfortunately. We switched over, as I told you, to the Navy 10 11 style, which is redundant power supplies. The fact that it's a relay K-1 and not K-5 is to keep off that --12 somewhere I have a schematic with me on that -- which has 13 two pairs of power supplies. Here it is. See, one, two, 14 three, four power supplies and the relay is a K-1 relay. 15

16 It's the same battery still, everything is still -17 -but this is actually the power supply plan which was 18 described in the manual which was supplied in 1985, and I 19 think my colleagues here from Field Service can go into why 20 it wasn't the right one.

21 MR. ROSENTHAL: I read this manual twice over the 22 weekend and I'm not sure that I was reading the right 23 manual.

24 MR. MACHILEK: On Page 210, you have a description 25 of the -- see, this one says here 817 K-1.



1 MR. ROSENTHAL: Right. MR. MACHILEK: This is not your power supply. 2 MR. ROSENTHAL: So what is the manual for what's 3 in the plant? 4 MR. MACHILEK: This is what it should read. 5 MR. ROSENTHAL: And who else has copies of this? 6 7 MR. MACHILEK: Angela Freeman. MR. HESS: This is the one you sent up to Niagra 8 Mohawk, right? 9 10 MR. MACHILEK: Yes. MR. HESS: She's in our Engineering Department. 11 Clarify your question, Jack. I don't think we got your 12 question. 13 MR. ROSENTHAL: So Niagra Mohawk had a manual. 14 15 MR. HESS: That's correct. MR. ROSENTHAL: Which I think is this manual, or a 16 copy of it. 17 18 MR. HESS: I haven't seen it. Do you want me to take a look at it? 19 MR. MACHILEK: This is a copy of the manual that I 20 brought and made a copy of. 21 22 MR. HESS: Okay. MR. MACHILEK: This is the one which Mike gave me 23 24 when I went up. MR. HESS: Then this is the 1985 manual. 25

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MR. MACHILEK: That's the 1985 manual.

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MR. HESS: Okay.

MR. MACHILEK: You have to explain if it's needed here or why the 1985 got into that.

5 MR. ROSENTHAL: What we're going to be talking 6 about today is the manual for the units that are in there 7 and the drawings for what's really there.

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MR. MACHILEK: Yes. The drawings --

9 MR. ROSENTHAL: And I don't know if Niagra Mohawk 10 had them. They have them now, I assume.

MR. MACHILEK: When I came to Niagra Mohawk, Bob brought in a whole stack of drawings because you guys or somebody wanted them. I looked at that stack and said, you know, what are you doing with all these drawings and he said, well, these are the ones we have to give to you people and to the institute and what have you, so many copies.

So I said, you mind if I look at it, and we looked 17 through the drawings and about two-thirds of them were not 18 even the same equipment. They were 100-KW modules and God 19 knows what. I conferred with him and said, you know, is the 20 documentation I have in hand the proper documentation, and 21 the answer was yes, that it was, except for some items which 22 we could not recover. There was in 1985 a request from the 23 24 plant to resupply a set of drawings.

The problem was that the original drawings which

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were generated were not around no more. So we only had prints. The manual was there. So what somebody in that department which is filling the request for documentation just simply took the 1985 manual and sent it on to you. So what you have there was what we did build, in fact, in 1985.

6 MR. HESS: We don't know what they have on-site 7 from the original units. Were you able to locate anything 8 on the site?

9 MR. MACHILEK: In order to find out what the 10 manual says exactly which was supplied was the units, we 11 would have to rely on the plant to hopefully have one around 12 somewhere.

MR. ROSENTHAL: Over the weekend, reading the thing I realized -- it looked like a generic manual where it said if you're a 60-KW, but if you're 100-KW you'll have an extra transformer. I can follow through. And that doesn't -- okay, fine. But then I get to very specifics where it looks like you get a logic trip if the SCR firing logic, without lighting some of the other lights.

For something like that, you've got to know whether that is the manual or a generic manual when you get into specifics like that, or maybe -- but you do have the drawings with you of the actual installed units, right? MR. MACHILEK: The drawings which were drawn onsite, identical to what the unit is. The manual does not

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2 MR. ROSENTHAL: And you've got copies of the 3 drawings with you.

MR. MACHILEK: Yes.

5 MR. ROSENTHAL: Good. Why don't we take a five-6 minute break.

7 [Recess.]

8 MR. ROSENTHAL: As an intro to where we are going, 9 I have 90 percent confidence that the design changes that 10 have been proposed make the machine less suspectable to 11 spikes on AC supplies, et cetera. We recognize that we 12 can't reduplicate the event short of throwing a crowbar 13 across a major transformer in the plant. What we were doing 14 up at the site was really simulations at best.

When you toggled off the AC supply to the control logic you did see a little spike on the output of the supply even with fresh batteries. So it is of interest to us to learn as much as we can about the logic response of the unit so we can fully appreciate what we are fixing and what vulnerabilities might still be there.

With that, let me give you back the floor.
MR. MACHILEK: What may be of value here is to
speak a moment about what a battery is doing.

24 MR. ROSENTHAL: What kind of battery?
25 MR. MACHILEK: Any battery. What you just

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described as having a little spike on it is what we refer to
 as a crack of the whip. If I may approach the board.

3 What you have on a lead acid battery is basically your open circuit voltage would be 2 volts per cell. 4 Your This is the charge voltage is 2.5 to 2.17 volts per cell. 5 6 constant voltage which comes out of the rectifier. It doesn't work like that on a standard UPS. The reason why I 7 discuss it like a standards UPS is because the power supply 8 of the little UPS behaves like that. If you loose the 9 charge voltage, automatically the battery voltage drops down 10 to 2 volts per cell. Unfortunately, it drops down a little 11 12 farther and recovers to 2 volts per cell. We call this a 13 crack of the whip.

The reason for that is that the series impedance was the battery. If you look at free flowing circuit, you have a little resister and a conductor and then you have your internal battery, your EMF, and then you have a little leakage, conductor, a resistor, and there is another leakage capacitor.

As soon as you have a charge curve in demand from the actual battery cell, you are deducting the voltage drop of the series impedance. If you go inside, you have a little plate, and then you have a little connection going up to the post and from the post there is a leak, which manifests itself in the sudden voltage drop and the spike.

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It recovers and stays basically at 2 volts per cell and then
 slowly decreases in voltage.

This behavior would include the large station battery as well. In your case, the reason why it is different is because you have another rectifier which really keeps the voltage. So you are not dropping down on the large station battery. You will not drop down to 2 volts as long as the other rectifier is keeping the flow voltage up.

9 We have two rectifiers in your case on the large 10 station battery.

MR. ROSENTHAL: Right. There is a separate
 rectifier.

MR. MACHILEK: There is a separate rectifier which
is on the other side of the auctioneering diode.

MR. ROSENTHAL: I don't know what its capacity is,
but I think that is moot.

17 MR. MACHILEK: It is of no consequence here.

The only difference in operation is that you would stay up at 2.15, because the other charger supplies flow voltage, whereas if you only had your own rectifier you would lose that source. So you have a redundant rectifier, if you will, installed in your system.

MR. ROSENTHAL: Our concerns with respect to this event is that these spikes are short in time compared to the time it takes relays to move and the shunt trips, et cetera.

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I don't know what the time scales of something like this
with a spike is compared to the CMOS logic, which I take it
is running at 180 kilohertz.

MR. MACHILEK: The power supply is monitored. The 4 CMOS logic is not affected by voltages below 16-1/2 volts. 5 If you would have gone with that spike below you would have 6 gotten an alarm which says your power supply is -- as a 7 matter of fact, it would shut down on you. In UPS design 8 you have to take the crack of the whip into consideration in 9 your window for the maximum/minimum voltage you can allow 10 11 the battery to operate, which includes the crack of the whip, of course. Otherwise all the UPS would go down as 12 13 soon as you had discharge.

14 MR. ROSENTHAL: Do you want to go on or do you15 have a plan for today?

MR. MACHILEK: No. I'm here to explain or
describe or theorize anything you may want to hear.

18 MR. IBARRA: Can we go into the details of what19 that battery was supposed to do?

20 MR. ASHE: So far Rudi has given us a broad 21 overview of a very simplified diagram that we have here. 22 Maybe as best you can understand or perhaps some of your 23 people understand the actual wire connections to that 24 diagram, I think we can then move on to the details of the 25 A27 panel.

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1 MR. MACHILEK: The only difference here is that 2 you have another rectifier sitting here, AC/DC.

3 MR. ROSENTHAL: That's external to your scope of 4 supply.

5 MR. MACHILEK: Correct. The idea here was that 6 your own station battery is keeping the battery floating and 7 the rectifier of the UPS is prohibited from recharging the 8 battery.

MR. ASHE: How is the actual wiring done here, 9 here and out here? Is it delta? Is it Y? Is it grounded? 10 Is it ungrounded? The actual Nine Mile Point installation. 11 12 MR. MACHILEK: The input is a delta, Y, double delta with the Y, and the delta on the secondary. The input 13 is a three-wire ungrounded. The only grounded three-wire 14 system I know of is in Japan, which they call a wild leg 15 16 delta. They are grounding one phase actually of the delta. I have never seen it in the United States or Canada. 17

18 MR. ASHE: So these are three wires, ungrounded19 delta input.

MR. MACHILEK: Ungrounded delta input.

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21 MR. ASHE: Fine. That's that one. Let's move to 22 this one.

23 "MR. MACHILEK: This transformer is a delta -- I 24 don't know if I brought it or not.

I did not bring it, but that is also an ungrounded

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MR. ASHE: And the output?

MR. MACHILEK: The output is a Y with a floating neutral. We ship it as a floating neutral. It is up to the systems engineering, which would be Stone and Webster in this case, to determine if that should be grounded and where.

8 Generally the reason why we stay out of that is because of what codes you have to meet. NEC 250 basically 9 10 tells you that a power source to a building can only be grounded at one point. In other words, if you come into a 11 building and you have a delta Y transformer, which most of 12 the building entrance transformers are, you have a wire 13 directly ground via neutral point to what they call 14 electrode or the main grounding point. 15

16 If you have an UPS, then you can consider that UPS as separately derived power only if you never parallel the 17 two sources. Unfortunately, on a static transfer you do 18 19 parallel the two sources. By code you cannot ground that system here separately. You cannot have two ground points 20 and parallel the two systems or you are violating the code. 21 Therefore you have to take this ground point here, this 22 23 neutral point, and bring it over to this one. This is to 24 meet the codes.

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If the ground electrode is connected to a ground

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grid or a main grounding distribution system meeting the definition of the National Electric Code, then you can of course connect that point to that system which is considered to be the electrode.

5 MR. ASHE: I think what you said is that the 6 output is a delta from the inverter.

7 MR. MACHILEK: Correct.

8 MR. ASHE: That ground is a straight piece of wire 9 that goes back to here.

MR. MACHILEK: This doesn't matter. Since this is
a delta transformer, you are isolated.

12 MR. ASHE: But how is the Nine Mile Point 13 installation, as best you understand it?

14 MR. MACHILEK: What we have here is another This is this transformer here. This 15 transformer. transformer has to come to here. Due to UPS output it is no 16 longer your building entrance transformer; it is now this 17 transformer which constitutes the alternative source. 18 Therefore the neutral point of this one and the neutral 19 point of this one have to be connected together and grounded 20 21 only at one point, either here or here or somewhere in 22 between. It doesn't matter.

23 MR. ASHE: You are saying the output here is 24 grounded back here with respect to this transformer. 25 MR. MACHILEK: These two neutral points have to be

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1 connected together and grounded once. Whether here or here 2 or anywhere else, to the best of my knowledge and 3 interpretation of NEC, is immaterial. 4 MR. ASHE: To the best of your knowledge, how is 5 it done at Nine Mile Point?

6 MR. MACHILEK: This one is connected to this one 7 and this one is grounded.

8

MR. ASHE: All right.

9 MR. STONER: Let me clarify something. I thought 10 you indicated that the AC source inputs were a delta.

11 MR. MACHILEK: Yes, sir.

MR. STONER: According to the utility drawings, the inputs are grounded Y's on the low side, which are the source inputs both --

MR. MACHILEK: Then whoever did these drawings
didn't know what it was.

MR. STONER: You have verified that it's a delta.
 MR. MACHILEK: I have known since 1962 they are
 delta Y transformers.

20 MR. STONER: Inside your inverter, you mean?
21 MR. MACHILEK: Absolutely.

22 MR. STONER: I'm sorry. I'm talking about the 23 source to the inverter.

24 MR. MACHILEK: I wouldn't know.

25 MR. STONER: So you were speaking of the

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1 transformer in your UPS.

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MR. ASHE:

2 MR. MACHILEK: Yes. MR. STONER: Fine. That's what I wanted to 3 4 clarify. I have no knowledge of what goes on 5 MR. MACHILEK: upstream from there. 6 7 There is no drawing here. This is MR. STONER: the drawing only for the customers' transformer. 8 MR. MACHILEK: If you start from the 375 or 9 whatever high voltage line that is, you have three 10 transformers before you get to this. 11 I just wanted to be sure that we were MR. STONER: 12 13 talking about the same thing. MR. MACHILEK: We are not. This is the 14 15 transformer which actually is within the UPS, within the 16 box, and there are only three connection points. MR. ROSENTHAL: That makes sense, because you go 17 delta Y, delta Y, delta Y. So you have got Nine Mile's Y 18 19 feeding your delta. MR. MACHILEK: We coiled the transformer 20 distribution downstream only to that end, to assure 21 ourselves that the phase that was the ground on the high 22 voltage always was the phase that was the ground on the last 23 one of the transformers. 24

Did you actually take it all the way

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· ·  1 back up, though?

2 MR. MACHILEK: Yes, sir. You did? 3 MR. ASHE: MR. MACHILEK: At least as good as you can 4 5 establish from the drawings. 6 So the 575 is between A and C phase or MR. ASHE: 7 B and C phase or A and B phase? MR. MACHILEK: Correct, 200 volts to neutral, or 8 199.6, or whatever. It is basically 200 volts. They 9 dropped down to 80 kilovolts. We took that ratio. If you 10 11 follow the whole distribution of all the transformers, you That was the basis for end up with the same 200 to 80. 12 13 asking for the adjustment of the rheostat or VRAC. 14 MR. ASHE: Most of the loads as far as you know were 120 volt loads. So when you say 120 volt out here, 15 three phase, what you are really saying is between a phase 16 17 and neutral. I don't think you have a four wire 18 MR. MACHILEK: 19 distribution off the UPS. MR. ASHE: For example, 1A, which powers a lot of 20 21 instruments loads. Isn't that 120 volts? 22 MR. MACHILEK: Yes, but you have a transformer in between the UPS and that load. 23 MR. ASHE: What does this 208 mean, between where 24

25 and where?

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1 MR. MACHILEK: Phase to phase. If it would be a 2 four wire system, it would be 120/208.

MR. ASHE: That is the way it is taken and used and then you go through a transformer if you need 120; is that the way it works?

6 MR. MACHILEK: That is correct. Or you could wire 7 the Y out and use it as a neutral.

MR. ASHE: Wouldn't it be easier to do that?

8

9 MR. MACHILEK: Our system allows you to work it as 10 a three wire system or a four wire system, floating or 11 neutral ground. We don't know how it is being used, so we 12 give you all the options.

MR. ASHE: If they have a ground and a neutral here, is that the same point? At this point. A ground and a neutral.

16 MR. MACHILEK: The ground and the neutral can 17 never be the same point except as executed in accordance 18 with NEC. That means the neutral is white and ground is If you have a distribution box on the wall, this is 19 areen. where the ground and the neutral can be connected together 20 because that point is considered to be the point of the 21 ground electrode. But you are not allowed to connect the 22 23 neutral and the ground together in the box.

24 MR. ASHE: Your box has a neutral.
25 MR. MACHILEK: My box has a neutral and it has a

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1 safety ground, which goes basically to the cabinet.

2 MR. ASHE: The neutral in your box connects where 3 in your box?

Nowhere. As shipped, it doesn't MR. MACHILEK: 4 It is up to the systems designer, the one 5 connect anywhere. who determines what the whole power system incorporating the б UPS looks like to establish if he has to ground the neutral 7 or bring the neutral to another point which is grounded or 8 let them float. We have floating neutrals in cases where 9 all the loads are step-down transformers, like on 480 volts. 10 We distribute three phases and then we step down all the 11 loads to 120 or 208 isolation transformers, which only 12 secondarily have an isolated ground for that system. The 13 14 reason we do that is because in large computer centers you do not want a common ground between different missions or 15 16 operations, and you isolate it that way.

MR. ASHE: Do you have a ground lug in your box?
MR. MACHILEK: Yes.
MR. ASHE: That connects where?

20 MR. MACHILEK: We don't connect it. Somebody 21 connects it.

MR. ASHE: But it is inside your box?
MR. MACHILEK: Correct.
MR. ASHE: Connecting where inside your box?
MR. MACHILEK: To the neutral of the transformer.

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That means you have the transformer and out comes one, two,
 three, four terminals.

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MR. ASHE: I got you.

MR. MACHILEK: Unless we have a turnkey job, meaning we are also the installers, we do not get anywhere near telling you how to do things. The installer usually is responsible for the codeworthiness of what he is doing.

8

MR. ASHE: Very good.

9 MR. ROSENTHAL: Ultimately I want to learn what 10 the logic is.

MR. ASHE: I think we need to go to the A27 board and go through some of the details of how this unit isolates when that DC power supply drops down and show the signals why it isolates: CB1, CB2, CB3, all of them. And through the details of the A27.

16

MR. MACHILEK: Then we need A27.

MR. ROSENTHAL: We will need copies of these prints. I leave it up to you guys to designate those things you consider proprietary or not. We will protect the proprietary but we still want a copy.

21 MR. MACHILEK: This is A27, which was supplied 22 with the unit. The wiring of it was exactly like that.

23 MR. ASHE: Maybe I asked for the wrong thing. We 24 clearly understand this guy. No problem. What I think Jack 25 is interested in is the downstream logic down here and

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1 showing how it sends the signal.

2 MR. ROSENTHAL: Or you could start here and work backwards. 3 I take it that you energized the shunt trip coils 4 on CB1, CB2, CB3 to shed the loads. 5 MR. MACHILEK: You have to get A21. 6 MR. ASHE: When this voltage out here drops below 7 a certain value, we want to show how it isolates this guy, 8 9 this guy, and this guy. MR. ROSENTHAL: Help me on this drawing a little 10 11 bit. You energize the shunt trip to trip the breakers, 12 right? 13 MR. MACHILEK: Correct. These contacts here, the two K1's, 14 MR. ROSENTHAL: 15 two K2's and two K3's, come from the 40 volts. 16 It's right here. MR. MACHILEK: MR. ROSENTHAL: It's not these? 17 18 MR. MACHILEK: No. MR. ROSENTHAL: What is the difference between 19 this K1 and that K1? These are different relays, aren't 20 21 they? Or is in fact the same relay shown in two places? 22 MR. MACHILEK: No. You will see here a dotted line. 23 24 MR. ROSENTHAL: Right. MR. MACHILEK: That dotted line is describing what 25

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we call the A27A1 board. That relay on the A27A1 is 1 2 associated with its conduct on the A27A1. These relays here, which are not within the confines of the printed 3 circuit boards, are actually hard mounted on the A27 panel. 4 5 So the K1 here and that K1 associate together. MR. ROSENTHAL: So these are to the motor 6 7 operators. MR. MACHILEK: You can take a scissors and cut 8 that. 9 MR. ROSENTHAL: I understand that. 10 11 In order to open up CB1, CB2 and CB3 --Shunt trip it. 12 MR. MACHILEK: Which means that you close these 13 MR. ROSENTHAL: 14 contacts, which takes the 40 volts from here. MR. MACHILEK: And dumps it on the shunt trip 15 coils. 16 MR. ROSENTHAL: Are there other sources of 17 electricity to the shunt coil? 18 19 MR. MACHILEK: No, sir. MR. ROSENTHAL: If that is the case, then you open 20 21 CB1, CB2, CB3 by closing these contacts, which means that 22 you do something to these relays. MR. MACHILEK: Yes, sir. 23 24 MR. ROSENTHAL: You change the state of these 25 relays.



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1 MR. MACHILEK: Correct. 2 MR. ROSENTHAL: I am sort of like working it backwards at this point. These relays are sitting at plus 3 20 volts here and going off to something off this page. 4 5 MR. MACHILEK: Yes, sir. I don't know if these are normally 6 MR. ROSENTHAL: open or normally closed, but when you make up the logic to 7 change these states, you trip. So what goes off this page 8 if I am working it backwards? 9 MR. ASHE: Would it be easier to work it the other 10 11 way, though? MR. ROSENTHAL: I'll leave it up to you. Would it 12 be better to work it backwards or forwards? 13 Similarly, I want to look at CB4 and the logic 14 that makes CB4 work. If you want to go from the front back 15 or from the back front, it is up to you. 16 MR. MACHILEK: This is what we call the top 17 18 schematic. This gives you all the wiring which is between the printed circuit board. A13 is the card cage, and load 19 division panel, and then the power supply panel A27 is 20 probably somewhere right here. This is the A27 which we are 21 22 talking about. MR. ROSENTHAL: For the transcript, what are we 23 looking at? 24 MR. MACHILEK: We are looking at what we call the 25

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top schematic diagram, Drawing No. D-110711102-77223.

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The CB3 has its three main contacts, phase A,B,C. As you will see, the neutral comes directly from the output transformer neutral and is brought out to a terminal which is marked N. What you want to do with it is up to the user at this point.

7 The phase A,B,C, now we do have high-speed fuses 8 on the output. The reason why they are are there, if you 9 should have a short in the transformer itself, then one of 10 those fuses will go if you try to transfer at the same time 11 because then the power from the other side would go in.

MR. MACHILEK: No. You have got a motor operator. All the motor operator is doing is simply mechanically closing and opening the circuit breaker much the same you would do it manually.

But those fuses didn't blow.

MR. ROSENTHAL:

We have a shunt recoil. Energizing of the shuntrecoil will trip the break open.

Then we have auxiliary conducts, which are two types, two normally opened and two normally closed, and as you see, we are only using the two normally opened ones.

In order to find out what the shunt tripper is powering we have to follow wire 595 and 589. This 595 and 589 go to a plug, which is called A27P1. We should go directly to the A27P1 plug. Unfortunately we don't have the

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1 wire numbers on it. A27P1, 9 and 15.

MR. ROSENTHAL: So we are talking about K3 that we 2 just followed and CB3. So we now went from CB3, the AC 3 output of the aux, and we followed that back to --4 MR. MACHILEK: Which means that you are coming 5 from plus 20, which if it is energized goes through the 6 coil, comes back and here and goes to the minus 20. So we 7 put 40 volts DC directly without any other interference and 8 put the trip voltage on here. 9 You will find a similar situation true for the 10 11 input in the battery breaker. MR. ROSENTHAL: So now I have to make up the logic 12 for K1, K2 and K3. 13 MR. MACHILEK: That is correct. 14 15 MR. ROSENTHAL: They are sitting on plus 20 volts and then they go off this board. 16 MR. MACHILEK: Since this is the A27A1, we have to 17 18 identify the plug. The plug is at J2, 9, 12 and 15. So we go to A27P2, plug 2 and jack 2. There is always a plug and 19 And 9, 12 and 15. There is 9; there is 12; and 20 a jack. there is 15. BBTR, OBTR, IBTR -- well, the "R" you have to 21 leave of. The signal is BBT, IBT and OBT. "R" simply says 22 it's a relay. 23 MR. ASHE: Okay. We are going to go back up 24 25 stream.

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MR. MACHILEK: Then 15 is 273; 12 is 272; and 9 is 2 274, and 274 was OBT, and there is IBT, and 15 is BBT. That 3 should jibe with what we have here.

4 MR. ROSENTHAL: Let me stop for a second. We were 5 looking at Drawing No. 110611334.

6 MR. MACHILEK: Correct.

7 MR. ROSENTHAL: Now we are going backwards.

8 MR. MACHILEK: Now we have to follow those three 9 wires as they go into that wire bundle here, come up here, 10 and go to 272, 273, and --

11 MR. HESS: I think it's 274, not 774. It's 274, 12 which is right.

MR. MACHILEK: Now we have to take A13, the motherboard. If we take those three, 9, 12 and 15, we established that 9 is K3, 12 is K1, and 15 is K2. What we were saying here was that corresponds with plus 20.

17MR. ROSENTHAL: These are just small relays with18100 or 200 millisecond strobe time or something like that?19MR. MACHILEK: Correct. Because we are switching

20 a total of probably 2 milliamps at the outside.

MR. HESS: You are on J3.

21

MR. MACHILEK: It says here Al3P3, and since the plug goes into a jack we have to look for an Al3J3 on the Al3 motherboard. Al3 is the card cage and everything is plugged into the motherboard. Those connections are now

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1 made through OBT, right here, IBT, and BBT.

2 Now you are on your own because you have to follow the printed circuit. The BBT, for instance, goes to the A1; 3 the IBT goes to the A1 right besides it; and the OBT goes -4 -5 6 MR. HESS: It goes nowhere because it didn't 7 shadow well. MR. MACHILEK: Wait a minute. Let's go slowly. 8 We'll find it. MR. HESS: 9 MR. MACHILEK: Let's get the A1 and the A20. 10 MR. ROSENTHAL: So that goes to the motherboard 11 and then on to the individual cards? 12 MR. MACHILEK: That is correct. 13 14 MR. HESS: This one here, Rudi, is IBT and then this one is IBR, and this is pin 11 on the A20, which is the 15 OBR. 16 The input breaker, 17 MR. MACHILEK: Right here. IBT, goes to A12; the battery breaker goes to A13; this goes 18 19 to A20, pin 11. We are there. A1, 2 and 3 incorporate the shunt trip, right 20 here; input breaker shunt trip goes to a transistor driver 21 output. This is the output of that logic against ground. 22 In other words, we take the plus 20 volts and go directly 23 over a transistor driver to ground. The controller is 24 telling you once the K3 is closed and other conditions are 25



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correct there are other conditions which are tripping that
 relay.

MR. ROSENTHAL: Here we are going to find all the logic that causes ultimately CB1 to open.

5 MR. MACHILEK: The same thing should be true from 6 No. 3. There you have a transistor driver; ground against 7 plus 20 powers that relay. The same as you will see under 8 A20.

9 MR. ASHE: Can we back up and see what saturates 10 this guy right here? Obviously if this guy goes to 11 saturation, you pick up the relay. Can we show reduced 12 voltage out here causes this guy to saturate?

MR. MACHILEK: You would have to go to A21. The question is what portion of the circuity tells this transistor to saturate, right?

MR. ROSENTHAL: Right. In normal operation, and
also we can think in terms of reduced voltage.

MR. ASHE: Obviously we are saturating this guy, so we bring this guy. The collector here goes down to ground to protect the relay. What I think we want to establish in this drawing trace here is when this guy goes low we want to show how we saturate that transistor.

It may be easier to work this way. There must be something here that comes back into the front side of this transistor over here.

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MR. MACHILEK: Let's trace it. We are bringing it over to J4. A27 J4; A27P4. We have the minus 20; we have ground.

4 MR. ASHE: J4-8. Rudi, you come over here and you 5 come straight over on a line to the A30 bypass panel.

6 MR. ROSENTHAL: Let's take a five-minute break. 7 [Recess.]

8 MR. ROSENTHAL: We are now on the record. Frank 9 Ashe.

MR. ASHE: Before we went off the record we had saturated Q1 on drawing number D-11007116877223. We were attempting to see how Q1 was saturated by tracing the signals upstream of Q1. Rudy, do you want to take over now?

MR. MACHILEK: We went to the other end for a 14 moment and said the plus one to the ground and the minus one 15 16 is distributed throughout the cage door on the areas. On the A18 board we have the plus one at the ground and the 17 minus one and monitoring it over high position regulator. 18 19 There is some adjustment for the three points and will come The PSF signal is brought over to the A21 20 out with PSF. 21 PSF.

22 MR. ROSENTHAL: What is the function of PSF? 23 MR. MACHILEK: PSF, it monitors the control 24 voltage to be within maximum of 19 volts I believe, and a 25 minimum of 16. That's the adjustment range of that

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1 monitoring.

2 MR. ASHE: Excuse me. Is that monitoring both 3 sides there, plus with respect to neutral and minus with 4 respect to the --

MR. MACHILEK: Minus, plus. If either one of the 5 two would for instance go below 16 and one-half volts it 6 would issue a PSF signal which would go over -- comes in 7 8 here -- and switches the latch but uses a Q output which does two things. Number one, it brings the light on the A21 9 board which says power supply failed. Number two, on a 10 11 separate circuit over a gate which simply detects also the 12 frequency and the voltage on the frequency. It is just we use the same one for both. 13

14 MR. ASHE: That's AND gate there.

15 MR. MACHILEK: Right.

MR. ASHE: How do you get this guy again?
MR. MACHILEK: This one it gets from PSF comes up
here and sets the latch.

19 MR. ASHE: Right. We got that one.

20 MR. MACHILEK: We got this one.

21 MR. ASHE: That's one signal going to the --

22 MR. MACHILEK: This is one signal.

23 MR. ASHE: How do we get this guy?

24 MR. RANSOM: They are just together because there 25 are not enough inputs on this gate over here. Either one

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1 of these going --

2 MR. MACHILEK: Either one of the two. This is not this plus two, it's either the one or the two. 3 4 MR. ASHE: That's a NAND, n-a-n-d. 5 MR. MACHILEK: Either one, yes. Giving you number one the light, which is the light on the A14 which says 6 7 logic failed, and giving you the trip signal over to the 8 number three to the --9 MR. ROSENTHAL: Trip light on A14. 10 MR. ASHE: This is SSTR and has to go back over 11 here somewhere. 12 MR. MACHILEK: The SSTR --13 MR. ROSENTHAL: It changes SSTR from high to low 14 or the other way. 15 MR. MACHILEK: And the SSTR --MR. ASHE: This drawing right here somewhere, 16 17 right? MR. MACHILEK: No, the SSTR should go directly --18 19 you have to trace that back. The transfer from one point to 20 the next. MR. ROSENTHAL: From here we decided that it had 21 22 to go to that transistor, C1. 23 MR. MACHILEK: C1, yes. SSTR, goes to the trip 24 relays -- you have to trace it because I don't know how it 25 comes in. The SSTR goes to the -- we have to locate the

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1 mother board and comes out --

2 MR. HESS: The mother board on the top print. MR. MACHILEK: It comes out of the A1 off the A21 3 and I think it goes to the 4 MR. ROSENTHAL: The A23 and the A21. 5 MR. MACHILEK: It gives you a leg off and gives 6 you this CB 1, 2 and 3 trip. 7 MR. ROSENTHAL: That corresponds to Q1 going to 8 9 ground. MR. ASHE: You have it to SST1 here but we have to 10 make the relationship between this guy and Q1 saturated. 11 12 Then, if we can do that, that's it. MR. ROSENTHAL: No, because this is monitoring the 13 14 voltage; right? 15 MR. ASHE: Yes. The Q1 has to saturate it, so that has to --16 17 MR. ROSENTHAL: We have to get to Q1. 18 MR. ASHE: Right. MR. ROSENTHAL: Also, this should have lit -- what 19 other thing should it have lit? 20 MR. HESS: It also ties over to B 834. 21 MR. MACHILEK: Yes. 22 MR. HESS: This is 163, wrong one. 23 MR. MACHILEK: We still have to come over to the 24 Al board. I can't understand where this SSTR comes over 25

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here. I have to get the signal -- therefore, I have to come 1 in here somewhere, and I cannot spot it. Where is the --2 3 MR. HESS: It also goes under the TB bar too. 4 MR. ROSENTHAL: Isn't this PIN 23 on some 5 connector? 6 MR. HESS: That would be the plug in connector, 7 Is that the A21 card that you have? Jack. MR. ROSENTHAL: Yes. It's the A21. A13, A21 8 9 card. That comes off and it would come off on 10 MR. HESS: J8 which is the SSTR command. 11 12 MR. ROSENTHAL: It says 23 here. 13 MR. HESS: That's PIN 23. 14 MR. ROSENTHAL: PIN 23 on connector J8? 15 MR. HESS: No. That's the plug in PIN. 16 MR. ROSENTHAL: Right. 17 MR. HESS: You plug the board in and that comes off that -- that coincides with this PIN right here. 18 That 19 comes off the board on an SSTR which comes off of here, which is J8. J8 is over here, which is right -- that's SSTR 20 21 right there. 22 MR. ASHE: That comes in here somewhere. 23 MR. HESS: Yes. MR. ASHE: Is that what it does? 24 It doesn't show a wire coming off of 25 MR. HESS:

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2	MR. MACHILEK: We have three latches here now, one
3	for each breaker.
4	MR. HESS: That's right.
5	MR. MACHILEK: We have to set the latches, it's
6	that simple. This is UPS okay input breaker closed,
7	okay. This is logic command. The shunt trips
8	MR. ASHE: Basically, all we need to do is make a
9	relationship between SSTR and over here somewhere.
10	MR. MACHILEK: Yes.
11	MR. ASHE: It looks like by the way of this thing
12	over here.
13	MR. MACHILEK: Yes.
14	MR. HESS: SSTR also comes off the A13 P5
15	connector which is right there.
16	MR. IBARRA: Hold it. That's a PIN number, right?
17	Isn't that a PIN number there?
18	MR. HESS: What breaker are you looking for,
19	Bernie?
20	MR. MACHILEK: We have to get a signal to trip
21	those three characters, CP1, CP2 and CP3.
22	MR. HESS: There's SSTR, off the TB1. As you look
23	here it's tied in there. It's tied in there and it's tied
24	in there.
25	MR. MACHILEK: What way are they going?

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MR. HESS: That come back up -- that follows the 1 2 648. MR. MACHILEK: That means with this three there, that's why I came --3 That's right. 4 MR. HESS: MR. MACHILEK: How do they come in here now? 5 MR. HESS: You find it on that side. In fact, I 6 found it on the mother board up here. Let me fold this out 7 8 here. MR. MACHILEK: You have to see where we come back. 9 That means we get the SSTR --10 MR. HESS: You tie SSTR, so SSTR ties over here on 11 the A34 card here. 12 MR. MACHILEK: Yes, this is fine. That's where 13 14 the transfer, but we also have to go -- this is the one that I am looking for. Where does it go. 15 16 MR. HESS: It goes in right there. MR. MACHILEK: SSTR on 13 of P5. 17 MR. HESS: P5 13, mother board. You want mother 18 19 board? 20 MR. MACHILEK: Yes. 21 MR. HESS: Five. SSTR. MR. MACHILEK: SSTR, right. 22 MR. HESS: There is also an SSTR connection off of 23 the A21 card. 24 MR. MACHILEK: This is the A21. I am looking at 25

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the A1. We have to split it somewhere. It goes to the A21 1 -- it comes from the A21. It goes on to what --2 Down here we split it up, off here. 3 MR. HESS: 4 You split coming down. MR. MACHILEK: I don't know how we did it here. Ι 5 6 don't know how we did it. 7 Would it be better if we go off the MR. ASHE: 8 record and try to figure this out. There's a lot of blank space on 9 MR. ROSENTHAL: 10 the tape right now. Other than wrestling papers and people going on. 11 12 MR. ASHE: We can stop it. Let's stop it. MR. ROSENTHAL: Let's go off the record. 13 14 [Discussion off the record.] MR. ROSENTHAL: Okay, let's go. Do you have it? 15 MR. MACHILEK: It changes the mother board from an 16 17 SSTR to a UPT. The question was, where is it happening? 18 MR. ROSENTHAL: We are back on and Rudy is talking. 19 20 MR. MACHILEK: The SSTR on the A21 which is over here, goes from here to the A20 boards. On the A20 board it 21 comes in on -- where does it change to --22 MR. RANSOM: Right here on A21 it's STR. That is 23 24 right where it changes, right there. MR. MACHILEK: SSTR PIN 23, all right, is 25

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statically connected in 53 on the A20. You see that is
 called a UPT.

MR. ROSENTHAL: Now we have UPT --3 MR. MACHILEK: It's the same --4 MR. ROSENTHAL: On drawing D-110071196. 5 MR. MACHILEK: This is where it comes in and 6 trips. It trips the output breaker if other conditions can 7 also trip it, right? Either one of those ones is tripping 8 it, and one of those is the UPT. Also, it comes in on the 9 K1 as a UPT and trips number 1B input breaker at the same 10 point. Breaker and input breaker is tripped on UPT signal 11 12 off the A1 and off the output breaker. MR. ROSENTHAL: By design then, we have now 13 followed through that a low voltage on the control power 14 15 supply should -- MR. MACHILEK: No, low voltage on the logic 16 bus. MR. ROSENTHAL: On the logic bus should result in 17 18 tripping of --

19MR. MACHILEK: Tripping of all three breakers.20MR. ROSENTHAL: Right. Now, we go to --21MR. MACHILEK: It also goes to the A34 -- do we22have an A34. What we have to show here now is that -- is it23SSTR or SSTR comes in the A34 and does all kinds of things

24 now.

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MR. ASHE: Such as?

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1 MR. MACHILEK: Well, we should end up in a gate in 2 a logic that says that if a bus is available -- this is a 3 trip signal. If a bus is available -- let me see how we are 4 going to do that. Transfer ready to bypass and this one 5 comes from either -- now we have to tie it into the SSTR, 6 okay? That means we have to walk ourselves --

7 MR. HESS: We have to walk ourselves all the way8 through.

9 MR. MACHILEK: Which one is it which we are 10 getting down here. This one -- this, if closed, and coming 11 out of here, go over to the 4066 and if it is selected, and 12 coming through there.

MR. ROSENTHAL: That's if the selected, you mean
 the auto select? -

15 MR. MACHILEK: A lot of conditions have to be -number one, it checks if the CB4 got to be open in the first 16 17 place, okay? That means that if somebody goes and goes to 18 CB4 for instance, it would disable everything. If the CB4 is open and if the bypass sensing -- BC CA is showing that 19 number one, the voltage is within the window and the 20 frequency is okay and we are coming I believe from -- we are 21 22 in sync -- now we have to bypass -- that is reset -- the way this is drawn out you can't -- coming up there and this is 23 in the UV/OV transfer -- which transfer are we looking for, 24 UPS, right? 25

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If we get an UPS -- this is the UPS --1 2 MR. HESS: That's an output. 3 MR. MACHILEK: This is the output. 4 MR. HESS: Here is your SSTR right up through 5 here, Rudy. That comes up through the --6 MR. MACHILEK: The TP25 --7 MR. RANSOM: I think what it does is, it comes in through here. 8 MR. MACHILEK: Yes, I am trying to find my way 9 10 through here. 11 MR. RANSOM: Right here it's saying okay, we want 12 to trip the breaker but we are looking to see if --13 MR. MACHILEK: We need a command to the -- I am 14 looking for the command to the CB4. If I get a one here I 15 got a static switch on, all right? This one is giving me the conditions if the bypass breaker is in fact open if I 16 17 don't have a load down. This is in the input, and this is 18 the output. 19 Right here is the critical bus MR. RANSOM: 20 sensing. We are also looking at the bypass fault sensing back through here. This signal down here is going to try to 21 22 hold off this signal if we are at tolerance, and this signal is the signal that comes off of here which comes back to 23 your SSTR. 24

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MR. MACHILEK: Okay. Here we go.

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1 MR. RANSOM: It comes back through to your SSTR. 2 MR. MACHILEK: Yes, 4066. That is going to hold it off if your 3 MR. RANSOM: bypass is not available or not in sync with your critical 4 5 bus. In terms of time, how long does it take б MR. ASHE: 7 it to make up its mind? MR. MACHILEK: One hundred-twelve micro seconds. 8 MR. ASHE: Once it makes up its mind that you are 9 out of tolerance. 10 11 MR. MACHILEK: Yes. 12 MR. ASHE: How long does it hold there? 13 MR. MACHILEK: How long does it hold there? 14 MR. ASHE: Right. 15 MR. MACHILEK: It holds there until the bypass breaker has closed. The bypass breaker tells them it is 16 closed then we remove the signal. In other words, the CB3 17 18 does not go open until the CB4 is closed unless bypass is 19 not available and the CB4 is open. 20 MR. ASHE: Once it decides that the bypass is not 21 available --MR. MACHILEK: Once it is not available --22 23 MR. ASHE: Very quickly. MR. MACHILEK: If it decides the bypass is not 24 available you will never get a transfer signal out of here. 25

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MR. ASHE: What I am saying is, what is the minimum time it can hold that?

MR. ASHE: Suppose that one instance of time the bypass isn't available but for whatever reason it creeps back up and readjusts, and everything comes back.

MR. MACHILEK: That is not available?

7 MR. MACHILEK: Once it becomes available -8 MR. ASHE: Right. Right away?

9 MR. MACHILEK: Then you get it a sync signal, okay 10 sync signal, and then it waits until it is synced. Once the 11 sync is confirmed, then you get the third condition which 12 says that you are in sync which allows you to advance a 13 command. You are checking the voltage, okay, making sure 14 that the voltage is within plus - minus ten percent.

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MR. ASHE: Right.

MR. MACHILEK: You are checking the frequency 16 which says the frequency is within one-half a hertz. If 17 18 these two conditions are right, then you wait until it is If you have a sync confirmation, that means that if 19 synced. you are within seven degrees of each other -- okay -- then 20 you release the third condition and from then on it takes 21 you 120 micro seconds to close the static switch. 22

If you takes you one-half hour to sync, then you know that it simply isn't -- that the conditions are not given.

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MR. ASHE: How long -- it resets immediately. 1 2 MR. MACHILEK: There is no reset. It is not the 3 light, it is simply a gate. I understand. If you come back in sync 4 MR. ASHE: such that your criteria met, it will permit --5 6 MR. MACHILEK: Immediately to transfer. 7 MR. ASHE: Right. 8 MR. MACHILEK: If the transfer is still desired. 9 That means -- you know what I mean. 10 MR. ASHE: Right. 11 MR. MACHILEK: If you get an SSTR and all the other conditions are right, you have 120 micro seconds and 12 13 you are on bypass. 14 MR. ASHE: I am asking all these questions really, 15 because I think these units went out of sync just prior --16 after the transformer fault. That's why it wouldn't 17 transfer. They locked out. 18 MR. MACHILEK: No. 19 MR. ASHE: Just prior. 20 MR. MACHILEK: You lost voltage. 21 MR. ASHE: The question could be asked why didn't they transfer. Why didn't they transfer to maintenance when 22 23 you had a maintenance good. What I think happened was, when 24 we got the fault these units picked that the maintenance 25 supply was no good, it locked out the transfer and it held

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that lock out because it wasn't any good. The voltage
 decayed and the unit tripped out. That's why they lost the
 bus. Is that a fair assessment of it?

4 MR. MACHILEK: I would suggest to go the other The voltage suffered a decline 5 way. The UPS was running. 6 of the phase speed, which means that it is phasing off. No It's running on battery now. The bypass voltage 7 problem. 8 now suffers a decrease in voltage which causes the power supply to go out of limits. 9

10

MR. ASHE: Right.

11 MR. MACHILEK: Which issues the trip signal. But 12 the fact that the voltage has to decrease first before you 13 get the trip signal means that it is assured that the bypass 14 wasn't there at the time you got your trip signal.

MR. ASHE: That's right. You are actually saying
the same thing. The units lost sync prior to tripping.
MR. MACHILEK: What does this have to do with

18 sync?

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MR. ASHE: To me it lost sync prior to tripping.
That's why --

21 MR. MACHILEK: You did not lose sync. The voltage 22 decreased.

23 MR. RANSOM: What do you call losing sync, locking 24 out?

MR. ASHE: Prior to the event you were probably in

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sync, and by in sync your three criteria -- difference
 criteria - MR. MACHILEK: Delta - MR. ASHE: Your maintenance supply were met so it
 will permit a transfer.

MR. MACHILEK: Right.

7 MR. ASHE: When the B phase fault occurred, I 8 think the electronics picked this up right away and said 9 hey, this maintenance source is no good. I cannot do 10 transfer.

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MR. MACHILEK: Right.

12 MR. ASHE: Subsequent to that, the voltage decayed 13 and isolated the unit.

MR. MACHILEK: It happened at same time. It's the same voltage. It's the same voltage. I suggest the Delta V is really the one which locked them out because as the voltage decayed there is no reason to go out of sync. A phase B reaction of voltage does not change the frequency of the --

20 MR. ASHE: Right.

21 MR. MACHILEK: Therefore, if you were in sync --

22 MR. ASHE: It was amplitude.

23 MR. MACHILEK: Yes.

24 MR. ASHE: Yes, voltage difference.

25 MR. MACHILEK: The amplitude locked yourselves

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1 out.

2 MR. ASHE: Right. MR. MACHILEK: As soon as you passed the ten 3 percent -- as soon as you decrease below 90 percent it said 4 5 no more transfer. I guess what I am trying to get to is 6 MR. ASHE: the order which this occurred. I am saying I think, these 7 units lost sync prior to tripping. 8 MR. MACHILEK: Why do you say lost sync? 9 MR. ASHE: Because I think your electronics picked 10. 11 it up --MR. MACHILEK: Why should it lose sync? 12 13 MR. ASHE: Let me say --MR. MACHILEK: You have one voltage and you have -14 15 16 MR. ASHE: I'm sorry. MR. MACHILEK: You have another voltage. Why 17 should it lose sync? 18 MR. ASHE: I am saying that I think we are having 19 problems with the word "sync", what sync means. It blocked 20 the transfer prior to the unit trip. 21 MR. MACHILEK: Correct. 22 23 MR. ASHE: Okay. So, we are saying the same 24 thing. MR. ROSENTHAL: By the way, this no longer looks 25

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like a 60 cycle sine wave because it has all the crap on it
 now.

3 MR. MACHILEK: It doesn't matter. As long as this 4 coincides, that's all it looks at.

MR. ROSENTHAL: Right.

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6 MR. ASHE: A signal was generated to preclude 7 transfer prior to the unit's tripping?

8 MR. MACHILEK: Right. Prior, we mean may be a 9 circle or -- right. The time constant it takes for the 10 output capacities of the power supply to --

MR. ROSENTHAL: Let me go back to CB3. We took that as an example where we said that you had to apply voltage to the shunt coil to open this nice big break.

MR. MACHILEK: Correct.

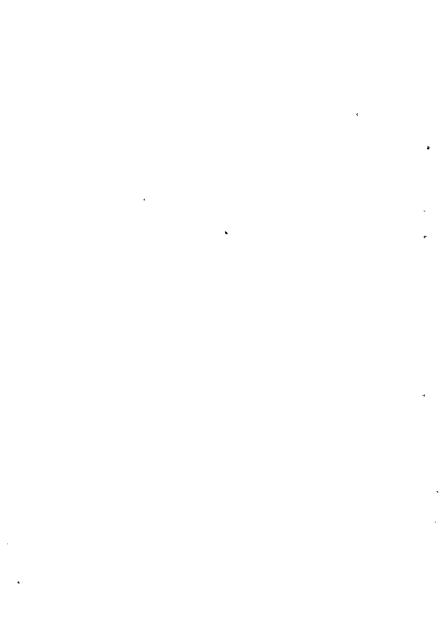
MR. ROSENTHAL: You had to apply that early enough, before the power supplies went dead, or there wouldn't have been any power to in fact open CB3.

18 MR. MACHILEK: That is correct.

MR. ROSENTHAL: I am advised that that is typically maybe like five cycles that you had to apply the current to the shunt coil.

22 MR. STONER: Do you know how long it is for that 23 breaker?

24 MR. MACHILEK: It takes about 50 milliseconds for 25 the blades to actually open. A few cycles, I would say, at



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least two or three cycles. It wouldn't matter.

2	MR. ROSENTHAL: Two to five to
3	MR. MACHILEK: Right.
4	MR. ROSENTHAL: To a 48 volt nominal coil you
5	normally apply 40 to it. You had to put some sensible
6	voltage on that, or that breaker wouldn't have opened
7	which we know it did for a couple of cycles.
8	MR. MACHILEK: Right.
9	MR. ROSENTHAL: When we were following the under
10	voltage sensor we didn't see any latches, right? They were
11	all large gates.
12	MR. MACHILEK: No. The power supply which isn't
13	latched if you lose the power supplies then you do not
14	latch.
15	MR. ROSENTHAL: It was PSS
16	MR. MACHILEK: If you lose the voltage it causes -
17	-
18	MR. ROSENTHAL: It's coming in but there's no
19	latches here.
20	MR. MACHILEK: Oh yes, sure.
21	MR. ROSENTHAL: I'm sorry, that's a latch. We
22	just decided on a micro second level.
23	MR. MACHILEK: Yes.
24	MR. ROSENTHAL: Nano seconds and this RC here,
25	micro seconds. These lights then

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MR. MACHILEK: They come immediately after the 1 2 latch has been --Right. We got some of them on 3 MR. ROSENTHAL: 4 some of the units. I remember seen an under voltage/over 5 voltage load. 6 MR. ASHE: That's right. MR. MACHILEK: Different --7 MR. ASHE: He's referring to the as-found data 8 which I think Wayman is familiar with. Perhaps as recorded 9 10 data than as-found. MR. MACHILEK: What we do not know is how fast the 11 12 voltage actually decayed from the 200 kilovolts to the 80. 13 It just didn't close that --14 MR. ASHE: Wouldn't the oscillograph on a high 15 side show some rate there? 16 MR. STONER: I don't think you can take that as an indication of what was happening on the low side. 17 18 MR. MACHILEK: There was some decay time I assume, right when the transformer failed. 19 20 MR. STONER: Decay time? MR. MACHILEK: Of the actual voltage. 21 22 MR. ASHE: Reduction in voltage. MR. STONER: The reduction was almost 23 instantaneous. 24 MR. MACHILEK: Almost instantaneous. 25

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MR. STONER: Constant.

2 MR. ASHE: Physical insight, and I am not an --MR. MACHILEK: You do have --3 4 MR. ASHE: Three-quarters of the cycle I think it 5 dropped ten percent, and when you got four fault current 6 flowing to the step function down --7 MR. MACHILEK: We did the three test. MR. ASHE: Repeatedly. We demonstrated these 8 units. 9 10 MR. MACHILEK: You know, it was the -- there is 11 enough capacity in the output of the power supplies --12 MR. ASHE: That's a question that I had. Do we 13 have a blow up diagram of the power supplies in here? 14 MR. MACHILEK: No. 15 MR. ASHE: That is a transistorized regulator. 16 MR. MACHILEK: It's a linear power supply. It is not a switch power supply or anything like that. 17 It's 18 simply a --19 MR. ASHE: Transistor regulated. 20 Yes. It's a transistor regulated MR. MACHILEK: 21 filtered power supply. 22 MR. ROSENTHAL: You just decided that you have to squelch Q1, Q2 and Q3 in order to make those circuit 23 24 breakers pop. MR. MACHILEK: In order to make the circuit 25

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1 breakers.

2	MR. ROSENTHAL: You have to do that
3	MR. MACHILEK: You have to have enough
4	MR. ROSENTHAL: Cycles.
5	MR. MACHILEK: You have to consider here that
6	the shunt trip, even if the 40 volts decay considerably, the
7	shunt trip still would be effective, you know. The trip
8	comes from the fact that the logic cannot stand anything
9	less than six and one-half volts. You can shunt trip with
10	considerably less voltage the current goes up, okay?
11	MR. ASHE: What was the design intent of that trip
12	to isolate like this? Obviously, the logic would reduce
13	voltage and cannot function properly. Would it destroy the
14	unit or would it do something else?
15	MR. MACHILEK: It would cost you probably eight
16	fuses.
17	MR. ASHE: A few SCR's or a few other proponents?
18	MR. MACHILEK: It shouldn't. It should not.
19	MR. ASHE: If the fuses act faster than
20	MR. MACHILEK: The current limiting fuses
21	protecting the semiconductors the switching SCR's it
22	is really a question of who is protecting whom, you know.
23	MR. ASHE: Are the fuses thermal?
24	MR. MACHILEK: The fuses are fast acting.
25	Instantaneous.

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MR. ASHE: Fast acting thermal, right? MR. MACHILEK: Instantaneous. They have --MR. ASHE: They are faster than SCR's is what you

4 are saying.

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MR. MACHILEK: They should protect the SCR.

6 MR. ROSENTHAL: We followed one circuit to the 7 power transistor that I raised earlier and we can start on 8 the next one.

9 MR. ASHE: Would it be helpful if you perhaps 10 trace it out beforehand, do you think?

11MR. MACHILEK: What do you want to trace, to be12exact.

MR. ASHE: I think what he was trying to say was that he wants to go through every way you can get isolation from the -- CB1, CB2, CB3 isolated. We traced one. We know for a fact that when the DC voltage was dropped it repeatedly tripped on all of the units.

18 MR. MACHILEK: It is relatively easy. Why I am 19 saying that is, you have to get an SSTR -- from here on we 20 know what happens, which is tested.

21 MR. ASHE: That's right.

22 MR. MACHILEK: Once we got a logic output here we 23 tripped --

24 MR. ASHE: Right.

25 MR. MACHILEK: The question is, how many ways can

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1 we do that, right?

MR. ASHE: Right. That's three --2 3 MR. MACHILEK: We can do that one, two, three, , four, five, six, seven ways. Any inputs to that gate here 4 will --5 6 Basically what we have to say is how many of those 7 inputs are trip --8 MR. ASHE: Triggered. I did a working analysis, and if 9 MR. MACHILEK: 10 you permit me to just -- we said you have all the inputs 11 which are latched. This is the trip sequence initiation which is all what you see down there, okay? 12 13 MR. ASHE: Okay. MR. MACHILEK: Then we have beside the A21 we have 14 15 other inputs which can actually trip the units, okay. Now, 16 what I say then, since I didn't have any lamps which told me

17 what it was, I tried to establish for instance the AC under 18 voltage -- if you go down there -- I rule out as being a 19 possible source because it's ten second time delayed and it 20 seems that the whole thing was only --

21

MR. ASHE: Cycles.

22 MR. MACHILEK: Seven or ten cycles or 12 cycles. 23 This would never have come into the picture. The overload 24 is ten minutes time delayed so we can rule these two out, 25 okay? Rule out because the event only lasted 200

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milliseconds, so no way. Those ones, logic failed,
 frequency failed and fuse failed would have required a
 repair. You don't get any of those without having logic
 elements going bad on you.

5 MR. ASHE: The point is, you can't bring the unit 6 back up with some of that stuff wrong.

7 MR. MACHILEK: No way, because you have to fix 8 something. You have to change or fix whatever. I say to 9 rule out all down stores and store it without repair. That 10 means you push the down store button which no reset and no 11 latches, and it was back in operation. It was just a matter 12 of getting that latch reset.

I say over temperature needs reset of thermal relays in the legs. That means the over temperature comes from thermal relays which are all mounted on the heat sinks of the switching legs. In order to get rid of that you have to push in the button to reset the over temperature.

18 MR. ASHE: That's important. If the unit trips 19 out on over temperature, it will not reset itself 20 automatically.

MR. MACHILEK: No.

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22 MR. ASHE: You have to manually go there and push 23 it in.

24 MR. MACHILEK: Reset. Once they are all reset,
25 then you can reset it --

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1 MR. ASHE: If it trips out on over temperature 2 though, does it open all the breakers, CB1, CB2 and CB3?

3 MR. MACHILEK: Oh yes, it's a trip signal that comes out the same. We rule that out because nobody said 4 anywhere that they had to go in and set thermal relays, 5 okay? Circuit board interlock, that's another one which 6 If the circuit boards are not all plugged in 7 comes. 8 properly then we have one circuit which simply runs in and out and one out the other -- if it's not plugged in it 9 10 doesn't let you start up. In other words, if you go and pull a printed circuit card while the unit is running you 11 get an instantaneous trip signal. I ruled that one out 12 13 because it wouldn't reset.

14 That left me with the logic power supply fail 15 alarm before this. I say suspect, because it is direct 16 connection to the maintenance source which could explain the 17 simultaneous fail in all five UPS systems.

MR. ASHE: All right now, key question.
 MR. MACHILEK: That was only a logic deduction,
 and I am --

21 MR. ASHE: These are the only guys that can give 22 you the kind of isolation that was actually experienced? 23 MR. MACHILEK: Right. 24 MR. ASHE: Those are the only ones. There are no

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1 MR. MACHILEK: No, sir. I tell you here which 2 ones are latched and which ones are not latched. Also, what 3 is doing what. For instance you see this latched one is 4 giving you a trip. The alarm reset, of course, acts on over 5 flows. It is important that if you push the alarm you 6 cannot reset one of the three different sources of trips.

7 MR. ROSENTHAL: In the manual, I thought that I 8 saw if the SCR legs aren't firing right or aren't getting 9 the right instructions to fire, then I would get a light.

MR. MACHILEK: Then you get fuse blowings and you get a fuse fail alarm and trip. You cannot restart the unit without fixing it. Big time maintenance -- intervention you have to make. Everything worked fine. Later on some atmospheric or phenomena which I cannot find anybody to give me a rationale I can test against to duplicate against.

This was all done prior to knowing anything about the batteries, okay? As soon as I learned the way the dead battery is, I said gee, maybe I am on the right way with my determination. I would have gone in -- as soon as I saw the manual I thought we got it. Then I looked at the A27 and confirmed that it was exactly like the module, there was no help here.

23 Unfortunately or fortunately -- whatever you want 24 to put it -- every circuit worked the way it was assigned to 25 work. It shouldn't have done all of that.

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At the same time that PSV is MR. ROSENTHAL: 1 coming down -- whatever that you run to this chip --2 MR. MACHILEK: No, this works on 12. 3 4 MR. ROSENTHAL: Okay. MR. MACHILEK: Only the lamp is on the 12 volts. 5 The five volts to the lamp is 6 MR. ROSENTHAL: 7 coming down --8 MR. MACHILEK: See, this --This latch is coming down. 9 MR. ROSENTHAL: No, it works on 12 volts. 10 MR. MACHILEK: MR. ROSENTHAL: But the 12 volts is coming down 11 too, isn't it? 12 13 MR. MACHILEK: No. 14 MR. ROSENTHAL: Where did this 12 volts come from? It wouldn't latch if I don't put --15 MR. MACHILEK: 16 if there is no voltage there. We know it latched. 17 Otherwise, it wouldn't get a trip which is latched and 18 requires a reset. MR. ROSENTHAL: Play that again. I apologize. 19 Just repeat what you just said. 20 MR. MACHILEK: The lamp works on five volts, only 21 the lamp. The latch going through to the A14 and to the 22 trip is a completely different circuit. If you lose the 23 24 five volts you lose the lamp, but the rest of the circuit still works. 25

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MR. ROSENTHAL: We are assuming by virtue of 1 2 knowledge of our design -- your knowledge --3 MR. MACHILEK: We know by knowledge that the latches latched. 4 5 MR. ROSENTHAL: How? 6 MR. MACHILEK: Because the lamps, which are on the A14 -- these two lamps here -- there is one lamp here which 7 says trip. There is one lamp here which says logic. This 8 9 is both red. These two lamps, they are coming off here. MR. ROSENTHAL: Which says inverter logic type 10 A14. 11 12 MR. MACHILEK: On A14 and then we have a trip 13 light on the A14. Trip light on A14, these are the two These two lights, they can only stay on and 14 lights. requiring reset if the latches -- which latches were, I 15 don't know because we didn't have the corresponding --16 There is no latch over here. 17 MR. ROSENTHAL: The 18 latches are simply these RS --Simply those RS latches, yes. 19 MR. MACHILEK: 20 MR. ASHE: What is the explanation? What if the unit had no logic lamp, this guy here, and no trip --21 22 MR. MACHILEK: After it had tripped -- after it had physically tripped -- which means an SSTR logic came out 23 of here, the two lamps came on and were on, were stored. 24 25 None of these lamps got lit.

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MR. ASHE: One-D unit is different, in that there
 was no logic lamp on the data sheet only for the 1D.

3 MR. ROSENTHAL: Let me back up a little bit. 4 Based on our interviews they go down in one UPS. I am still 5 not sure what was done on the first UPS. They then decide 6 to manually close CB4, and it's our understanding then that 7 the -- they dispersed and don't hit any more switches, they 8 just closed the other CB4's.

9 I am not sure exactly what was done, and I think 10 my guys may know better than me, on the first of those 11 units. But then the other units, I think that they adjusted 12 CB4 so that the data recording which is about two hours in 13 the event and then reconstructed on the others -- on the 14 four others -- ought to be pretty good and little bit -- we 15 could argue all day what on the first one.

16 Which is the first one they go to, Frank? Is it
17 1C or Id?

18

MR. ASHE: One C.

19

MR. ROSENTHAL: One C.

20 MR. MACHILEK: One C, after ram reset and normal 21 start sequence system operated without need for a UPS. One 22 D, same thing. One A, after a ram reset normal start up 23 stayed one, closing to CB1 input breaker caused upstream 24 breaker in the panel to trip. That happened twice in a row, 25 so they decided that there was something wrong in the



1 rectifier section of the UPS and it was left on bypass.

A worker request, 162319 was issued for its
repair.

4 MR. ROSENTHAL: Since then we know it was the 5 actual breaker.

6 MR. MACHILEK: Then there comes UPS 1B after a ram 7 reset and normal start sequence, the UPS power conversion 8 module operated without need for a repair. The retransfer 9 from bypass did not work because of a defective CB3. Work 10 request 138173 was issued for that repair. None of the two 11 dissimilarities with the other three had anything to do with 12 the actual event, because the CB3 being flaky was known --

MR. ROSENTHAL: Beforehand.

MR. MACHILEK: Beforehand, and the charger
breaking doesn't matter.

MR. ROSENTHAL: Can I take an aside. These are nice sized breakers, all right?

18 MR. MACHILEK: Yes.

13

MR. ROSENTHAL: Either they were flaky beforehand, or we broke them in the course of testing. I know the plant manager talked like you are breaking my units by testing them. It seems to me that these breakers ought to be good for many cycles.

24 MR. MACHILEK: Two hundred-fifty.
25 MR. ROSENTHAL: Two hundred-fifty cycles.

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1 MR. MACHILEK: Yes, sir. 2 MR. ROSENTHAL: They are not. Or, they saw a fair number of cycles over the years. 3 MR. MACHILEK: Or, they are just not holding up 4 the way we expect them to. 5 6 MR. ASHE: When you say --7 MR. ROSENTHAL: We were there on one occasion when the thing tripped on over temperature. We were just 8 standing in front of the unit and it tripped out. That over 9 temperature is on the SCR leg heat sink, as I understand it. 10 11 MR. MACHILEK: Are you talking about the scenario 12 when I was there when we tested? We broke a gate and then 13 14 we got an over temperature. 15 MR. ROSENTHAL: That wasn't a trip. It wasn't a Maybe it was the next day. We were just there. 16 trip. MR. MACHILEK: We were 18 20 board. We got an 17 over temperature and we couldn't reset it. 18 MR. ROSENTHAL: This was another time. 19 20 MR. MACHILEK: Another time, okay. MR. ROSENTHAL: Subsequent. The thing just 21 tripped out, and I assume it -- it was in auto reset and it 22 must have cooled down and sometime goes back on to --23 24 MR. MACHILEK: If you had an over temperature you

have to reset. If you get an over temperature and none of 25

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the button needs resetting then you probably have a U4 chip
 failing on the A20 boards. That's a guess. It might be a
 U6, either one of the two.

MR. ROSENTHAL: What I am wondering is, if over time this unit has automatically switched to its maintenance supply as designed and is in the auto reset mode and switches itself back onto the preferred AC --

8 MR. MACHILEK: If that would happen, you would get 9 a stored alarm that says that happened. In order to get rid 10 of the horn you have to physically push the one silence 11 button. Otherwise, the unit will sit there and blare at 12 you. You have a guard in that room, or somebody must hear 13 if that alarm goes off.

MR. ROSENTHAL: Why wasn't the horn blowing when we were tripping the units out, Frank, when we were intentionally tripping the units?

17 MR. ASHE: It was sometime.

18 MR. ROSENTHAL: It was.

19 MR. ASHE: Sure.

20 MR. MACHILEK: You say sometime?

21 MR. ASHE: Yes, sometimes it was.

22 MR. MACHILEK: Each time you should get an alarm.

23 MR. ASHE: Maybe it was each time. Most times --

24 MR. ROSENTHAL: Do you recall hearing a horn.

25 MR. ASHE: Yes, lots of times.

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MR. ROSENTHAL: That systems guy is pretty good at
 hitting the button.

3 MR. ASHE: You have to push the button to silence 4 the horn. I can't say -- most of the time when the unit 5 tripped out there was a horn. That's the way I recall it.

6 MR. MACHILEK: I believe the units you have being 7 built ten years ago, if you got an alarm and you silenced 8 the horn button prior to resetting the alarms -- all right? 9 The lights, you have to reset separately. You silence the 10 horn and then you reset the lamps.

11 MR. ASHE: Right.

MR. MACHILEK: If you silence the horn and then other alarm came along before you reset the lights, you did not get the horn again. Today, you do on the new equipment, okay? If you silence the horn and another alarm comes the horn comes on again, okay? At that time it was not going that way.

18 MR. ASHE: Cycling the breakers 250 times, is that 19 full load cycle?

20 MR. MACHILEK: It doesn't really matter, they 21 mechanically fall apart.

22 MR. ASHE: Making and breaking is not the problem 23 with that. What is the real problem here?

24 MR. MACHILEK: The real problem is that a breaker 25 -- historically, okay -- is not intended to be switched a

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lot. If you have a lot of switching you use a contact where
 you lose control means. So, a breaker basically is designed
 to stay put for a long period of time such as the branch
 distribution of whatever you have, okay?

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If you have a situation like a bypass breaker like the CB3, there comes a customer who wants to see 50 switchings in test in the factory and wants to see 50 more once it is in store. That means you are exposing -- you are doing so much testing that only -- for instance, on surface security, 6.2 megawatt, 20 modules large system, okay.

I made then change all the fuses after we were doing a finish testing, because we had to show five circuit tests in the factory and five short circuit tests on the -each time you subject a fuse to near melting current it degrades itself, it compromises itself. After one or two months beyond the normal current all of a sudden the fuse goes and you don't know why.

I had this problem. You see, we started the units up and I had what they call modality failures, I lost fuse here and there. With 20 units like almost every day a fuse, I had them change all the fuses. Circuit breakers ditto -- we exercised this General Electric Circuit breakers. We had 52 breakers there, we had to service all 52 breakers after we were doing testing.

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There is a mechanical exercising of a breaker with

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no other -- sometimes doing something to the breaker, okay,
 molded case breaker specifically.

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MR. ROSENTHAL: These aren't molded case.

MR. MACHILEK: They are molded case.

Let me see if I got this. We were 5 MR. ROSENTHAL: 6 following how does CB3 trip, and we decided that you had to 7 close K3 and K3 had to close because Q1 saturated, and Q1 8 saturated off an SSTR signal on this drawing; that the trip 9 light on A14 came on; that the inverter logic light on A14 10 came on that is consistent; but that, none of these lights 11 came on. I thought that we got an under voltage, over 12 voltage light on one of them.

MR. MACHILEK: That was on the A34 board which isthe transfer board.

MR. HESS: That's the horizontal.

16 MR. MACHILEK: The horizontal, yes.

MR. ROSENTHAL: Okay. At some point let's go to
that board and see what turns on that light.

19 MR. MACHILEK: Which one is that?

20 MR. ASHE: The OV/UV.

MR. ROSENTHAL: The OV/UV, the horizontal lights on the upper left-hand side. We can take a break. Let's go off the record.

24 [Discussion off the record.]

25 MR. ROSENTHAL: Can somebody explain just the

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normal path to light these lights, because I am really a 1 2 nuclear engineer and this is not --3 MR. MACHILEK: Okay. MR. ROSENTHAL: I got five volts here to an LED. 4 5 MR. MACHILEK: That is correct. You get -- this б is the 12 volt power supply. MR. ROSENTHAL: I have five volts, right, and five 7 8 volts may be in fact degrading volts, right? 9 MR. MACHILEK: Yes. MR. ROSENTHAL: Plus five though the LED, through 10 the diode to ground -- how? It has to come back through 11 12 here -- no. This is now changed state, right? 13 MR. MACHILEK: Yes. As long as the latch is on, 14 the light is on. 15 MR. ROSENTHAL: Right. This PIN goes from high to zero? 16 17 MR. MACHILEK: That's right. That is correct. MR. ROSENTHAL: This is an inverter? 18 19 MR. POHIDA: Buffer. 20 Just a buffer, okay. Then, what MR. ROSENTHAL: 21 is switch one? 22 MR. MACHILEK: If you put a ground on the --MR. ROSENTHAL: Is this a lamp test? 23 24 MR. MACHILEK: Yes. 25 MR. ROSENTHAL: That's the lamp test. Now, what

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is the story with -- I am sitting at -- this switch is
 normally in this position. I have plus 20, the voltage
 dropped here across the zenar and across the transistor and
 plus 12.

5 MR. MACHILEK: This is at the 20 volts level. 6 MR. ROSENTHAL: That's at 20 and this is at 12 --7 this K1 -- energizer.

MR. ASHE: This is the collector on up through here and that's normally closed, right through here. When this guy saturates K1 --

MR. ROSENTHAL: Which means that contact is open. MR. ASHE: All that's doing is just monitoring the 20 volt supply, it looks like to me. What is it doing other than that?

MR. POHIDA: I think it might just be a delay,
monitoring and then also a delay.

MR. MACHILEK: All this is doing is, you are deenergize K1 if you are testing the lamps.

19 MR. POHIDA: Right, that's all it does.

20 MR. MACHILEK: That's all it does.

21 MR. ASHE: It breaks that and returns back and 22 puts this whole thing back into circuit. The only way to 23 change this guys state is through here, isn't it?

24 MR. MACHILEK: Yes.

25 MR. ASHE: That's ground, so this point has to

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raise or lower in order to get this guy to change in the
 normal.

MR. POHIDA: It just gets around through K1.
MR. ASHE: All it really is doing though, K1 never
changed state and nothing happened down here.
MR. MACHILEK: Your main -- you prevent a reset if
you lamp test, right?
MR. ROSENTHAL: In this case the plus 12 is

9 decreasing.
10 MR. ASHE: I don't know where you get these plus

11 12 and plus 5 decreasing.

12 MR. ROSENTHAL: If the 20 is coming down --13 MR. POHIDA: I think you may not lose your 12 14 immediately. Is there a voltage regulator -- a voltage 15 regulator could hold the voltage about a minute and one-16 half.

MR. RANSOM: It will hold it down to about 13.
MR. POHIDA: You won't necessarily lose your 12
immediately.

20 MR. MACHILEK: We know we went below 16.5 but we 21 don't know how far.

22 MR. ROSENTHAL: The one constant here is the 23 voltage across the zenar.

24 MR. MACHILEK: If that whole circuit wouldn't be 25 in there I don't know why -- all they do is they disconnect

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1 the --this is shown in a discharge position and that means 2 that it is normally open. If he pushes the lamp button he 3 grounds the reset, right?

4 MR. ROSENTHAL: I guess the question is, what 5 would have happened --

6 MR. MACHILEK: That's the lamp button. This 7 prevents you from unstoring the lamps if you make a lamp 8 test.

9 MR. ROSENTHAL: The only issue that we heard 10 postulated was did K1 -- did this relay change state.

MR. MACHILEK: It didn't unlatch the latches, because we would have lost the lamps which are held by the latches.

14 MR. ASHE: Actually, the only purpose of that 15 relay is after you do a lamp test --

MR. MACHILEK: If you have an alarm when you do a lamp test you don't want to unlatch the latches because after you let the lamp test go you want to have the same alarm still there.

20 MR. ASHE: It seems like if you are going to try 21 to build an argument around here that some kind of way you 22 reset these guys due to this decay of voltage here, then why 23 didn't you reset these guys up here when they originated? 24 MR. ROSENTHAL: That's what the two of them are

25 saying. There is no other latches up there on these.

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MR. MACHILEK: No, sir. This goes directly to the 1 lamp and to the ground. You have the A14 to show them? 2 MR. HESS: Right here. You want the print? 3 4 MR. MACHILEK: Yes. Which one was it, UPS trip, right? 5 MR. MACHILEK: In order for that light to be on 6 MR. ROSENTHAL: two hours later, I need the logic to not have changed state 7 8 and the power to have been restored. 9 MR. ASHE: Right. I need the logic -- for 200 10 MR. ROSENTHAL: milliseconds you need the power back to 200 milliseconds. 11 Ι 12 need the logic not to have changed state. MR. ASHE: Right, okay. 13 14 MR. ROSENTHAL: When I get down on the 12 volt level here with the regulated power supply, are we 15 16 postulating that this 12 volt in fact didn't degrade in the course of the 200 milliseconds. 17 18 MR. MACHILEK: I had hoped that the generator logic during this subsequent tests, that we will get an 19 20 abnormal lamp indication pattern of some sort. 21 MR. ASHE: To suggest something is wrong with --22 MR. MACHILEK: I had hoped, because I was --MR. ASHE: Possible explanation. It didn't 23 24 happen. MR. MACHILEK: No, we couldn't make it happen, 25

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2	MR. ROSENTHAL: Unfortunately, if I had it to do
3	over again, I think I would have gotten 12 dual trace
4	oscilloscopes from the plant when we were doing this test
5	and we didn't, for better or worse.
6	MR. IBARRA: Do you mean the tests that you all
7	have done?
8	MR. ROSENTHAL: Up at Nine Mile.
9	MR. MACHILEK: We tried to reset out of I don't
10	know if we took the logic off for a long period of time, I
11	don't know. If the logic was we turned the logic down to
12	like 50 volts and let it sit there.
13	MR. ASHE: That's right.
14	MR. MACHILEK: For a considerable period of time.
15	MR. ASHE: That was done on 1C and 1D.
16	MR. MACHILEK: Tried to have a transient behavior
17	off it.
18	MR. ROSENTHAL: Frank, you saw a test in which
19	they had fresh batteries and lifted the 110 volt AC lead.
20	MR. ASHE: Fresh batteries and they switched.
21	MR. ROSENTHAL: It was a test in which the logic
22	was living on the fresh batteries a couple of minutes.
23	MR. ASHE: No. There was some decrease of 120
24	volts down to the break fault in which the power supply no
25	longer regulates, which is about 96. Up until about 96

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volts the power supply tends to regulate pretty -- very good
-- and held it up there 19, 20 or something. Below 96 volts
it dropped off very rapidly.

With fresh batteries it tended to stabilize and still hold it up but it was decreasing, but it still held it up.

7 MR. MACHILEK: It goes from 2.15 down to two volts 8 per cell. You cannot have more than open circuit voltage on 9 the discharging battery.

MR. ASHE: That was the question that I wanted to ask. How much current does it take at 20 volts to drop this logic; does anybody have any idea?

MR. MACHILEK: Oh, yes, sir. I measured that when 13 I got back. When the unit was not running and wasn't 14 energized, the positive through 1.14 -- between 1.14 and 15 The negative had .283 or three-tenths of an amp. 16 1.17 amps. 17 When the unit was running the positive through 4.44 amps and that was under no load. The negative through 1.084 amps and 18 then we loaded the module full load. The positive stayed at 19 4.44 amps and the negative went from .084 to .092, which 20 means that loading or not loading the module has no bearing 21 22 on that.

23 MR. ASHE: Could you go back to the no load case. 24 You first started off with no loaded it was 1.1 --25 something. Positive was what?

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MR. MACHILEK: With the unit not running. 1 2 MR. ASHE: Yes. 3 MR. MACHILEK: One point one four. 4 MR. ASHE: One point one four. MR. MACHILEK: Amps positive and .283 on the 5 negative. 6 7 MR. ASHE: Okay. Then, you went with the unit running. 8 MR. MACHILEK: Yes. We started the unit up under 9 10 no load, and through the output was 4.44 amps on the 11 positive and 1.084 on the negative. Then, running. 12 MR. ASHE: 13 MR. MACHILEK: Then, with loaded --14 MR. ASHE: Loaded. 15 With loaded it had the same current MR. MACHILEK: on the positive and the negative was 1.092. I don't know 16 17 that anything had changed. the question is, what would have happened --18 That's the lamp button. 19 The relay, I placed it at really K-5 and found --20 21 per the data sheets, it should drop off between 65 and 20 percent, which means between 78 and 24 volts. Once we saw 22 on the lower end, I believe 45 volts were lost. 23 24 The 120 volts, if we applied a ratio of 200 25 kilovolts to 80 kilovolts, somehow we can theorize that the

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**z** - 1 s ' 120 volts went down to 50. The one relay we tested was at
 45. So it would have stayed in at 50. The power supply
 input lost regulation at 96 volts and it would trip itself
 off at 84 volts.

5 Considering all the tolerances, it could trip 6 between 86 and 78 volts, depending on the control feature, 7 depending on the tolerance of the control. On the output, 8 the 16.5 volts is adjustable between 17.3 and 15.7. The 9 last observed state on the C unit, it tripped at 16.9.

MR. ASHE: How often is that adjustment made? You have no idea?

MR. MACHILEK: We check that adjustment at every MR. MACHILEK: We check that adjustment at every PM, at every maintenance, preventative maintenance check. I don't know how steady -- does it change?

15 MR. RANSOM: No.

MR. ROSENTHAL: What do you mean by everypreventative maintenance check?

18 MR. MACHILEK: Under normal -- if we have a 19 maintenance contract.

20 MR. ROSENTHAL: What I'd like to do, whenever 21 you're ready, is to take one of the lights that did go on 22 and see how that would go on by design.

MR. ASHE: Right now. He wants to -MR. ROSENTHAL: I'm sorry. It went to the D?
MR. ASHE: No, no. We went through all of how you

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get to CB-1, CB-2 and CB-3. 1 2 MR. ROSENTHAL: Which is the UPS that they went to 3 first? 4 MR. ASHE: 1-C. MR. ROSENTHAL: 1-C, not 1-D. 5 MR. ASHE: In testing. 6 MR. ROSENTHAL: No, no. When they --7 MR. ASHE: 8 1-D. MR. ROSENTHAL: 1-D. 9 10 MR. ASHE: Yes. MR. ROSENTHAL: So let's go look at 1-C and some 11 light was reported lit. 1-A, 1-B, 1-C. And then let's 12 13 follow that backwards. 14 MR. ASHE: Which is what we've already done, I 15 think. No. Wasn't any of these lights 16 MR. ROSENTHAL: lit? Not these. On the other -- on the horizontal --17 18 there's a --19 MR. ASHE: On the A-34. MR. ROSENTHAL: On the A-34 board, there is some 20 21 light that gets lit. 22 MR. ASHE: Is that UV/OV? 23 MR. ROSENTHAL: UV/OV. MR. ASHE: The as-found data, I gave that to you 24 the other day. You have it. No. The as-found data sheet, 25

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which really is right there, too. It's the same thing. 1 It's 1-C. 2 3 MR. ROSENTHAL: 1-C, 1-G. So the OV/UV light on -4 MR. MACHILEK: On C, on D and on G. 5 MR. ROSENTHAL: Okay. So why don't we go to that 6 light on the A-34 board and see what turns that on. If 7 somebody has a better suggestion, I'll listen. 8 9 MR. HESS: We're here. Go ahead. MR. ROSENTHAL: No, no. We'll do it. 10 If you look at 1-D, you'll see 11 MR. MACHILEK: Wouldn't that suggest that this one is on A-34? 12 ov/uv. That would be A-21, right? 13 MR. RANSOM: That is an alarm on A-34. 14 15 MR. MACHILEK: This would indicate that it did, in fact. 16 But that's a suspect, Rudi. I think 17 MR. TERRY: 18 it would be better to go any of the other four. MR. JOHNSON: It obviously didn't transfer, 19 20 because they did it manually. That's just strictly recollection. 21 MR. TERRY: MR. MACHILEK: You've got the A-34? 22 MR. HESS: Where were we? Out put OV/UV? 23 MR. MACHILEK: OV/UV. It comes from a rectifier 24 Simply a level detector, that's all it is, 25 here.

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adjustable. BCCA/AB and we're feeding that into a level 1 2 detector, come out to the lamp. MR. ASHE: What's feeding in here now? 3 MR. HESS: Critical bus loads. 4 MR. ASHE: What is that? I mean what senses that? 5 6 Just a resistor --7 MR. MACHILEK: Voltage transformer. MR. ASHE: A voltage transformer. 8 MR. MACHILEK: Direct input from the voltage 9 10 transformer. 11 MR. ASHE: Okay. Direct input from the That's really simple then. 12 transformer. It's pretty straightforward. Yes. 13 MR. MACHILEK: You do the same with critical bus and bypass and compare the 14 two and that is the difference. 15 MR. ASHE: How the hell does that get there? 16 You come in through the --MR. MACHILEK: 17 I'm coming through there, through here, 18 MR. ASHE: I've got you. Okay. I've got you. Through the base of 19 this and then the collector. Okay. 20 21 MR. HESS: I saw it before. 22 MR. MACHILEK: They are difficult to follow. Is the rest of these things like this, 23 MR. ASHE: 24 just pretty much --MR. MACHILEK: 25 Yes.

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Through these amplifiers and gates? 1 MR. ASHE: 2 MR. MACHILEK: There is no complicated circuitry involved, none which might be considered in today's computer 3 age, microprocessors. 4 5 MR. ASHE: This would be lost, though, if this 6 condition corrected from here. If it works, yes. 7 MR. MACHILEK: 8 MR. ASHE: In other words, whatever triggers this input, if that goes back to the norm, this light goes out. 9 10 It might be broke, I don't know. MR. MACHILEK: 11 MR. RANSOM: The critical bus goes bad. So that's why they came down and saw the lights on, because that 12 13 condition existed. 14 MR. ASHE: I don't know if I followed you. 15 MR. MACHILEK: If the maintenance bypass goes away, this goes away. Of course, you have a voltage 16. difference, right? 17 18 MR. ASHE: Right. 19 MR. MACHILEK: More than plus/minus. MR. ASHE: You're saying go away, but you don't 20 21 mean that. If the maintenance bus has degraded. 22 MR. MACHILEK: Same thing. If it goes down to 50 volts from 120. 23 24 MR. ASHE: Okay. Right. Your point was what,

25 now?

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MR. RANSOM: When the unit shut down, it flipped
 off. It didn't close the bypass breaker.

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MR. ASHE: Right.

MR. RANSOM: Which meant your critical bus voltage was zero volts. So if you're looking at the critical bus and the bypass switch then returned, you have the voltage difference.

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MR. ASHE: I've got you.

9 MR. MACHILEK: Each time you have a discrepancy 10 between the presence of the two voltages, yes, you get that 11 lamp.

12 MR. ASHE: So in theory, that should have been on 13 all five units.

MR. MACHILEK: Depending on when you looked at it because it's not latched. It's just a lamp. As soon as you bring the unit up and the output becomes available --

MR. ROSENTHAL: This data was taken at two hoursinto the event.

MR. MACHILEK: Consider the following. There were three different teams going down in a two-hour period. They all did something, right? They first ones did something, the second ones did something, the third ones did something.

Now, if you take all the accounts and you really go through with a fine-toothed comb, then selectively you can say that one makes sense, it's probably good, this one



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doesn't make sense, it's probably no good. Now, as soon as
 you do a selectivity in what is believable and what not,
 then you have to say I believe nothing or I believe
 everything.

5 But you cannot make a point either way in order to 6 support yourself or convince yourself of something, saying, 7 yes, you know, this is probably the right thing which was 8 recorded here, this one doesn't make sense, it's probably 9 not right.

We are talking about idiosyncrasies here, something which we believe cannot happen, but yet we accept that it did happen. With the knowledge and experience we have, we'd walk away from it and say, hey, forget it, it never can happen. But all we can say is to the best of our knowledge and ability, to analyze it or to duplicate it. We cannot make it happen.

MR. ROSENTHAL: Frank, the OV/UV on the A-34, the
horizontal strip of lights, doesn't latch.

MR. MACHILEK: No, sir. It's not an alarm. It's
only an indication. It's a status indication.

21 MR. ROSENTHAL: Okay. Is it possible that people 22 are confusing OV/UV on the A-34 board with the under-voltage 23 with the lights on the A-21 board? There's an under-voltage 24 fast and an over-voltage light. Those are separate LEDs on 25 the A-21 board, right?

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MR. MACHILEK: Okay. The under-voltage fast is 1 2 not in operation. It's only for parallel units. The ACO voltage would lock, yes, sir, but it doesn't trip. 3 MR. ROSENTHAL: But it doesn't --4 5 MR. ASHE: Wait a minute. Why do you say it 6 doesn't trip? MR. MACHILEK: It would transfer, right? 7 8 MR. ASHE: It looks like to me it sends a signal 9 to the same place. 10 MR. ROSENTHAL: If I detect an under-voltage here 11 MR. ASHE: I'm sorry. He's right. You're right, 12 you're right. No, it doesn't go to the same place. It 13 14 doesn't trip the unit. Over-voltage doesn't trip the unit. Wait a minute. Over-voltage --15 MR. ROSENTHAL: I'm sorry. Over here, here, here, this gate, this buffer, 16 over here, up here, to here. Okay. It gives you a light. 17 18 MR. MACHILEK: It gives you two lights. MR. HESS: That's the trip over here. It gives 19 you light over here. 20 MR. ROSENTHAL: That's a trip light and that's a 21 logic light, but here is the actual trip. I'm sorry, I'm 22 being slow. 23 MR. MACHILEK: But you will get a transfer on the 24 A-34, which again cranks into the one because it opens the 25

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CB-3 eventually, the output after you have confirmation that
 the CB-4 has failed.

3 MR. ASHE: If you put full amp load on the three
4 D-cell batteries, what is the load --

5 MR. MACHILEK: It goes through immediately and 6 from then on it decreases commensurate with the state of 7 charge. It's fully charged.

MR. ASHE: But you've actually tested it.

9 MR. MACHILEK: Well, I hope they did. They put 10 new batteries in it and let it run for a while.

MR. ASHE: No, no, no, no, no, no. I'm saying outside the unit, we reconfigure 3 D-cell battery packs, just like the plus or minus 20. Take an oscilloscope or something, put a full amp load on there and watch the voltage. Nobody's done a test like that, to your knowledge, right?

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MR. MACHILEK: No.

18 MR. ASHE: But they should be able to have full 19 amps in a very short period of time, no problem, right, 20 fully charged?

21 MR. MACHILEK: It should hold it for a minute. 22 MR. ROSENTHAL: I'm sorry. The under -- you said 23 one of these is not on that unit, under-voltage or over-24 voltage?

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MR. HESS: I think you're talking about the

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1 parallel lights, the AC/UV fast.

2 MR. MACHILEK: What about it? MR. ROSENTHAL: It's not on the units there. 3 MR. MACHILEK: No, sir. No. This is only for 4 5 parallel operation. 6 MR. ASHE: The under-voltage is the one that's not 7 there. They only thing they've got is the over-voltage. MR. ROSENTHAL: Could this have been on? What 8 9 would have made the over-voltage? MR. MACHILEK: Well, we had the other problem. We 10 11 had a decrease in voltage, not an increase. I don't think 12 if you short a transformer you'll get much of an over-13 voltage on it. 14 MR. ROSENTHAL: Okay. Let's pick another light that they're reporting. OV/UV doesn't latch. 15 16 MR. MACHILEK: It's a status indication. 17 MR. ROSENTHAL: OV/UV transfer. Voltage 18 difference. 19 MR. ASHE: Am I saying something wrong here? I'm not saying anything wrong, right? 20 MR. MACHILEK: No. If you have -- I don't 21 22 understand -- we have a transfer? MR. ASHE: Transfer went on the same diagram. 23 24 It does latch. MR. RANSOM: MR. ASHE: Wait a minute. It does? Okay. A11 25

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1 right. He's right.

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2 MR. MACHILEK: That latch is the -- if you do 3 transfer, you maintain that.

4 MR. RANSOM: It won't stop the unit from running,5 though.

MR. MACHILEK: No, no, no, no.

MR. ROSENTHAL: OV/UV transfer.

8 MR. MACHILEK: If it helps the statement, you can 9 take the A-34 out of the module and the module runs. It's 10 strictly a bypass control. It has nothing to do with the 11 operation of the module itself.

MR. ASHE: I think what Jack is trying to get to is a possible explanation for these lights. I think that's where he's going with this.

MR. MACHILEK: On the A-34, the only lamps which you want to have stored is that a transfer has taken place or a transfer command was given. The rest are status indications, saying that one voltage or one frequency is different from another one. But if that condition would go away, then the lamp would go away.

21 MR. ASHE: Why didn't this show up on all the 22 units, then?

23 MR. MACHILEK: It depends when you look at it, 24 what the exact situation was. Was the maintenance voltage 25 there or was it not there. Of course, once you try -- once

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a module goes on the internal oscillator, then it drifts 1 away from the bypass. Different speeds, it can stay there 2 or it can drift off. It's really hard to say. 3 MR. ASHE: These reset bus tables, they're just 4 5 dual in-line pin ICs, right? 6 MR. MACHILEK: Which ones? 7 MR. ASHE: The reset bus tables, they're latching 8 9 MR. MACHILEK: Latches, yes. MR. ASHE: How many, eight pin, 16-pin, dual in-10 line pin? How many is on a one --11 12 MR. MACHILEK: Twelve. Twelve on one guide, right? Close, 13 MR. ASHE: 14 some number thereabouts. 15 MR. RANSOM: Twelve of the actual devices? 16 MR. ASHE: No, no. It would have to be 14 or 16. 17 MR. RANSOM: MR. ASHE: Sixteen. In terms of reset modules on 18 19 that device, there's probably four. 20 MR. MACHILEK: Yes. 21 MR. RANSOM: Yes. Sounds about right. 22 MR. ROSENTHAL: What's the voltage difference? It means that the output voltage of 23 MR. MACHILEK: the module, that the bypass voltage and the critical voltage 24 is different from each other. 25

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MR. ROSENTHAL: Does that latch?

MR. MACHILEK: No, no, no. It's an indicator. 2 It's like two volt meters to tell you what they are doing. 3 MR. ROSENTHAL: The voltage difference is that 4 light. 5 MR. MACHILEK: Yes. It comes and goes as the 6 7 situation changes. MR. RANSOM: These two phases. 8 MR. ASHE: So that's AB phase, right? 9 MR. MACHILEK: AB and -- all three, sum it up, put 10 an average to it and look at the DC signal, the level to 11 12 take that. MR. ROSENTHAL: They are saying that when they 13 went down to look at two amps, they saw an OV/UV light, and 14 we're saying that there's no latch, it's got nothing to do 15 16 with what happened at T-zero. 17 MR. MACHILEK: Right. It's only an assumption to 18 do at the time you look at the light. MR. ROSENTHAL: The voltage difference, same 19 20 story, right? And the OV/UV transfer does latch. MR. MACHILEK: It will tell you that you did, in 21 fact, get a transfer signal, which is strange, though, 22 because if you do get a transfer signal, if the transfer is 23 24 not executed, then you get a transfer fail alarm, which wasn't there. 25

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It's almost as wierd as if you switch the lights
 on in your car and the horn comes on.

MR. ROSENTHAL: I had something like that and the stalk to the multi-function lever switch is a cable that runs down inside the steering column, and it had abraded the insulation and depending on just where the vibrations were and whatnot, as you turned this on north, it would occasionally -- the wipers would come on when you turned the lights on, etcetera.

They had to pull the steering wheel. It cost me 11 100 bucks for a guy to pull it apart to put a piece of tape 12 on it because they addresed the leads wrong. That was an 13 inadvertant or a sneak circuit, right? And what's the 14 parallel here?

15 MR. MACHILEK: I don't know.

MR. ROSENTHAL: But there's a sneak circuit. MR. MACHILEK: But if we want to investigate for a possible problem of that sort, it would be -- what my problem is, it's an atomic power plant and all the things have -- it was a multiple happening at the same time. Any one of the happenings by itself would not have done anything.

The shorting of the transformer would not have bothered anybody. The batteries dead, by themselves, wouldn't have bothered anybody either. You see what I mean?

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MR. ASHE: Let's backup now.

MR. MACHILEK: What was the coincidence of the 2 3 dead battery and the loss of the Phase B. If you would have 4 lost A or C, nothing would have happened. So dual failure. It's inconsistencies in the reporting of lamps. 5 6 MR. ASHE: Let's flip that around. Let's say 7 fully charged batteries and take the same scenario. MR. MACHILEK: Nothing happens. I wish I could 8 throw a --9 MR. ASHE: Are you saying with fully charged 10 batteries, the same Phase B short, this unit would have 11 12 stayed up, the five units would have stayed up. MR. MACHILEK: Yes. For the 12 cycles or whatever 13 14 it was, for sure. But this can be tested. This can be 15 proven. It's not -- we don't have to rely on anybody's opinion here. This is very provable. 16 17 The only suggestion I felt was a good one is to switch the relay coil. 18 19 MR. ASHE: Correct. 20 MR. MACHILEK: So that I'm going to inverter right 21 away and I prevent switching later on. Are we covering all 22 the bases with that? No, we don't, because if you lose one power supply and you do not have a bypass at the time, it's 23

not in sync or God knows what, then you still would lose the

25 load. See what I mean?

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I want to make this 100 percent clear. That
 change improved the situation as far as that scenario is
 concerned.

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MR. ASHE: Sure.

5 MR. MACHILEK: A different scenario with different 6 combinations of problems at the same time could still get 7 you in trouble.

8 MR. ASHE: Yes. The fix is also dependent on the 9 inverter's voltage either being there or not there.

MR. MACHILEK: Also, I want to mention that if the AC/DC converter in the other unit goes bad, you've had it. You see what I mean? You lose it right away. Single point failure. Just damned lucky that it never happened. Now, we are not talking about --

MR. ROSENTHAL: We have had individual 1-E
inverter, the losses of the --

MR. MACHILEK: If you lose the power supply, and this is why we never considered a AC/DC converter, for that reason. It's a single point failure. We could not qualify it with the Army, Navy or Air Force because we can't get away from this single point failure syndrome.

If you lose that AC/DC converter, the logic goes away and you crash and you lose your output load.

24 MR. ASHE: You mean the Army has none of these 25 other kind of inverters?



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MR. MACHILEK: The old ones.

2 MR. ASHE: No, no, no, no. The one with the DC 3 converter on it.

4 MR. MACHILEK: No, I don't say that. I said we 5 could not qualify it.

6 MR. ASHE: In your case.

7 MR. MACHILEK: Yes.

MR. ASHE: In your case.

9 MR. MACHILEK: No. The Army has a lot of things, 10 but so does everybody else because a lot of things are being 11 purchased on the open market by a local distributor, low 12 bid.

MR. ASHE: It's bench stuff, right?

MR. MACHILEK: One of the reasons why the armed forces particularly liked this type of equipment was because everybody can fix it and we teach you how to. We have a course which teaches you every circuit down to the component leave, not only the subassembly level.

That means if you really want to understand our particular system, come down to Raleigh and go to school. Every circuit, every component, we teach you what it's doing, why it's doing it, and how it is doing it and what it is. We have no secrets there at all.

24 MR. ASHE: Some of the people from NOM now have 25 gone down to the school you're talking about, right?

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MR. GRADY: We haven't been able to find out who they were.

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MR. ASHE: Okay.

MR. MACHILEK: The ones which are still around haven't been there. But if you really want to understand it, you'll need two weeks -- a three-week course and you'll know as much as we do.

8 MR. ROSENTHAL: Let me take an aside before I come 9 back to this. We have seen random failures of converters 10 which we have attributed to pre-conditioning due to 11 temperature. But you don't expect five to all go at the 12 same time due to that sort of problem.

Nevertheless, since we're thinking about the logic, let's talk about temperature for just a second. The over-temperature trips of this unit, I take it, are really on the heat sink temperature.

MR. MACHILEK: Right.

18 MR. ROSENTHAL: The chips there are -- they're not 19 mil spec ships, they're just chips, high quality chips.

20MR. MACHILEK:70 degrees C logic.21MR. ROSENTHAL:70 C?

22 MR. MACHILEK: Yes, sir.

23 MR. ROSENTHAL: Centigrade.

24 MR. MACHILEK: Yes.

25 MR. ROSENTHAL: 70.

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1 MR. MACHILEK: 70. Which means that if you have a 2 40 degree C inlet temperature and a 15 degree C internal 3 device, this is what our design criteria is. You have 55 4 degree logic. Because that unit is that tightly packaged, 5 we have a separate blower on the controller itself.

6

MR. ROSENTHAL: On the card cage.

7 MR. MACHILEK: Yes. Which the other units do not <sup>8</sup> have. Only the single cabinet has that and the 60-KW is the 9 only one we have in a single cabinet. Once you go to the 10 100-KW, you have two cabinets. It's much looser packaged.

The problem with the 60-KW is that you need an air exchange. You have to get the PTUs away from the module. It has a tendency that the air does not want to readily come out and simply dissipate. So we specify if we install it or if somebody asks, three times an hour air exchange, which isn't all that much.

The Army, for instance, or the Navy, if they don't use air conditioning, they have a plenum on top and suck the unit, exhaust the -- and the plenum has a little blower which makes up for the static pressure which is generated. But the reason why you don't get the heat out of the units is because there is really nothing which makes the heat come out.

24 Simply the temperature difference between the 25 inlet and the outlet, the blowers which are in there are

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really not blowing, if you want, or transporting the heat 1 away from the unit. 2 3 MR. ROSENTHAL: Now, the little batteries, the 4 four-year is based on 77 --MR. MACHILEK: 77 degree format, yes, sir. 5 6 MR. ROSENTHAL: And it's hotter than that in 7 there, isn't it? MR. MACHILEK: Well, depending on the inlet air 8 9 temperature. One evening we were there, I would say it had 10 probably 80 degrees in there. MR. ASHE: 80 degrees in where? Where the 11 12 batteries are located? In the room itself. 13 MR. MACHILEK: MR. ASHE: I was in that room and I would say it 14 15 was over 100 degrees in the room itself. I think that was their problem at that time. The chillers or something like 16 17 that. Most times, it was probably --MR. IBARRA: It was hotter than 80 at any time. 18 MR. MACHILEK: But you have a 15 degree C internal 19 The filters were immaculately clean, so I don't 20 device. 21 know if they have been recently changed. 22 MR. ROSENTHAL: Apparently that is in the PM 23 program. They were really -- I mean, 24 MR. MACHILEK: Yes. there was not a speck of dust in any of them. That was the 25

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first thing, when I felt the one panel, I said to myself
 maybe that I had filter obstruction. There was none.

MR. ROSENTHAL: Whether it was the original design intent or not, to me, is irrelevant. What I'm seeing is that for certain scenarios, the little batteries do play an important role.

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MR. MACHILEK: Yes, sir.

8 MR. ROSENTHAL: And I don't have your design 9 change memorized, but I am under the impression that they 10 would continue to play as important a role, if not more 11 important.

MR. MACHILEK: Shouldn't play a more important role now. The reason why I'm saying that, while you're on bypass, you've got to have the load on bypass before you start up the inverter. So the load is on bypass and so is your power supply. Now you are ready to transfer. You bring up the module and run it.

As soon as the inverter output voltage becomes available, it switches over. If you cope while you are switching over, no problem because it's on purpose. So you just have to fix it and then switch it over.

22 Once you are on inverter output, you don't need 23 the battery no more.

24 MR. ASHE: You go to the face plate. You take 25 that little switch and you put it in auto restart. Now the

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unit goes off the inverter. For whatever reason, it 1 2 transfers. Okay. 3 MR. MACHILEK: MR. ASHE: You're in auto restart. 4 5 MR. MACHILEK: Yes, sir. It's going to try to go back. MR. ASHE: 6 7 MR. MACHILEK: Okay. MR. ASHE: The batteries have got to play a role. 8 9 MR. MACHILEK: Then you stay on bypass, you get in a RAM. 10 You know about it if it did make it. 11 MR. ASHE: MR. MACHILEK: Yes, but it doesn't bother you. 12 You do not lose the load. 13 If the batteries were dead --14 MR. ASHE: 15 MR. MACHILEK: You're on bypass already, right? No. He's saying you're sitting 16 MR. ROSENTHAL: running with dead batteries. You now have a fault in the 17 inverter. Your logic has to stay up long enough to execute 18 the transfer to the maintenance supply. 19 MR. MACHILEK: But the UPS does not fail in 20 21 decreasing its output voltage. MR. ASHE: It has to go down to some value, right? 22 Wouldn't it go down to some value? 23 MR. MACHILEK: If an UPS trips, it's gone. 24 25 MR. ROSENTHAL: At least it's more apparent

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1 failure modes.

MR. ASHE: What's the purpose of auto restart and 2 three tries to go back onto the inverter, then? 3 MR. MACHILEK: This is if you want to go from the 4 5 UPS to bypass. MR. ASHE: No, no, no, no, no. Auto restart means 6 7 you're going from the maintenance supply back to the 8 inverter, right? 9 MR. MACHILEK: Okay. MR. ASHE: I'm putting you in the same scenario as 10 11 you starting up the inverter. MR. MACHILEK: Yes, sir. 12 MR. ASHE: Now, how do you get around the 13 14 batteries? 15 MR. MACHILEK: You're on bypass, okay? 16 MR. ASHE: Yes. MR. MACHILEK: You want to auto restart. 17 18 MR. ASHE: Right. MR. MACHILEK: Now you give a command to go back 19 20 to UPS. 21 MR. ASHE: Right: MR. MACHILEK: You have no logic to do it with. 22 MR. ASHE: Are you saying the inverter output is 23 going to come up instantaneously? 24 25 MR. MACHILEK: No. Whenever it comes up, you

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switch over to inverter. If it doesn't come up, then you
 don't.

MR. ASHE: No. But the thing is it's not going to
come up instantaneously. It's going to be a ramp-up, right?
MR. MACHILEK: Okay.
MR. ASHE: So that's going to put you right back

7 to where you were starting up.

8 MR. MACHILEK: No. You're going upwards in 9 voltage, you don't come down.

MR. ASHE: Yes. I know you're going up, but there is a latch-up before that K-5 is going to pick up. It's got to be.

MR. MACHILEK: Yes, but the K-5 is on bypass all
the time.

MR. ASHE: K-5 is deenergized the way it is now, 16 right?

MR. MACHILEK: The supply to the power suppliescomes from the bypass.

MR. ASHE: Yes, but when you flip to -- when you deenergize K-5, you reroute to supply. K-5 is deenergized. When you energize, it's from the inverter, right?

22 MR. MACHILEK: Correct.

23 MR. ASHE: So it means that when you're coming up, 24 unless the inverter brings it up instantaneously, the 25 battery is going to have to hold it a little bit while it's \* 1 . · • • • t • 

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1 making the switch, right? Wait a minute. Am I making 2 myself clear? Is that right?

3 MR. RANSOM: I understand what you're saying. You 4 transfer it off-line to an auto restart. The module shuts As the inverter tries to come up, as the inverter's 5 off. 6 making potential as it goes through the neutral point, the 7 relay is going to try to pick up, at which point the batteries have to be there to handle the switch-over, just 8 like if you had a utility failure previously. Then the 9 10 control batteries will trip off. We tested it with the 11 control batteries. We put the .6 volt back in and tried it.

But, like you were saying, you were in bypass, so at that point, all you then have to do is find the -- it tries to come up and when it goes to switch over and shuts down again. You know there's a problem at that point, but you're not jeopardizing your load because you're in bypass.

17 MR. ASHE: Right. But I observed most of the 18 units, as I observed, were in the auto restart mode, for 19 whatever reason.

20

MR. MACHILEK: It wouldn't bother you.

21 MR. ROSENTHAL: When we were looking at whatever 22 drawing has the power supplies on it, the logic power 23 supplies, and we were looking at the battery discharge light 24 and the continuity battery discharge off-light or whatever 25 you call it, it's clear to us that that really isn't

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monitoring the battery while it's in standby, but rather 1 simply what's happening to the battery if the power supply 2 3 fails.

4 MR. MACHILEK: It really monitors the power 5 supply.

6 MR. ROSENTHAL: It monitors the power supply. 7 So if they --Okay.

MR. MACHILEK: Once the power supply is gone, then 8 it monitors the battery. 9

MR. ROSENTHAL: Yes, yes. Well, I'm sure that 10 these will be the most watched batteries in the nuclear 11 12 industry. Okay. But they're running at some elevated temperature relative to that which you would associate with 13 their four-year life. 14

What kind of advice can you provide them on what 15 to do with the batteries and when to change them out? 16 17 If you do a full-blown maintenance MR. GRADY: 18 program on the system, then that's something you would We are shifting through our paper right now, so bear 19 check.

20 with us for a second.

MR. MACHILEK: Our contracted maintenance 21 22 programs, we do it every half-a-year, check the batteries. 23 MR. ASHE: Every six months, check it out. What do you do, a load test on it? 24 25

MR. MACHILEK: Yes.

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That means you pull 1 MR. ASHE: Actual load test. them, do a load test and if it passes, you put it back. 2 3 MR. MACHILEK: Correct. 4 MR. ASHE: Okay. MR. MACHILEK: There is unfortunately no other 5 6 way. I'm just trying to understand. 7 MR. ASHE: MR. MACHILEK: We have a lot of installations, 8 rather than go through a load test, we exchange the . 9 batteries every half-a-year. 10 MR. ASHE: Frankly, I think that's --11 12 MR. MACHILEK: It cost you less money to stick in 13 six D-cells. 14 MR. ASHE: Yes. Then it's a replacement program 15 rather than testing. MR. ROSENTHAL: Okay. Well, look. This is a very 16 expensive meeting and we have all the people here. How can 17 we learn the most about this thing, what's -- did we decide 18 Let me go back to the basics. 19 -- okay. I decided that the -- we know that the circuit 20 breakers changed states, CB-1, 2, 3, and we decided that you 21 22 had to change K-1, 2, 3 on that first drawing we looked at. That was the only way to do that. Then we decided that that 23 meant that you had to change the state of Q-1, Q-2, Q-3 on 24 25 the third drawing that we looked at.

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1 MR. MACHILEK: Right. 2 Then we followed back one way of MR. ROSENTHAL: 3 changing the state of those power transistors was by 4 detecting a low voltage on the output of the larger power 5 supply, and we traced that all the way back. MR. MACHILEK: Right. 6 7 MR. ROSENTHAL: Let's go back to Q-1, Q-2, Q-3 and say how else does this change its state, unless somebody 8 9 else has a better idea. 10 MR. MACHILEK: How many ways are there to turn on 11 a transistor who is between ground and the voltage. 12 MR. ROSENTHAL: Where's the drawing? We've got it out here on the table someplace. If you could advise me on 13 a better thing to do with the next few hours, let me know. 14 15 MR. MACHILEK: The fact that the signal which made it happen was latched and confirmed, I see -- it did turn 16 17 on, right? The breakers tripped as a response to it. 18 MR. ASHE: Right. I think what he wants to do, 19 though, is to back up. What other ways can we get that 20 other -- we know we can get it on loss of logic DC power, if the power decreases below the trip set point. 21 22 How else can Q-1 be turned off is what he's trying to get to, I think. 23 Turned off, you mean tripped? 24 MR. MACHILEK:

MR. ASHE: Well, the thing is -- I think we agree

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1 -- we had to saturate these guys to pick up the relay coil.
2 Normally, they're sitting there, they're all cut off, and
3 then we trace through everything. But now what I think he
4 wants to do is how many other ways, other than low DC logic
5 power, can this thing be saturated. So do you want to trace
6 all of those guys?

MR. MACHILEK: All those ones which go in here.
MR. ASHE: Right. But I think he wants to trace
9 it to everything on the drawing.

10 MR. ROSENTHAL: Is there a remote load dump? I 11 read it in your manual.

12MR. MACHILEK: No, no, no. The load dump is --13MR. ROSENTHAL: Like for a computer.

MR. MACHILEK: -- if you want to dump your load.
MR. ROSENTHAL: Right. But it would be -- right.
But it is not installed on this unit.

17 MR. ASHE: Are you going to let us have a copy of 18 that?

MR. MACHILEK: Well, they've changed it around.
 MR. ASHE: That's right. By the way, you have a
 final report, though, addressing most of this stuff.

22 MR. MACHILEK: Yes. Yes.

23 MR. ASHE: That's all right.

24 MR. ROSENTHAL: I think what we will do is we will 25 ask Nine Mile for a report from Exide.

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133 1 MR. ASHE: That's already done. It will be 2 finalized within the next day or so. 3 MR. ROSENTHAL: Okav. MR. ASHE: Basically, that chart with all of those 4 5 chips on there will be in that report, right? 6 MR. MACHILEK: Yes. 7 MR. ASHE: That's the key, I think, to what is really -- what we're going through. 8 9 MR. ROSENTHAL: If we just trace that out. Input breaker control, that's a physical switch on the breaker, 10 11 unlike the -- is it racked in? 12 MR. MACHILEK: Input breaker, it would be a toggle 13 switch which would be in here, which would automatically 14 switch the breaker on. Yours is manual. 15 MR. ROSENTHAL: Battery breaker control, and you 16 don't have it here. 17 MR. MACHILEK: No. It's manual. MR. ROSENTHAL: I'm sorry. So this is like a 18 19 universal board, as you were saying earlier. 20 MR. MACHILEK: Yes. MR. ROSENTHAL: So are these contacts now 21 22 floating? 23 MR. MACHILEK: It depends. MR. ROSENTHAL: Tied higher, tied lower. 24 25 Whatever the circuit will MR. MACHILEK: Yes.

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You cannot make it work without that. It depends if 1 take. 2 the signal is lower or higher. 3 MR. ROSENTHAL: What is this RCR-TCA-27? MR. MACHILEK: This is an output that comes from -4 5 MR. ROSENTHAL: It goes into that. 6 MR. MACHILEK: It's a remote switch on the A-14. 7 8 MR. ROSENTHAL: So you don't have it. 9 MR. MACHILEK: No. 10 MR. ROSENTHAL: We just traced this one. 11 MR. MACHILEK: Yes. MR. ROSENTHAL: REM. Local A-14. 12 13 MR. ASHE: What is that remote used for? 14 MR. MACHILEK: This is if you want to remove it 15 from a remote location. 16 MR. ROSENTHAL: You see your big computer burning Local A-14. Local A-14. What does LCL stand for? 17 up. 18 MR. ASHE: LCL? 19 MR. MACHILEK: I think this is a local UPS off 20 A-14, yes. switch. 21 MR. HESS: Yes. It's UPS off right there. And 22 that's if you had -- the remote is off the A-30, you put 23 remote switch off. MR. MACHILEK: Yes. We don't have it. 24 25 MR. HESS: Local is the A-14 front meter panel

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where you can press UPS off, and that's on the pictures that 1 2 I just gave back. MR. MACHILEK: The UPS on is the other button. 3 MR. HESS: There's a remote button for UPS on the 4 5 A-30, as you had a remote off. But we don't have it. Two buttons. 6 MR. MACHILEK: 7 MR. HESS: Two buttons, on and off. MR. ROSENTHAL: So are some of those not used, 8 unconnected, floating? 9 10 MR. MACHILEK: Yes. 11 MR. ROSENTHAL: Is this all C-MOSS or --12 MR. MACHILEK: Yes. MR. ROSENTHAL: So you have some C-MOSS inputs 13 14 floating. MR. MACHILEK: Except the transistors on the 15 16 output. MR. ROSENTHAL: Do you run into problems with 17 having C-MOSS floating, oscillations or --18 MR. MACHILEK: Well, they are protected. They are 19 -- I don't think we have any loose gates, if this is what --20 for instance, this is a gate input and it's protected. 21 22 MR. ROSENTHAL: So anything that's not used is --It should be a point higher MR. MACHILEK: Yes. 23 and have a protection capacity against ground. 24 Wait a minute. Now what we're 25 MR. ROSENTHAL:

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saying is that the only way that you pop open CB-1, 2 and 3, 1 is from here -- is from the --2 MR. MACHILEK: 3 UPT. MR. ROSENTHAL: -- UPT which --4 MR. MACHILEK: Which comes from this --5 It changes 6 MR. ROSENTHAL: And UPT is SSTR. names, but it's a physical wire on the back plate. 7 8 MR. MACHILEK: Yes. MR. HESS: From A-21 to A-24, it changes. SSTR, 9 UPT. 10 MR. ROSENTHAL: Okay. Now we decided that the 11 under-voltage to this gate should have seen an under-voltage 12 and tripped it. Which one was that? 13 14 MR. MACHILEK: Power supply failed. MR. ROSENTHAL: FR is frequency? 15 MR. MACHILEK: Clock failure. 16 17 MR. ROSENTHAL: Clock failure. MR. MACHILEK: Which is --18 MR. ROSENTHAL: Okay. It's right there. 19 Clock failure. Fuse failed. But we know that that --20 MR. MACHILEK: They require repair if that would 21 22 happen. 23 MR. ROSENTHAL: OTA. 24 MR. MACHILEK: The OTA goes -- it's not stored, because you have to reset the buttons. 25

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1 MR. ROSENTHAL: FU is --2 MR. MACHILEK: Fuse. MR. ROSENTHAL: Fuse blown. WF is a --3 MR. MACHILEK: It's freq failure. 4 5 MR. ROSENTHAL: Frequency fail. MR. MACHILEK: That requires a board change if 6 7 that happens. MR. ROSENTHAL: AC over-voltage. 8 Yes. That's a legitimate -- by the 9 MR. MACHILEK: 10 way, AC over-voltage does trip. 11 MR. HESS: I thought we said it didn't. 12 MR. MACHILEK: Yes. MR. HESS: I thought we traced out how it didn't 13 14 trip. 15 MR. MACHILEK: Well, let's trace it again, because 16 I remember where voltage was tripping on me. 17 Over-voltage. MR. HESS: MR. MACHILEK: Over-voltage comes up here, comes 18 there, comes there, all right. Over-voltage and power 19 supply failure comes in at the same one. 20 MR. ASHE: That's coming in through here. 21 It's a 22 lamp through here. It's not the same. 23 MR. ROSENTHAL: Where is that over-voltage? 24 MR. MACHILEK: I just thought it was. MR. ROSENTHAL: Over-voltage. Where are you 25

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1 measuring the over-voltage?

2 MR. MACHILEK: On the output of the module. If the regulator goes haywire and you know your voltage goes 3 4 up. 5 MR. ROSENTHAL: Logic failed. MR. MACHILEK: Logic failed is a summary --6 anything you get --7 MR. ASHE: Wait a minute. Why doesn't that go --8 9 MR. MACHILEK: See, all of these go in here. All of those are tripping, either/or. That means any one of 10 11 those is tripping. In other words --12 MR. ASHE: Maybe you're right on over-voltage. 13 Let's go back to over-voltage. AC over-voltage --14 MR. MACHILEK: Over-voltage comes out here, here, goes here, and trips. 15 16 MR. ASHE: Provided this is met up, right? MR. MACHILEK: No, no. It says either/or. 17 It 18 doesn't matter. MR. ROSENTHAL: What is this 12-bit -- Bit 12, 60 19 20 Hertz. 21 MR. MACHILEK: Which one is that? This is from 22 the down circuit. This would trip you if it comes in. It results in a low under-voltage on the output of the module. 23 The voltage control oscillator is going haywire of you miss 24 25 the 12-count. You trip the unit before you see it on the



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output. It should go directly up to the trip without any --1 2 or is it. No, no, no, no, no. It goes over the -- it goes over the -- it depends on what the over-load is doing. 3 This goes up to the countdown. That's where 4 Yes. 5 they stuck it. This is only the 11 bits for the timing circuit. So you have the 1, 2 and 2-seconds timer. This 6 should be a frequency -- it's 94 Hertz, going down to the 7 That's not what I thought it was. They're summing 8 timer. that together on the FRs. 9 MR. ROSENTHAL: I know we've been over this three 10 I'm sorry. Okay. Here I've got chips, 11 or four times. 12 right? 13 MR. MACHILEK: Latches, yes. 14 MR. ROSENTHAL: Latches. And that itself takes 12 volts. 15 16 MR. MACHILEK: Right. MR. ROSENTHAL: Which is coming from this power 17 18 supply here, right? 19 MR. MACHILEK: Right. MR. ROSENTHAL: We have 20 volts, plus 20, 20 degrading here. 21 22 MR. MACHILEK: Yes. MR. ROSENTHAL: Do we know anything about the 23 24 plus-12 volts here? 25 MR. MACHILEK: Well, as soon as the 20 volts

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1 degraded to 16.5, we shut down the module.

2 MR. ROSENTHAL: By design. 3 MR. MACHILEK: Yes. MR. ROSENTHAL: But in the time being, what was 4 5 happening to the 12 volts here? MR. MACHILEK: Which time being? 6 The time it shuts down and --7 MR. IBARRA: 8 MR. MACHILEK: The time the unit shuts down? I think he's talking the time that the 9 MR. ASHE: 10 voltage degrades from whatever it's --11 MR. MACHILEK: If you start out at 12 and go to 12 16.5? MR. ROSENTHAL: 13 Right. 14 MR. MACHILEK: It's almost instantaneously. As long as the power supply holds the voltage up, it's there, 15 16 right? Once the power supply quits, you go on discharge from two more cells and from then on, since the batteries 17 18 were pretty much dead, it decreased to .64 or something like 19 that. But to shut the unit down, you can blink your eyes 20 fast enough to -- it's just, clink, and it's gone. 21 22 MR. POHIDA: Is the unit powered back up? MR. ROSENTHAL: After 200 milliseconds. 23 MR. POHIDA: Is there any consideration on power-24 up states, like what the modes will be of all these latches 25

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1 on power-up?

2 MR. MACHILEK: You have to push the reset button. If you don't reset the latches, you cannot restart the unit. 3 4 MR. POHIDA: Even if you lose power. 5 MR. MACHILEK: Even if you lose --MR. POHIDA: The outputs won't toggle. 6 MR. MACHILEK: The outputs won't toggle. No, sir. 7 Except if you switch off the logic. 8 MR. POHIDA: That's what you may have done. 9 When the 20 volts came down, if it got below, what did you say, 10 11 13 volts? MR. MACHILEK: 16.5. 12 MR. POHIDA: When do the 12-volt supplies start to 13 14 MR. MACHILEK: We don't monitor the 12-volts. 15 MR. TERRY: Rudi, doesn't that K-1 -- that's what 16 I'm asking about, that K-1. That K-1 relay --17 18 MR. MACHILEK: That K-1 is there --19 MR. TERRY: They'll reset the latches. MR. MACHILEK: Well, it's there not to reset the 20 21 latches if you do a lamp test. 22 But if it loses power, it will reset MR. TERRY: those latches. That's why I asked about that. 23 MR. POHIDA: Well, what if you did lose your 12 24 volts? 25

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MR. MACHILEK: If you lost your 12 volts --

2 MR. POHIDA: What is the power-up condition of all 3 of the latches?

If you lost the 12 volts, then the 4 MR. MACHILEK: latches would -- no. You have to apply a -- you have to 5 As long as you do not reset, they stay where they 6 reset. They are bi-stable. They're not like a computer. If 7 are. 8 you lose the logic, you lose the memory or anything like 9 that. It's like a toggle switch.

10 MR. ROSENTHAL: We could just pull a manual and 11 look up the 4044s.

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MR. MACHILEK: Yes.

MR. POHIDA: So they'll power-up as they powerdown. Wait. Let me --

MR. ROSENTHAL: In order to -- I'm sorry I'm being redundant again. I thought earlier this morning we decided that you have to apply power to the shunt coils for two to five cycles in order to make the breakers change state.

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MR. MACHILEK: Right.

20 MR. ROSENTHAL: And there has to be some 21 reasonable voltage. That gives us a hint then about the 22 condition of the logic, that the logic had to change state 23 to initiate an open signal and there had to be enough 24 voltage and enough power left to actually open the shunt 25 coils, trip the shunts. Right? · · · · · ·

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MR. MACHILEK: We are not collapsing all the 1 2 valves. They are linear power supplies. MR. ROSENTHAL: It's a sub-component that you 3 4 purchase. MR. MACHILEK: Yes. It's a chip. 5 6 MR. ROSENTHAL: Do we know the -- but if we go to look up 4044 in a manual --7 MR. MACHILEK: We can review it, but I don't have 8 it here. I can get parts lists of all the components. 9 10 That's no problem. MR. POHIDA: You said earlier that you probably 11 did not lose the 12 volts. 12 MR. MACHILEK: I do not believe you lost 12 volts. 13 MR. POHIDA: But we did diminish the 20. 14 15 MR. MACHILEK: The 20 -- we know that it ran to a 16.5, yes, sir. 16 MR. POHIDA: Is that a voltage regulator? 17 MR. MACHILEK: It's a voltage regulator. 18 MR. POHIDA: How fast can that act to correct for 19 the 20 volts being pulled down? 20 I don't know. 21 MR. MACHILEK: MR. POHIDA: What I'm wondering is the 12 volts 22 may have also dropped instantaneously. 23 MR. MACHILEK: It's possible. 24 MR. POHIDA: You lost your logic. The voltage 25

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1 regulator, you just can't -- I don't think you can just put 2 a sine wave into it and get --

3 MR. MACHILEK: We maintained the latches because
4 the light stayed on and they are held by the latches.

5MR. POHIDA: Did all of them stay on?6MR. MACHILEK: Yes.

7 MR. POHIDA: All the latches?

8 MR. MACHILEK: No, no. These two. Why they 9 didn't --

MR. POHIDA: I'm not 100 percent familiar with the event, but it seems as though you could have problems if your 12-volt supply and your five-volt supply -- well, the five-volt just runs the LEDs, I guess, but moreso the logic. If you have your 12 volts dipping down and then coming back up, you say you will not lose the latches.

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MR. MACHILEK: Well, I don't --

17 MR. POHIDA: I think you might.

18 MR. MACHILEK: If you remove the power, you would
19 have to -- you have to ground the --

20 MR. POHIDA: You're also losing your inputs. 21 MR. MACHILEK: In order to re-circuit, you have to 22 ground the S terminal. If you don't, you simply don't 23 notice it. If you lose the 20 volts altogether -- I have to 24 look at the data sheet.

MR. POHIDA: I don't know which latches were held,

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1 which ones weren't. The other thing that --

2 MR. MACHILEK: You're familiar with the 4044s. 3 MR. POHIDA: The other thing that bothers me --4 MR. ASHE: The 4044, that's the standard. Radio 5 Shack or any of these places have probably got the same 6 transistors as these guys do.

7 MR. HESS: Jack, you asked me earlier about some 8 of the things that we should talk about for Niagra Mohawk 9 and what they should be looking at. Then you went on to 10 another piece. Did you want to revisit that or did you want 11 to hold on that?

MR. MACHILEK: If it helps, five units were running for five years. We had one scenario we cannot fully explain. With normal maintenance, which we are doing for the industry as a whole, applied to it, we can say with high probability that we will not have any problem.

I don't know what much we can do else. If we had an inordinate amount of failures, normal operation, whatever, I don't know. I can probably see a concern, but it's really not there.

I would suggest it's none of my business, but to look at the other aspects of the obligation of the unit, classification of it, the maintenance level. These units turned out to be a hell of a lot more important than what they are perceived as.

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1 So there's a lot of things which can be done. A 2 maintenance bypass can be installed. The units can be half-3 yearly checked all the way through. We have roughly two-4 and-a-half-thousand units sitting out there in the field. 5 We have a good reputation in the marketplace. We're not 6 junk sellers. We usually don't even participate in low-7 dollar type deals.

8 MR. ASHE: Let me ask you something. How many 9 units like this were -- do you have a handle on that --

10 MR. MACHILEK: We estimate around 700 prior to the 11 shipment of the five here.

MR. ASHE: 75 KVA ratings.

MR. MACHILEK: No, sir. They all have the same logic. They all have the same -- the commonality is what the armed forces like, from 60-KW all the way up to 1000 or 800-KW. They all have the same logic, same circuitry, same everything; 68 percent commonality.

MR. ROSENTHAL: I know that the Reporter would like to take a break. So why don't we take a break and then when we get back, I guess the issues are, one, what could be done with respect to these units, that's one thing; two, a little bit more information on where else they're used and then by that time, maybe we'll come up with some more bright ideas.

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MR. ROSENTHAL: Your nickel.

2 MR. HESS: I'm sorry. I was waiting for Frank to 3 say go ahead and do your thing. What I'd like to do is put 4 in the record some recommendations that we have for Niagra 5 Mohawk, and we'll follow this up with Niagra Mohawk in a 6 full report to them shortly.

7 Under recommendations, I'd like to put number one, 8 Niagra Mohawk is aware that the current UPS systems 9 represents technology that is over ten years old. Exide 10 Electronics' current UPS systems represent three 11 technological advances and represents state-of-the-art power 12 protection. It is our recommendation that Niagra consider 13 replacement of the present systems with our present designs.

14 Recommendation number two, if Niagra Mohawk 15 chooses to have Exide Electronics maintain the UPS systems 16 at Nine Mile Point, we recommend our Powercare Preferred 17 Service Package that covers all facets of maintenance, 18 seven-by-24 emergency service, preventive maintenance 19 inspections and modifications and parts.

Number three, if Niagra Mohawk chooses to continue maintaining this equipment, the following recommendations are applicable. Section A, inspect logic power control battery condition at least once every year. B, perform an annual preventive maintenance on UPS modules per manufacturer's recommendations or have manufacturer perform

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C, obtain necessary product and technical
knowledge through an ongoing training program for Niagra
Mohawk maintenance personnel. Exide Electronics can supply
formal technical training programs at the Niagra Mohawk
facility or at the manufacturer's training center in
Raleigh.

D, as-built systems schematics diagrams must be 8 9 maintained with equipment. These documents take precedent 10 over any other manual, text or verbal communications and should be referenced during maintenance procedures. 11 Ε, we've got to replace all DC input filter capacitors in each 12 F, Exide Electronics stands ready to fully support 13 module. Niagra Mohawk in any service requirements. Niagra Mohawk 14 15 can call 1-800-84-Exide for service support should this be 16 required.

17 G, our last recommendation is peripheral equipment 18 that directly impacts the UPS operations should also be 19 under manufacturer's recommended maintenance programs. End 20 recommendations.

21 MR. ROSENTHAL: Are you worried about the circuit 22 breakers based on what you know now?

23 MR. HESS: Not knowing -- yes. I would have to 24 say yes. We're concerned about them. We can't tell how 25 many times they've been worked. The only way to really go

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in there would be to have somebody come in and take them out, and I believe they're all sealed. No. They come apart, don't they? They're just molded case. Have them looked at and/or replaced. Throw them away probably would be the best thing to do and put new ones in, knowing what we know today from this meeting.

7 MR. ROSENTHAL: Rudi, we wanted to give you the 8 floor. Where are these units used? You have to expansive 9 in terms of the same logic or similar enough logic, 10 independent of the power rating.

MR. MACHILEK: About 700 we've come up with. They have identical logic. I wish you come to our plant and as you go through the production line, you see the same card cage being used. Sixty-eight percent of the subassemblies are commonality.

MR. ROSENTHAL: And at other nuclear power plants?
 MR. MACHILEK: Well, the only ones I was
 personally aware of was Yankee Atomic and Duke.

MR. ROSENTHAL: Yankee Atomic and Duke. But how
do we go about having to check your --

21 MR. HESS: We'll run a list. We can look through 22 our users list and determine which facilities have our 23 equipment.

24 MR. ROSENTHAL: I'd appreciate it if you'd do that 25 in general. That assumes you can.

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1 MR. HESS: Sure. 2 MR. ROSENTHAL: Those that are non-nuclear you can delete from that list. 3 MR. HESS: Understood. You want a strict nuclear 4 5 application only. MR. ROSENTHAL: Right. Now, I recognize that you б 7 may not know the application. MR. HESS: That's true and chances are we probably 8 don't. 9 MR. ROSENTHAL: With the understanding that the 10 11 UPS may run the security computer or the UPS may run lights 12 or whatnot, you may now know that, but I think we need to 13 have that fairly fast. 14 MR. HESS: Do you want that faxed to you? 15 MR. ROSENTHAL: Yes, please. We'll give you our fax number. 16 MR. HESS: 17 Okav. 18 MR.' ROSENTHAL: So now we're back to drawings. I'm down to either there's a sneak circuit or we 19 Are we? 20 understand it. One or the other. 21 MR. ASHE: Maybe what we need to do -- what about let's go over some of the timing as possibly related to the 22 event or what happened to the units. Can we do something 23 like that? 24 25 MR. MACHILEK: In what respect, timing?

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• \*  1 MR. ASHE: Maybe what we need to do is suggest --2 just start with the guards and see how they generate a time 3 base.

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MR. MACHILEK: It has nothing to do with nothing. MR. ASHE: Has nothing to do with nothing.

MR. MACHILEK: There were no problems with the 6 switching, with the power. All the time clock is doing is 7 it determines what sequence of filing of SCRs. All units 8 started up. There was no repair, there was no damage. If a 9 clock fails, you would know it. You have -- well, you 10 wouldn't really because we have what we call a clock 11 watching circuit and as soon as we lose a beat, we are ready 12 to shut down. We don't wait on a disaster to happen in the 13 14 first place.

MR. ASHE: All right. How do you shut down?
MR. MACHILEK: On a clock fail.

MR. ASHE: All right. Maybe we need to go on that. When you shut down, what do you do? You open the CB breaker?

MR. MACHILEK: Same thing. SSTR.
MR. ROSENTHAL: But don't you -MR. MACHILEK: The clock fails and there is -MR. ASHE: Right. All that part is the same.
What about up here?
MR. ROSENTHAL: But don't you turn the SCRs off

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1 even faster than ultimately the circuit breakers will open?

2 MR. MACHILEK: If you don't turn an SCR on or off 3 at the exact precise time, you blow a fuse. You blow a fuse 4 because you would have a direct shortcircuit of positive and 5 negative on the battery. What you do is you simply switch 6 the parallel voltage on and off, and then you do the same 7 thing negative and you feed the transformers on the output.

8 MR. ROSENTHAL: In the manual, you said you've got 9 like a 12-step --

The transformers which are --10 MR. MACHILEK: Yes. two of them -- and if you had an imbalance of the positive 11 and the negative, you would have a saturation effect, DC 12 saturation, and you would blow just about anything. If you 13 are a fraction of a millisecond off, you blow. Like we used 14 to say, when you are power switching, you are always a 15 millisecond away from disaster. 16

17 There was no problem in the power train in the 18 conversion of the DC to AC.

MR. ROSENTHAL: Yes. We understand that nothing failed and the units were restarted, etcetera, but it might be useful to educate us a little bit. In this event, the SCRs were turned off, right?

23 MR. MACHILEK: You simply turn all SCRs off. You 24 have to turn them off with a leg-off command.

MR. ROSENTHAL: Which comes from --

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Are we just passing time or --1 MR. MACHILEK: MR. ROSENTHAL: I'm just trying to understand. 2 MR. MACHILEK: -- do we want to have some analysis 3 of the event. 4 Could we take about two minutes and 5 MR. ASHE: just go over the gating of the SCRs in general. I think 6 that would be helpful. I agree with you. I don't think 7 this is so much relatable to the event. 8 9 MR. MACHILEK: GFM. MR. ASHE: You have a GFM? A-9. 10 11 MR. MACHILEK: We would really have to go through 12 the circuitry big time. MR. ASHE: But I think we can just illustrate the 13 format a little bit without really going through a detailed 14 15 timing diagram and so forth. MR. MACHILEK: Basically, what we have is six --16 we have 12 switching legs. 17 18 MR. ASHE: All right. MR. MACHILEK: Now, as you know, you can only turn 19 off an SCR if you have interrupted forward current. 20 In order to interrupt this forward current, you have to push 21 22 current backwards against the direction of current flow. The way you are doing that is you are charging the capacitor 23 and you have accommodation SCR, a static switching element. 24 You should turn on and dump the capacitor charge backwards 25

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1 through the SCR and you turn it off.

2 Then, of course, in the next cycle, you have to charge up the capacitor again. 3 MR. ASHE: All right. 4 5 MR. MACHILEK: The gate firing modules, as you see, you have -- it comes from the logic which turns on the 6 various -- you have the main resistors and you have the 7 accommodation, accommodating resistors. Each one is simply 8 taking the capacitor charge. The main -- this goes directly 9 -- the connection out of here is feeding directly into the -10 11 12 MR. ASHE: Okay. I think we can --MR. MACHILEK: We would have to have the right 13 14 schematic. We'll look for the schematic. So pulse 15 MR. ASHE: comes out of here and goes into the gate zone. 16 MR. MACHILEK: You have the gate command coming 17 18 here. Which comes from the -- okay. 19 MR. ASHE: MR. MACHILEK: The leg switch-off -- see the leg 20 switch-off commands. 21 22 MR. ASHE: Yes. MR. MACHILEK: All the legs are getting a zero 23 here which turns off the main SCR. At this point, you have 24 a discharge capacitor. The accommodation SCR is turned on. 25

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The charge is done through the main SCR, which is turned
 off, and you do not get any more gate commands.

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MR. ASHE: Okay.

MR. MACHILEK: Should one of the leg switch-offs not execute, you blow the fuse. You see on the leg, you are directly between plus and minus DC. The two SCRs aren't serious. Should they ever turn on at the same time, for whatever reason, you have a shortcircuit positive.

9 You have a leg fuse which blows and the leg fuse
10 is not on here. The leg fuse is -- one, two, three, four,
11 five, six, one per leg pair.

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MR. ASHE: Right there, yes.

MR. MACHILEK: You have the accommodating
capacitors, the chokes, accommodating chokes, and diodes,
standard leg, designed from the 1950s.

MR. ASHE: What is this guy doing here now?
MR. MACHILEK: This is the gate circuit.
MR. ASHE: Yes. This one right here. I know this

19 is the gate that goes in and --

20 MR. MACHILEK: Between gate and the five-six gives 21 you the firing circuit and this comes right out here. 22 Similar, you have a gate against here and then the same 23 thing, you have the accommodating SCR three, four and one 24 and two.

The sequence in which the gate comes in up here,

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comes directly out of the A-8 pin. 1 2 MR. ASHE: Eight and nine. MR. MACHILEK: As you see, it's straight logic, 3 nothing --4 MR. ASHE: What kind of gate voltages are we 5 6 talking about here? MR. MACHILEK: I believe it's 12, but I -- what we 7 8 used ten years ago. MR. ASHE: I think that's a broad overview of --9 MR. MACHILEK: Yes. It basically agrees with the 10 11 control oscillator, with the countdown circuits. MR. ASHE: Is it actually discrete control or is 12 it --13 MR. MACHILEK: Or discrete. 14 MR. ASHE: It's discrete crystal control. 15 MR. MACHILEK: Discrete crystal control. 16 MR. ROSENTHAL: This goes to a logic fail. 17 18 MR. MACHILEK: Yes. MR. ROSENTHAL: Is that covered? 19 MR. MACHILEK: This is the one from the guard 20 21 watcher. MR. ROSENTHAL: Twelve bits, whatever? 22 MR. MACHILEK: No. The 12-bit is simply used as a 23 timing signal for the timers, all these timers. See all 24 these timers here, they are run by the 12-bit circuit. 25

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Now, in order to explain all that, you need timing
 diagrams.

MR. ASHE: Yes. They're too involved.

4 MR. MACHILEK: They give you the sequence of it. 5 MR. ASHE: I think that's an overview of how it's 6 really working.

7 MR. MACHILEK: There it is. There's the crystal 8 sitting right here, 1.47 megahertz, and then it goes through 9 the countdown circuits. We're counting it down until we get 10 the 60 hertz. We are watching the countdown, comparing it 11 against the standard and if we have discrepancies, then we 12 shut down on clock failure.

13 MR. ASHE: What is this 100 --

MR. MACHILEK: This is 1.47 megahertz crystal.
We're just counting it down.

MR. ASHE: Something that is relatable to this is how does this thing bump up or change the frequency?

18 MR. MACHILEK: It doesn't and cannot.

19 MR. ASHE: We saw it.

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20 MR. MACHILEK: There's a crystal control, 21 oscillator which is influenced by the circuit.

MR. ASHE: Right. How does that -- just go through that, because I think that was somewhat relatable to the event.

25 MR. MACHILEK: What the crystal control oscillator

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is doing, the voltage controller oscillator is doing, it
 takes the synchromat and corrects it to be in concern with
 it.

Through voltage? MR. ASHE: How does it do that? 4 5 MR. MACHILEK: It's voltage-controlled. The 6 voltage level is established by the frequency of the voltage 7 converter from the bypass directly compared to the frequency which comes out of the countdown circuits of the clock. And 8 9 it corrects -- I'll show you how it corrects for the incidents. 10

MR. ASHE: It does that in a period of what, about 30 or 40 seconds or so, depending on the ranges?

MR. MACHILEK: It does it -- no, no. It does it
every 737,000 hertz level.

MR. ASHE: What kind of band is this thing operated in? For example, if you lose more than a few hertz, it won't bring it back into sync anyway, will it?

18 MR. MACHILEK: Yes. If you are 180 degrees other19 phase, it brings it back.

20 MR. ASHE: No, no, no, no. Supposing the 21 frequency, for some reason, goes down to --

22 MR. MACHILEK: Internally?

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23 MR. ASHE: No, no, no. The unit works fine. The 24 maintenance supply --

MR. MACHILEK: If the sync frequency is going .5

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1 hertz, we disconnect the sync.

So you lock out really. 2 MR. ASHE: MR. MACHILEK: You disconnect from the sync, yes. 3 4 We no longer let you influence us. So it only rises and falls by that 5 MR. ASHE: amount basically, because otherwise it --6 7 MR. MACHILEK: Plus/minus .5 hertz, that's it. MR. ROSENTHAL: Based on your knowledge of the 8 design, number one, you know that the SCRs were fired as 9 10 designed for however long --MR. MACHILEK: If one gets a little out of step, 11 12 you blow down right away. MR. ROSENTHAL: And you would know failures of --13 14 MR. MACHILEK: There was no repair, no 15 readjustment, at least not reported. MR. ROSENTHAL: And that's both from the rectifier 16 and the --17 18 MR. MACHILEK: And the worst -- the only repair which -- two repair orders have been issued, one for the 19 circuit breaker on one unit, and I don't know what the --20 the rectifier -- it was a breaker problem. 21 MR. ASHE: 22 What is the maintenance cost you're talking about on one of these units per year? 23 24 The maintenance contract or the actual MR. HESS: 25 cost?

MR. ASHE: The actual cost. Well, contract cost for one unit.

3 For one unit, it could vary from --MR. HESS: you're talking about full coverage? There's a whole --4 5 MR. ASHE: Full coverage. 6 MR. HESS: Full coverage. 7 MR. ASHE: Ballpark figure. 8 MR. HESS: Three to 5K a year. Now, that depends -- that could be a guesstimate. 9

10 MR. IBARRA: Per unit.

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MR. HESS: Per unit, yes. It would be per unit and that would be depending on what spares were maintained on-site.

MR. GRADY: That would include parts.

MR. HESS: Yes. What we normally do is a customer has a spare parts package and then we work from that spare parts package and replenish that to them underneath the contract. So they have an ever present supply of parts. MR. ROSENTHAL: When the AC input, normal input

20 degrades, as I understand the design, you turn off the SCRs 21 in the rectifier.

22 MR. MACHILEK: Correct.

23 MR. ROSENTHAL: At some point in this scenario, 24 this event, the SCR is -- were the SCRs on the inverter 25 turned off? . . . .

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1 MR. MACHILEK: No. 2 MR. ROSENTHAL: No. MR. MACHILEK: Only when it shut down. 3 MR. ROSENTHAL: It was only following --4 MR. MACHILEK: You got the leg-off command. Leq 5 switch-off. 6 MR. ROSENTHAL: And it gets the leg switch-off --7 8 MR. MACHILEK: Simultaneously on all 12 legs. MR. ROSENTHAL: From where does it get it? 9 10 MR. MACHILEK: From --You knew he was going to ask that. 11 MR. ASHE: It's on eight or nine. 12 MR. MACHILEK: It ties in. It's over there on 12 and 13 MR. HESS: 14 it's tied in on the nine. This is the nine right there. MR. MACHILEK: It's 20. 15 Which is tied in across down the 16 MR. HESS: Yes. 17 back here. It basically takes it -- if we get 18 MR. MACHILEK: an under-voltage -- there's the UPT, which is the -- see the 19 That's the same one which is coming out, this one 20 UPT? It switches off to three breakers, comes in 21 here, the UPT. here, and it gives you a leg-off command, which is 22 transmitted directly to the K-5 module. 23 24 MR. ROSENTHAL: Let me see if I can get this Because the fuses weren't blown and because the SCRs 25 right.

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were not damaged, in the inverter, you know that it got a 1 leg switch-off. The leg switch-off came from which drawing? 2 From here, which gets its input from --3 4 MR. MACHILEK: UPT. MR. ROSENTHAL: One is UPT, which is the same --5 MR. MACHILEK: Yes. 6 7 MR. ROSENTHAL: -- which is the output of SSTR. MR. MACHILEK: UPS trip. 8 MR. ROSENTHAL: From the UPS trip or --9 10 MR. MACHILEK: Do you see UV? 11 MR. ROSENTHAL: I'm sorry. MR. MACHILEK: Output voltage low. In your case, 12 not used. This is only used on a parallel circuit. 13 MR. ROSENTHAL: Okay. Or --14 MR. MACHILEK: That's it. UPT is the only thing 15 which gives you a leg-off. 16 17 MR. ROSENTHAL: Okay. So that had to be --18 MR. MACHILEK: Yes. Everything is consistent with 19 operation. 20 MR. ROSENTHAL: But that's an independent way of -- okay -- or supporting. 21 MR. MACHILEK: I understand. 22 MR. ROSENTHAL: Okay. So now let me try to 23 24 verbalize it. MR. MACHILEK: Sure. 25

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1 MR. ROSENTHAL: And then you verbalize it better. 2 It is my current understanding that, by design, the 3 rectifier would turn off -- would be shut down on seeing bad 4 input, that the inverter would be turned off by an SSTR 5 signal only, and that same signal would end up opening CB-1, 6 CB-2, and CB-3.

7 MR. MACHILEK: And give a transfer command.
8 MR. ROSENTHAL: To the --

9 MR. MACHILEK: To the A-34 transfer circuit. 10 MR. ROSENTHAL: To the transfer circuit. 11 MR. MACHILEK: The transfer circuit makes a 12 decision if or if not to execute that, depending on three 13 conditions; bypass frequency, voltage and sync.

MR. ROSENTHAL: But we know that that was also
effected by the original fault.

16 MR. MACHILEK: Correct. We would not expect the 17 maintenance voltage to be there, because it wasn't.

MR. ROSENTHAL: We follow back the SSTR signal and we decided that that had -- that the only probably way, other than a sneak circuit or something we don't understand, is that that would have come from a power supply failure input and then we followed that back to power -- to the logic power supplies which we know were powered off B-phase and saw the --

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MR. MACHILEK: Yes. Or that can be a verified

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1 test that duplicated --

2 MR. ROSENTHAL: The one thing that we don't 3 understand then --

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MR. MACHILEK: Is the discrepancy with the --

5 MR. ROSENTHAL: Discrepancy with the lights. On 6 the lights, we decided that the under-voltage UV does not 7 latch. So that the observation of that light was the time 8 that somebody wrote down what they saw, which was at roughly 9 two hours -- two or three hours -- two hours into the event.

MR. MACHILEK: I would really consider that as a
status indication rather than an alarm.

MR. ROSENTHAL: And that the voltage difference light does not latch as the UV -- OV/UV, but that the OV/UV transfer light does latch and may have -- and we don't know if that latched and lit at time T-zero or five, ten, 20 minutes or an hour into the event.

17 MR. MACHILEK: Right.

18 MR. ROSENTHAL: Go on. What else do we know? 19 MR. MACHILEK: We know that we didn't have to make 20 a repair or adjustment and the units started up after the 21 alarms were reset.

22 MR. ROSENTHAL: Right. Let's break.

23 [Recess.]

24 MR. ROSENTHAL: Let's go back to UPS. What we 25 decided was it is not single failure-proof.

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MR. MACHILEK: It is, because the power supplies 1 2 are a single point failure -- not a single point failure. You've got to have something else to happen; namely, the 3 maintenance has to get lost at the same time. 4 MR. ROSENTHAL: But we did decide that there are 5 lots of redundancy in it. For example, if you lose the 6 rectifier, you have the battery. 7 MR. MACHILEK: Correct. 8

MR. MACHILLER: COII

9 MR. ROSENTHAL: And if you lose the inverter 10 itself, you have the maintenance.

11 MR. MACHILEK: Bypass.

MR. ROSENTHAL: Bypass. So although it's -- so
there is a level of redundancy there.

MR. MACHILEK: The only time your redundancy gets lost is if the redundant is if the primary source fails at the same time.

MR. ROSENTHAL: Wait a minute. Given the loss of power supply, including the battery, with the dead battery, if the maintenance supply had been good --

20 MR. MACHILEK: Nothing would have happened. 21 MR. ROSENTHAL: Then it would have -- what would

21 MR. ROSENTHAL: Then it would have -- what would 22 have happened?

MR. MACHILEK: What would have happened? Nothing, because the power supplies would have to be maintained and you wouldn't know a thing.

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MR. ROSENTHAL: If there was some other fault in
 the power supplies --

MR. MACHILEK: If there's another fault in the power supplies, it would --

5 MR. ROSENTHAL: Or the card cage or something. 6 MR. MACHILEK: Then the UPS would have shut down. 7 It would have transferred to maintenance. It transferred 8 many times over the years, right?

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MR. ROSENTHAL: Yes.

MR. MACHILEK: And certainly the batteries didn't go bad. So the dead batteries, by itself, if nothing else happens with it, something specific happens with it, you would never in your life would have known that you have dead batteries.

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MR. ROSENTHAL: Okay.

MR. MACHILEK: Given the assumption that nobody 16 would have checked it. Now, we have to recognize it is 17 difficult to test, check or make a major investigation on 18 the modules since you have no way to power a flow. So I 19 don't -- probably, out of my own, I probably -- given the 20 difficulty to shut down a module and maybe not even getting 21 22 permission to do it, it is considered that maintenance at times is falling short because of it. 23

I have to give you an example on the first Boeing installation we did in Vienna, not far from here, and we

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wanted to perform the first preventative maintenance, halfa-year after installation, and we were told no way in the world are they going to go off the UPS. We have to wait. Well, three years later we had the first PM. Nobody wanted to let the load get off the UPS. So if you want an enforced maintenance deficiency because of that.

And users are paranoid. Once you have an UPS
installed, you have a computer operation going, they simply
don't let you get off the UPS, period.

MR. ROSENTHAL: We have discussed how do we know that the batteries were not -- were discharged or not charged at the time of the event rather than after the event.

MR. MACHILEK: It was not a matter of --

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MR. ROSENTHAL: But I'd like to hear your werbalization of why you believe the batteries were no good at time T-zero.

MR. MACHILEK: Because of the amount of time it was operating in the elevated temperature environment, experts were indicating that the batteries probably were no longer batteries after one-and-a-half years after installation.

I hope it was confirmed that all five batteries were dead. Not that they couldn't get charged, they were simply incapable to hold a charge. г., " х. 1 .

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There was one that was -- plus 20. It 1 MR. TERRY: 2 was half. The plus 20 volts. MR. MACHILEK: The plus was good? 3 MR. TERRY: 4 Yes. MR. ASHE: Which unit was that, do you recall? 5 MR. TERRY: Gulf. 6 And you actually load tested that? MR. ASHE: 7 That's measured voltage. 8 MR. TERRY: No. MR. ASHE: No-load voltage. That doesn't -- was 9 the load test -- it wasn't load tested, was it? 10 No. I'm just talking about the as-11 MR. TERRY: found voltage. 12 MR. ASHE: Okay. No-load voltage will certainly 13 14 come up and that --MR. ROSENTHAL: But the as-found no-load voltage 15 measured roughly a week after the event was after the power 16 17 supplies had been re-powered three to five days earlier and, hence, are effectively on a triple charge, are on a charger. 18 19 MR. HESS: Yes. Is there a blow-up diagram for the 20 MR. ASHE: power supply, PS-1 and PS-2? Do we have that someplace to 21 show the internals of that? 22 It's a purchased product. A11 23 MR. MACHILEK: No. 24 of our drawings shows only the information necessary to

procure it. We don't fix it or service it if it's broke.

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1 We simply replace it.

2 MR. ASHE: Well, how do we know what's in there? MR. HESS: When you order one, it comes with a 3 small diagram inside the box, if I remember correctly. 4 MR. ASHE: You don't retain any of the diagrams 5 like that? 6 MR. HESS: They're in the purchase part of it. 7 MR. MACHILEK: We don't fix it. It's what we call 8 a non-repair subassembly. 9 MR. ASHE: What happens to the old unit you take 10 out then? 11 MR. HESS: Throw it away. 12 MR. ASHE: Who do you purchase that from, do you 13 recall? 14 MR. HESS: I knew you'd ask that question and 15 there's been a couple different vendors. Economate. We 16 17 have a list of vendors. Would you like --MR. GRADY: We have a drawing that lists the 18 vendors in the specs. 19 20 MR. ASHE: For the power supplies. Yes. We can send that to you. 21 MR. MACHILEK: MR. ROSENTHAL: Okay. That might be helpful. 22 Because if those power supplies have, let's say, big 23 capacitors inside there, they have finite lives also. 24 MR. ASHE: I'm not certain that that's really 25

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This power supply appeared to act more as a 1 true. 2 transistorized regulator rather than a capacity guide. MR. MACHILEK: It's a series -- it's a linear 3 series regulator, transistor regulator with filter 4 capacitors on the output. The DC is being filtered because 5 it is --6 MR. ASHE: Right. 7 8 MR. MACHILEK: That's why the capacitors are 9 there. The output is across the capacitor. 10 MR. ASHE: MR. MACHILEK: Absolutely. Yes, sir. Otherwise 11 we wouldn't survive with the power you had there, not even 12 on the normal charges. Capacitors are holding you up right 13 14 now. MR. ASHE: Okay. 15 MR. ROSENTHAL: I'm sorry. K-5 flips from one 16 state to the other. 17 18 MR. MACHILEK: The capacitor --MR. ROSENTHAL: The capacitor and the power supply 19 is what's holding you up. 20 MR. MACHILEK: Yes. 21 MR. ROSENTHAL: Then I guess it would be good to 22 know what --23 MR. ASHE: So you have seen the diagram and you 24 know that's the way it is. 25

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No. I don't see the diagram. The 1 MR. MACHILEK: 2 power supply. Same power supplies which are on the pan which --3 MR. ASHE: When you say on the output, what I'm 4 saying -- to me, what that means is between plus and the 5 neutral, you're saying that output is across the capacitor. 6 7 MR. MACHILEK: Correct. 8 MR. ROSENTHAL: That's another age-related Did you want to review the --9 problem. 10 MR. ASHE: I'm saying the internals. The internals. It didn't seem like the data was suggesting that 11 12 to me. MR. HESS: As soon as we get back, we'll get you -13 14 You can do that, from the internals, 15 MR. ASHE: I'm saying. The internals. I'm talking about the one from 16 17 the inside of the power supply. 18 MR. HESS: In fact, I think it's on the back of the power supply now, they've gotten it. I saw one where it 19 was actually glued onto the back of it. 20 MR. ASHE: And you have one of those laying around 21 someplace, you think, or might? 22 MR. MACHILEK: At the plant. 23 MR. HESS: Let us take care of that. Let us get 24 25 one.

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MR. TERRY: Are you just talking about filter 1 capacitors across the power pack? They're external. 2 They're internal. 3 MR. HESS: No. MR. HESS: We will take that as an action item and 4 get you a copy of the schematic of the power supply itself, 5 not the subassembly, which we already have. 6 7 MR. ROSENTHAL: We know that large tantalum type capacitors, batteries, are age-related components. The 8 chips, hypothetically, have an infinite life. What other 9 components are there which you would consider age-related? 10 MR. MACHILEK: DC electrolytic capacitors which 11 12 are on the main DC bus. MR. HESS: That was called out in the 13 14 recommendations. 15 MR. ROSENTHAL: Go on. 16 MR. MACHILEK: That's it. 17 MR. HESS: Age-related like that. MR. MACHILEK: Nothing else has a shelf or 18 operating life. 19 MR. ROSENTHAL: Wear-related rather than age-20 21 related. MR. ASHE: The diodes, you said that's a chip, 22 too? Is that just -- that takes the 20 volts? 23 24 MR. MACHILEK: Yes, yes. The output regulators which are little chips. 25

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MR. ASHE: Is that just a resistive voltage - MR. MACHILEK: It's a transistor series regulator.
 MR. ROSENTHAL: That's a 7812. We could look that
 4 up.

5 MR. MACHILEK: Yes. They're all over the place. 6 MR. ROSENTHAL: What were you going to say? 7 MR. ASHE: I was going to ask Rudi to characterize 8 the whole thing very simply, starting from the transformer 9 rectifier, downstream propagation to the power supply, trip 10 of the units.

MR. MACHILEK: Okay. The loss of Phase B voltage translated itself over the areas Delta Y transformers to show up as a Phase II voltage reduction all the way through, including the 100-volt switch we use for control.

The effects of the voltage reduction on the 15 rectifier input was that the rectifier phased off. The 16 inverter continued to operate on the main station battery. 17 The supply to the control power supplies reduced itself from 18 120 to roughly 50 volts. The drop-out voltage was, I 19 believe, 45 on those relays. So we did not switch over, 20 which starved the input to the power supplies and they lost 21 22 regulation, reduced the output DC voltage and the batteries, which were not able to hold up, decreased their voltage on 23 the load to below 16.5 volts, which caused an UPS trip 24 signal to be issued, which was properly executed. 25

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, , 1 The transfer to bypass signal was not processed 2 because the bypass was not of the quality acceptable to the 3 circuit, and the load was lost.

MR. ROSENTHAL: Break.

[Recess.]

6 MR. MACHILEK: It can be shown that if you, for 7 instance, simply take the power supply pan, the A-27, and 8 you supply it with voltage and you monitored the load of the 9 power supplies with four-amp and one-amp, respectively, 10 which is the normal draw, then you can really demonstrate 11 what would happen.

If you reduced the input voltage to the power 12 supplies, was switched to power supply availability from one 13 14 input to the other, all that can be duplicated and shown what's going to happen. The draw is a constant draw. So 15 even if you simply put a resistor float on here which draws 16 about four amps or thereabouts, draws about one amp or 17 thereabouts, then you can direct it to break it. And what 18 will happen is given the capacity of the battery and the 19 discharge current of four and one amps, you can directly 20 calculate or get from the manufacturer the voltage decay 21 over time, and whenever you hit 16.5 volts, that time, you 22 will be able to support the operation of the UPS without any 23 other supply. 24

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You will see, if you do that, that it is

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considerably longer than the 12 cycles of voltage we're actually experiencing. Given that, which can be demonstrated, tested and shown, you can make the conclusion that if the batteries would have been good, you would not know that anything happened. MR. ROSENTHAL: I think that's it. [Whereupon, at 5:10 p.m., the meeting was concluded.] 

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## 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: Nine Mile

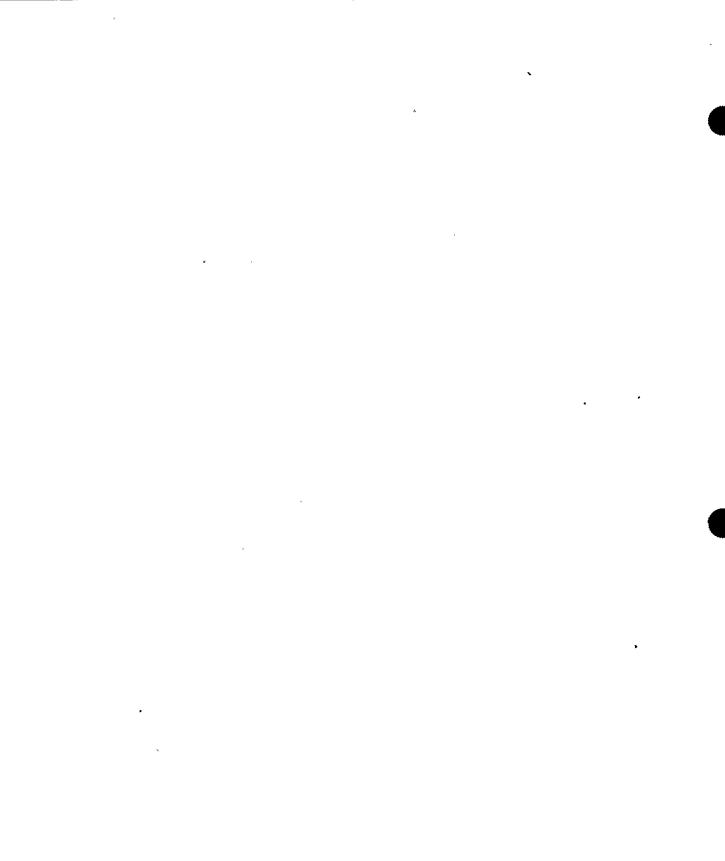
DOCKET NUMBER:

PLACE OF PROCEEDING: Bethesda, Maryland

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

Mory C. Lait

Official Reporter Ann Riley & Associates, Ltd.



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07-459B-91

## OFFICIAL TRANSCRIPT OF PROCEEDINGS

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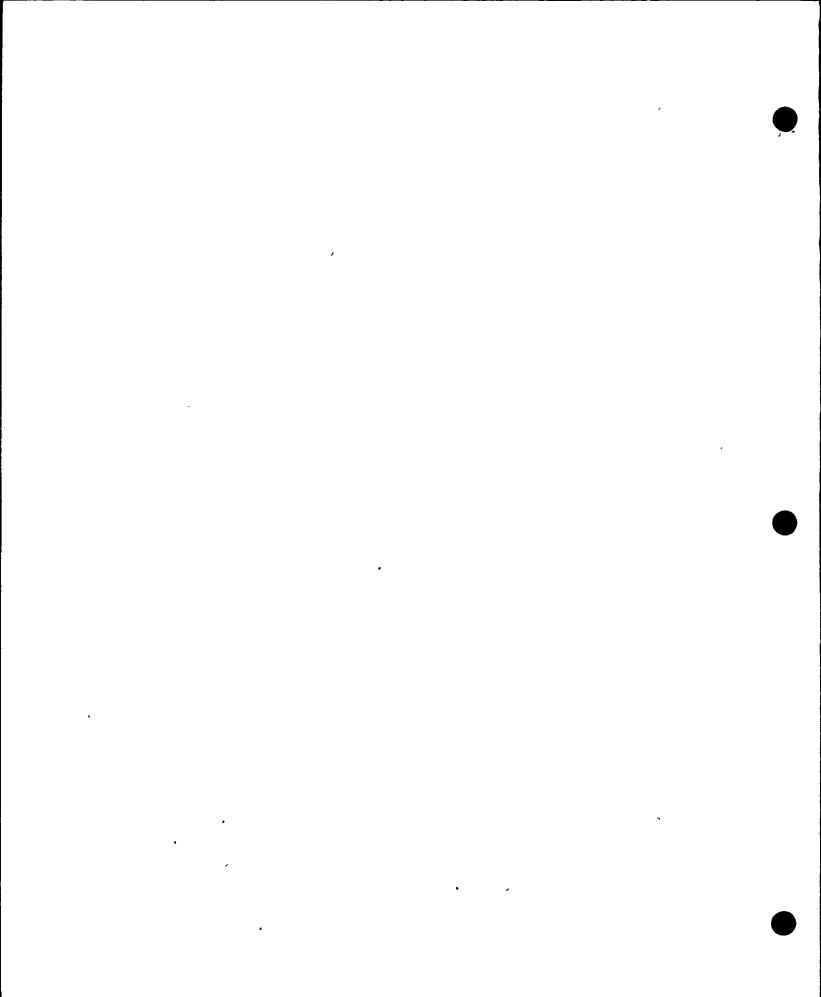
Agency:	U.S. Nuclear Regulatory Commission Incident Investigation Team
Title:	, Nine Mile Point Nuclear Power Plant Information Meeting

Docket No.

LOCATION:	Bethesda, Maryland			
DATE:	Tuesday, September 3	, 1991	PAGES:	1 - 175

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	l	UNITED STATES OF AMERICA
	2	NUCLEAR REGULATORY COMMISSION
	3	INCIDENT INVESTIGATION TEAM
	4	Nine Mile Point Nuclear Power Plant
	5	Information Meeting
	6	Nuclear Regulatory Commission
	7	The Woodmont Building
,	8	Room W-100
	9	8120 Woodmont Avenue
	10	Bethesda, Maryland
	11	Tuesday, September 3, 1991
	12	The meeting in the above-entitled matter convened,
	13	pursuant to notice, in closed session at 9:30 a.m.
	14	PARTICIPANTS:
	15	JACK ROSENTHAL, NRT/ITT Team Leader
	16	FRANK ASHE, NRT/ITT Team
	17	JOSE IBARRA, NRC/IIT TEAM
	18	WALTER JENSEN, NRC/IIT Team
	19	MICHAEL JORDAN, NRC/IIT TEAM
	20	JOHN KAUFFMAN, NRC/IIT Team
	21	TOM POHIDA, NRC/ITT Team
	22	JIM STONER, NRC/IIT Team
	23	BILL VATTER, NRC/IIT Team
	24	MICHAEL GRADY, Exide Electronics
	25	D. J. HESS, Exide Electronics

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,	1	RUDI MACHILEK, Exide Electronics
	2	WAYMON RANSOM, Exide Electronics
	3	KYLE TERRY, Niagara Mohawk
	4	KERRY JOHNSON, Failure Prevention, Inc.
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## PROCEEDINGS [9:30 a.m.] MR. JORDAN: Good morning, gentleman. My name is Michael Jordan. I'm out of Region III with the NRC. It is September 3, 1991. We're conducting an investigation of an ' event that happened at Nine Mile Point on August 13, 1991. MR. IBARRA: I'm Jose Ibarra and I'm part of the IIT Team, Instrument and Controls. MR. MACHILEK: I'm Rudi Machilek. I'm Director of the Technical Group of the Technology Center. MR. HESS: D.J. Hess, Director-Customer Support Operations for Exide Electronics. MR. RANSOM: Waymon Ransom, Customer Support Engineer for the Western Region. MR. GRADY: Michael Grady, Manager of Technical Support. MR. STONER: Jim Stoner, Consultant with the IIT Team. MR. ROSENTHAL: Jack Rosenthal. I'm the IIT Team Sitting next to me is Frank Ashe, who I look at as Leader. my central focus for this meeting. Frank Ashe, IIT Team member from the MR. ASHE:

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24 MR. TERRY: I'm Kyle Terry. I'm Vice President of 25 Nuclear Engineering for Niagra Mohawk.

Office of Nuclear Reactor Regulations.

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MR. JOHNSON: I'm Kerry Johnson, Vice President of
 Failure Prevention, Incorporated.

3 MR. POHIDA: Tom Pohida from Instrumentation and 4 Controls Branch, member of the IIT Team.

MR. ROSENTHAL: Rudi, I think that we really have 5 to rely on you. What we had related was that we wanted to 6 understand, truly understand the system, rather than 7 guessing and that the best thing to do is to do it top-down 8 on what's the system, what was its intent, how does it work, 9 and get progressively deeper into what makes this thing trip 10 a lot, what makes the thing run, with a lot of focus on the 11 A-13 card cage. 12

MR. MACHILEK: All right. Where do you want me to start? Basically, as you know, the uninterruptible power systems originally, if you go back in time, and I have to go back in time a little because we are talking about ten-yearold equipment that we're dealing with here.

Originally, the purpose of the UPS was an uninterruptible power supply, meaning that if your utility power went away, there was an alternate power source which takes its place. It carries you through a scenario where the utility goes away and then later on comes back again. It also had some elements of power conditioning, which means that it took the spikes and the switching

25 transients and so on out of the actual critical power supply

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1 which was supplied by the utility.

Later on, our customers and we in the industry found that the actual load which was connected to the critical bus was the subject of protection. That means the person who operated a piece of equipment which was powered by the UPS, his prime concern was the power on the terminals, actually where he was receiving power rather than what the UPS was doing or something else.

9 The explanation of UPS then became an 10 uninterruptible power system. If you really look at a UPS, what it was supposed to prevent is if you have a power 11 station, like an atomic power plant, the power is pretty 12 good. Normally, a failure in the power station itself, if 13 you're talking about generating stations of the old type, 14 steam power plants, coal-fired and so on, there were rarely 15 incidents of losing the whole power supply; for instance, if 16 17 an atomic power plant goes down.

18 The operations were from the transmission of the 19 power from the generating plant to the actual users input, 20 and then the distribution of power down to the terminals of 21 the equipment which was supposed to be protected.

So our whole focus as time went on was to safeguard the power not only from the standpoint of having a power conversion module or a box sitting there, but examining the whole system, recognizing the fact that all

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the maintenance and fail operations in a distribution system still exist, coming off the UPS like they did exist before coming off the power plant, except the scope was reduced to exclude all the transmissions and the outside elements from there.

What we did after that was to actually start б 7 supplying uninterruptible power systems, meaning that we 8 took responsibility for the design of the system from the 9 actual utility power input to a user's distribution system, 10 to include the supply circuitry to the UPS, the UPS itself, its bypass circuitry, the maintenance of all those elements, 11 and then, of course, the coordination of the downstream 12 distribution to the actual user of the equipment. 13

14 The reason why I was saying all that is that at 15 the time ten years ago, whoever designed the system was not 16 designing an uninterruptible power system. Switchgear was 17 purchased, a UPS was purchased, and all kinds of 18 installation effects were done. On the end, you had 19 something there which was considered to be adequate at the 20 time.

The equipment was purchased as being best commercial grade. There was no special requirement for it in enhanced meantime between failure or availability. Usually, if we sell UPS systems or if they are specified by militaries or by nuclear power plants and so on, a percent

availability of power is specified. For instance, 99.9
would be a 99.9 percent of the time you have to somewhat
guarantee that the power will be there. Six nines is about
it; 99.9999, which basically gives you 18 seconds of actual
power loss per year. So maybe every 15 years you can afford
to lose the power for a little noticeable time.

Of course, you will understand that in order to achieve that, you have to go beyond the box, the actual power converter. You have to examine the input switchgear, the bypass switchgear, and, last but not least, the downstream switchgear with it.

12 The high reliability equipment avoids two things. 13 Number one, single point failure mechanisms; that means any 14 circuit which would bring the whole system down, and the 15 system, we are talking only about the power conversion box 16 and the bypass circuitry, and the circuit which would be 17 vulnerable or which would cause by its failure as a single 18 point to bring the whole system down should be avoided.

Number two, in good UPS systems design, you do not want to rely on anything to happen in the case of a corrective emergency situation, which has not actually happened already in operation. In other words, you do not want to say if something happens, this relay has to switch or that breaker has to change state or whatever.

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If you depend on that to happen, there's a certain

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risk. If I may digress for a moment, if you would rob a 1 2 bank and you run off to your getaway car, of course, you 3 wonder is it going to start or is it not going to start. On the other hand, if it's already running, then the risk of 4 5 does it start or not start is falling away and it becomes a 6 certainty that the car is starting because it's already running. 7

8 In this spirit, we are usually avoiding -- and as 9 a matter of fact, the latest changes which are proposed to be done in the A-27 was in that spirit, that if I have to 10 11 switch the K-5 relay, for instance, why don't I only switch it at the times where if it doesn't work, it wouldn't cause 12 me a load loss, that it would be an inconvenience and so on. 13 14 I'm just telling you where we are coming from in this 15 respect.

The fact that the A-27, for instance, the new one 16 or the one which was generated by the Navy, came from that 17 kind of investigation. Somebody said, hey, what happens if 18 a power supply fails. You go to bypass. What if there is 19 no bypass? Usually you have to differentiate here between 20 21 one failure, does it survive the failure of one component, does it survive the failure of two components that fail at 22 the same time and what is the probability of that, what if 23 24 there are three things happening at the same time, what is the probability of that, because last, not least, all those 25

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1 questions can be answered with a big sign, which is dollars.

Of course, if you compete for an order; for instance, the equipment for the Nine Mile Plant, it's a complicated situation. They cannot give you a Cadillac if all you want to go is from here to there and you call it transportation. See what I mean?

7 So we have to understand here that the equipment 8 which was installed was not the highest scrutinized 9 equipment, such that it would go into high military or high-10 risk military installations or installations which specify 11 the percentage of availability and the quality which has to 12 be maintained to that end.

13 So from about 1972, we introduced the Series 3000, which the new equipment that is the subject of our 14 discussion here is part of it. The Series 3000 was 15 16 developed, if you want, between 1968 and 1972. The first system of that sort went into operation in the spring of 17 1972 at Philadelphia Electric in Philadelphia; not in the 18 power plant itself, but in the office in the building they 19 have downtown. It is still running. It is still there. 20

It is the system we have the longest in service, about 19 years now. I think if there's a question on what is the failure rate and what is the availability of power and how vulnerable is the equipment, I believe that installation would be the most indicative of that 3000

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1 circuitry.

2 The 3000 was improved. The problem was that it used to be that the development time of a piece of apparatus 3 was maybe one year and the lifetime of the design was maybe 4 ten years. Now the design time is maybe two years and the 5 lifetime is minus one year. That means as soon as you come 6 up with a piece of equipment, enough technology has been 7 made available that you almost can say whatever new I'm 8 introducing is obsolete at the time, unless you don't know 9 about the other thing yet. 10

So in that spirit, we had a Series 250 and a Series 300, 315, a Mark I, a Mark I-and-a-half, a Mark Iand-three-quarters, and then a Mark II, and then we had -from then on it became a little erratic because customers had specific needs or specific circumstances and we went more into the design of systems rather than the power conversion module.

In that spirit, we made changes, improvements, if you want, to meet certain specific requirements. The Mark II design was actually the one where we entered the era of systems rather than supply and made changes in the circuitry which had nothing to do with improving the circuitry itself, but had something to do with the operations effect of what we were doing.

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For instance, some customers said if a module went

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to bypass that it should not come back automatically ever.
They wanted to go there and investigate what caused it and
fix it or do whatever. The other customers said, gee, I
don't really care about all that; if I have a glitch in the
power and the power restores to normal, I want to come back
and I don't want to have that much to do.

7 So we had two versions already. One had automatic re-transfer and the other had manual re-transfer. The Mark 8 9 II-U was a design which consolidated all the features which were different for various customers into one universal 10 11 In other words, with the universal board, you can desian. 12 select if you want to come back automatic and manual. You have all kinds of features in there which we don't advertise 13 14 to be selectable, but they are there to aid us to come up with a board which meets everybody, and yet we can sell it 15 16 to you as a custom piece of equipment because we can adjust 17 it, but we don't have to make special production runs.

The reliability of the circuitry is better, of course, because it's done over and over the same thing. For instance, we came up with the Mark II-U selectable for 50 and 60 Hertz. So you can stick it into international units as well as domestic ones. You will never run it at 50 Hertz.

24 But if you want to test for clock failure, you can 25 actually switch a little switch and the inside of the unit



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gets programmed for 50 Hertz, and yet you have 60, the
 clock, of course, goes to hell, but the effects of it we can
 demonstrate.

In our design, anything failing in one module only 4 If you have a bypass, it will go 5 effects that one module. If you have a parallel module, such as a 6 to bypass. redundant one, the redundant one will take over without any 7 8 ill effects. We call it selective tripping. That means any failure within the module only effects the module. It does 9 not effect the output bus. 10

11 If you do not have a redundant module which works 12 with the one that you have on-line, then, of course, the 13 utility has to take its place. So the utility in this case 14 is the redundancy to the UPS. If the UPS fails, it will go 15 to bypass, the bypass being the utility.

There is a misconception, of course, if you want a reasonable assumption that once you are in the power blend itself, that you'll never lose utility power or the utility power is highly, highly reliable there. The module itself was designed to have a meantime between failures of 20,000 hours.

In other words, every 20,000 hours, if you operate the equipment for an infinite amount of time, then, as an average, every 20,000 hours you would have a failure, which does not mean that you will not have a failure until 20,000

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1 hours have passed.

As you know, if you have a dice, the probability for infinite amount of throws is that you have each one, one to six, come up exactly at the same one-sixth of the time. Of course, if you only throw the dice ten times, you will find that distribution is not true. So we are talking about probabilities here. We're talking about MPTF.

So we have to expect that you may not have a 8 failure in five years, but you may have three in two months. 9 We don't know. It's the quality of the components and the 10 design intent is of that sort. So every 20,000 hours, if 11 you want, as an average, for an infinite period of time, you 12 would have a need -- now, this 20,000 hours is only failures 13 of components which would actually effect the output of the 14 15 module itself.

16 If a meter goes bad or what have you, which has no 17 effect on the operation, we do not consider that a failure 18 in that sense. Now, if the UPS fails for an internal 19 component failure, blowing of fuses or a malfunction of 20 whatever sort, there is a mechanism in place where it shifts 21 the critical bus over to the alternate redundant source.

The redundant source can be a diesel plant which is already up. The redundant source can be a utility, such as in your case, or the redundant source can be another UPS which was running in parallel with the one you already have,

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and if one fails, the other one simply takes over and you
 wouldn't even know anything was going on.

Now, in case the UPS fails, the UPS module fails 3 itself and, as a second failure at the same time, the 4 utility isn't there either, then, of course, we're talking 5 about a double failure. The meantime between failures of 6 that to happen is calculated at 100,000 hours if the utility 7 has an MPTF for 3,000 hours. That means if the utility 8 doesn't fail more often than to generate 3,000 hours MPTF, 9 then every 100,000 hours, if you operate the equipment an 10 infinite amount of time, you will have a load loss. 11

Why do I say that? Because if you have only one module and it quits and you have only one bypass and it's not there, then, of course, if the sky breaks, all the sparrows out there, you have nothing to work anymore.

16 Now, in the case of the incident, if I may refer to the incident, you'll know what happened here. We had 17 that situation happen. The UPS tripped, became unavailable 18 19 for the user and the bypass wasn't there either simply because its quality has to be a certain one in order to be 20 It's frequency has to be within 21 labelled in existence. 22 half-a-Hertz.

Its voltage has to be at least within ten percent, plus or minus, of the mean voltage which the system is adjusted to. Of course, it has to be in sync with the

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output of the UPS module. If any one of these three conditions are not there, then the bypass is considered not available. The reason for that is if you would switch to such a bypass, let's say you're out of sync and you will switch anyway, you are suffering a phase hot.

That means instantaneously you would see a huge 6 change in frequency in an extremely short period of time, 7 where the FTD would be substantial. Any piece of equipment 8 9 downstream which is of the computer type which would be sensitive to fast frequency changes would either have a data 10 problem, it's output would be unusable, or else it would 11 even be physically damaged, such as it was in the case if 12 you go back ten years when the equipment was not able to do 13 this kind of thing. 14

Now, most of the users say that no power is better than bad power. In other words, if I have no power, well, equipment stops functioning and if I have bad power it gets damaged. Single phasing, for instance, if you lose one phase, was considered a serious problem because you're rotating all the motors and so on, drives, what have you, a lot of the three-phase pieces of equipment suffered.

So a lot of installations do have protection, that the circuit breakers actually open if you lose a phase. What that would have done any good, of course, is because the power supplies would not have seen a reduction in

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voltage on Phase B when you had the incident. It would have
 a seen a loss. We demonstrated it even was bad batteries on
 the power supply and actual loss of the bypass power was not
 detrimental.

It was a reduction in the voltage which really 5 caused us to go down. We did not consider that in the 6 design. Tell you that plain and honest. A loss of voltage 7 on one phase, a reduction of voltage on one phase was not 8 9 considered in the design of the UPS. It was designed for a loss of either one of the two supplies. If the UPS output 10 was lost, then, of course, you transfer. If you didn't have 11 12 a bypass at the time, bad luck, you go down.

13 It is designed to do that. If you lose both, if 14 you lose the UPS module, you do not have a redundant one and 15 your bypass is not available as defined, then you will lose 16 your load. So in the design application of the UPS, it had 17 to be considered that every 100,000 hours average over an 18 infinite period of time, I will lose that load.

19 That simple. Now, the question is was that fact 20 considered in the application of the module and since it did 21 happen, why was everybody upset. You have to look at it 22 from that point of view. Yes, we had five units around in 23 there for roughly five years, so we have 25 equipment years 24 of operation. How many times did we go down? We did go 25 down once and the circumstance was really one that the

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1 equipment wasn't designed for.

2 Should it have been designed for -- well, a lot of 3 should-it-have's we can discuss until we're blue in the face 4 here.

5 MR. ROSENTHAL: Let me just interrupt. What is 6 hung on the UPS, on what loadings, etcetera, is a subject 7 for the IIT, but I don't consider it a subject for this 8 meeting.

MR. MACHILEK: No, no.

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10 MR. ROSENTHAL: Just so we get agreement here.

MR. MACHILEK: I'm simply saying it in the relationship of what can be expected. If you have four passengers, you cannot have a two-seater sports car. In that relationship, I am simply saying that the severity of having that scenario happen, which was expected to happen based on the design criteria of the system, needs to be taken into consideration here.

The only reason why I'm saying that, if we would only be having a 10,000 or a 15,000 hour operating here, then we would be extremely disturbed here. The only reason I was making that dissertation was to say what is expected, and I believe this was the equation, what was the design criteria of the equipment, what is it expected to do.

Now, if the utility goes away, of course, the rectifier portion is not all that important of the UPS

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. because you have a battery there as a redundant DC supply
 for the inverter to operate. So the actual loss,
 disturbance of the input to the UPS, number one, it's much
 broader.

5 You can risk a plus or minus three Hertz of 6 deviation in the frequency and the rectifier would still 7 run. You can have a plus-ten minus-fifteen percent voltage 8 deviation and you can actually have an actual outage, or if 9 the rectifier itself breaks, all those considerations are of 10 little concern to the inverter as long as the battery is 11 there.

If the battery is not there, and now we're talking 12 13 about two failures again, the UPS would go down. The same way the little UPS, which we consider the power supply, 14 which is basically of the same design as the large one, we 15 16 have a little UPS within the big UPS. If you lose the supply to an UPS and you lose your secondary or redundant 17 power to it, which is the battery, the output goes bonkers. 18 19 It goes away.

This is the reason why you bought the UPS in the first place. You are well aware of that, that if the battery plant would go away and you have a power glitch, you've had it, you lose your load. Unfortunately, of course, the little UPS which is supplying the control power, which was at the time of the same design as the big one,

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doing the same job, suffers the same shortcomings.

All I want to say, that the normal operation of the UPS is utility power goes through the rectifier, it's been rectified, supplied to the inverter, the inverter inverts it and out comes the AC on the other end. The rectifier itself is redundant in the meaning that the battery power takes its place, not requiring a switching, though.

9 Normally, the battery is simply floating. It's in 10 parallel with the rectifier output and who supplies power to 11 the inverter simply determines who has the instantaneously 12 higher voltage at one particular moment. So whichever 13 voltage of the two, the battery or the rectifier is higher 14 in any one instant, this source will supply the power.

Of course, if one source fails, then -- now, you 15 can lose your battery as long as the AC and still nothing 16 happens. If you can restore the battery power, of course, 17 you're in good shape again. I've seen instances where, for 18 instance, auctioneering diodes, such as we have, were 19 20 paralleled with circuit breakers, that in case that one -now, an SCR fails always short, always meaning until one 21 fails open. 22

I've only had one diode open failure in the over
42 years I'm working with static power equipment, but it
happened one time. No matter if you work 60 years, your

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whole life on something, if it happens one time, that one
 time is considered a 100 percent of the failure. How come
 you did not consider that.

Of course, the question is why don't we have circuit breakers parallel to the auctioneering diodes. Well, we don't expect the auctioneering diode to fail open. Otherwise, you would have the parallel breaker, you get in a RAM, and we do have in a RAM that the auctioneering diode is, in fact, there and it's in good shape, it goes to the circuit breaker and you maintain power.

So what you expect, you design for. If you can afford to design for it depends now on the probability and if you want to spend the money. If it once happens in 60 years, do you want to really install it, maintain it, and do all these good things. Well a lot of people say no way, forget it.

But you only have one spare tire in your car. Why don't you have two? Well, how many times did you have a blowout on two tires at the same time? Never. None of us have, right? But it could happen, right?

So in that spirit, we have now the battery as a redundant power supply to the rectifier. Is it an absolute 100 percent true that you never lose DC power? No. You can only reduce probabilities, you cannot reduce the risk and son on.

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Now, once you have the inverter, unfortunately the
 inverter has to be -- I think we covered the basic
 operation. As long as you have AC and battery, you have an
 inverter, as long as you have a bypass, whatever happens,
 you go to bypass. So far, the load is not being effected by
 anything.

I follow the -- if you lose the MR. ROSENTHAL: 7 rectifier, you go on the battery, etcetera. As I understand 8 the design objective, it's that no single failure of the 9 10 battery or the rectifier will cause the normal UPS to go down. On going to bypass on loss of the inverter, I think 11 we're going to have to -- that's a design objective, I take 12 it, but I think we want to see drawings and, as the morning 13 progresses, truly understand that. 14

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MR. MACHILEK: Okay.

MR. ROSENTHAL: You'll get to that. Go ahead.
You're doing terrific.

MR. MACHILEK: Now, as long as we understand that the loss of the rectifier portion, or half of the box, really, would bother us little if we confide in ourselves to the existence of single failures.

As far as the inverter is concerned, of course --23 yes, sir?

24 MR. ROSENTHAL: Sorry. There are signals from the 25 card cage to the SCRs on the rectifier side.

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1 MR. MACHILEK: Correct. There are three circuit 2 boards, commonly known as A-30, A-1, 2 and 3, which control the rectifier. If you go back in time between 1972 and 3 1976, we had two card cages. One was in the rectifier, and 4 the rectifier was a separate cabinet, physically divided, 5 and you had an inverter at another card cage; of course, 6 7 constant cost reductions and looking to make the whole equipment to be smaller in footprint and so on. 8

9 Last, not least, the least amount of components you use is the most reliable unit, because we have the 10 11 failure, MPTF is calculating by the count of equipment, of components. We combined the card cage into one and designed 12 the UPS that it behaves much like a three-phase generator 13 14 would. The only difference is that it has the absolutely constant frequency on the output. The output frequency does 15 16 not change with loading at all.

17 It's just to explain the differences between a 18 three-phase generator. The impedance, of course, the output 19 impedance is higher, 16 to 18 percent versus maybe eight 20 percent in the generator. Other than that, it is phase-to-21 phase control, not as the static equipment was if you go 22 back in time prior to 1968.

23 So as far as we are now concerned, let's say the 24 AC goes away, the battery is powering the inverter. Now the 25 question is is the bypass power going away at the same time

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1 the input power to the UPS goes away or is it not.

If the bypass power and the UPS input power go away at the same time, then, in a sense, you do not really have redundant bypass power. You simply have a UPS sitting there without a bypass and you are back to your 20,000 hours MPTF, because the 100,000 hours we only realize by having the utility.

In order to overcome that, if you are a user, if 8 you are out in the plant somewhere taking utility power, you 9 10 would come from different substations. You would come from -- if the two substations go together in the same high 11 voltage line, of course, again, you can only go that far 12 until you make tradeoffs. If you have substations and you 13 have cables coming in, of course, you try to have separate 14 cables. You have redundancy, as much as you can afford. 15

Let's take the case where the bypass power is coming from another source. You lose your source to the UPS. You go on battery. The other source is available. Then what happens is that you run on battery at the design which you had at the time ten years ago.

You run on battery until the battery was depleted, which would never happen in your case because you have a battery charger which is keeping the DC bus alive, unless the battery charger also is supplied by the same utility source which supplies the UPS in the first place. But let's

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1 not -- let's say the DC stays put.

Then you would simply run on battery. You would 2 not have any need for the bypass source until the bypass 3 source comes back. That is the designed intent of it. 4 MR. ROSENTHAL: Let's stop this again. For now, 5 let's assume that all the logic was up and running 6 7 throughout the entire event. Let's assume that. 8 MR. MACHILEK: Yes. MR. ROSENTHAL: We believe that on the normal and 9 on the maintenance supply, for sometime between six and nine 10 cycles, the voltage went to about -- somewhat more than half 11 of its normal voltage, then went to zero for three cycles, 12 and then was back up after a total of 12 cycles. 13 I think that the relay time that we were looking 14 at in the switchyard and in the plant are a little bit off 15 by a few cycles. So for six to nine cycles, you saw a 16 degraded voltage on the normal input and on the maintenance 17 bus. 18 19 Let's assume that the electronics power source is 20 qood. 21 MR. MACHILEK: Logic power. The logic power. What MR. ROSENTHAL: Yes. 22 23 should I design the UPS to --MR. MACHILEK: To keep running. 24 MR. ROSENTHAL: And it would --25

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1 MR. MACHILEK: The inverter would keep on 2 supplying power from the battery. 3 MR. ROSENTHAL: From the 5100 battery. What would the rectifier do for that small period of time. 4 5 MR. MACHILEK: Just sitting there being phased off. 6 MR. ROSENTHAL: Phased off by the logic. 7 8 MR. MACHILEK: That's correct. 9 MR. ROSENTHAL: Then when it saw the voltage good again --10 MR. MACHILEK: The voltage comes good again, it 11 recognizes that fact, it waits for a little under ten 12 seconds to make sure -- see, if you have a utility 13 switching, sometimes it comes back suddenly and you have 14 about -- you deal with the supplies of networks coming. 15 So it makes sure that the AC, in fact, is stable 16 and is back. It synchronizes to it and then walks the load 17 18 back up. It means it increases the load gradually over about three seconds or thereabouts. 19

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The reason why that feature was put in is if you come from a diesel generator, because more often than not, if a utility fails, a diesel plant starts up and the diesel doesn't want to see a sudden in-rush or increase of power. So we are ramping the load up on the rectifier.

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Once that has taken place, you are back into

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normal operation like you had before. Regardless of how
 short an outage or disturbance you have on the input, you
 end up with about 14 seconds non-availability of the
 rectifier.

5 So your large station battery will always see a 6 14-second discharge period, even if your disturbance was 7 only nine cycles or six cycles or whatever it is. But the 8 inverter simply doesn't care. It doesn't know. The logic 9 often cannot differentiate if the DC power is coming from 10 the rectifier or the battery.

11 It can only determine that DC is available within 12 the window, as we call it, between the maximum and minimum 13 battery voltage which exists on the DC link. So the 14 inverter would sit there and run.

Now, since you lost your bypass power, the way the power supply input is configured on the units you have, the K-5 relay, the infamous K-5 would have switched over and would have put the logic on the inverter output. Now, that switch-over should or was, by design, done that the battery would not really be required to be there.

21 MR. ROSENTHAL: The little battery.

22 MR. MACHILEK: The little battery, yes. That 23 means there is enough capacity in the power supplies to 24 switch you over, to carry you over. The battery, of course, 25 was there, still there, because we believed that the little

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UPS is powering the pickups. That's our philosophy.

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Yes, we are the only ones in the industry which has a control power battery. The rest of our competition, if you should lose all the power, you do not know what happened simply because you would not have any light indication and, number two, we have enough power in the battery that if everything goes bad, it still has enough power to open all the circuit breakers.

9 So we believe and I believe very strongly today 10 that that battery is a very important feature; not for a 11 single component failure or a failure, but if you have a 12 more specific scenario which not one failure or two or 13 three, but simply accumulation of failures, you never want 14 to see. You don't want an aircraft to go down with 300 15 people on it, you know. It happens.

So in that spirit, I believe we do have -- we maintain the light indications, so if you come after this scenario, that you see or you can determine what happened. That feature failed during that event. That means on the end of the scenario, we did not realize the information we should have had. Namely, what caused the trip for the UPS.

When we got the first call of what happened, we never expected that the batteries were dead. That was not a consideration. We learned that after we got the site. But only in the investigations we did up to that point was

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1 considering that the battery was in good shape.

2 We tried to find a scenario, either a multiplicity, happenings never seen before, to theorize of 3 how could we possibly, and there we go now into circuitry of 4 the A-21 board, how could we possibly get a lamp indication 5 on the A-14, which is the meter panel, how can we possibly 6 get no indication on the A-21, and that was really the focus 7 of our intent to find out what happened was -- to assume all 8 9 that.

When I talked to -- and I don't have a record of who was on the conference call, the very first one we got after the event, and people wanted to have a quick -- you know, what happened, tell me, tell me now, not tomorrow, not in half-an-hour, right now I want to know.

So we stuck our heads together. Well, we were on the conference call and we said, gee, in order to get a latch-to-latch and the lamp's not lit and the other lamp which comes on at the same time is, what possibly could cause it. So our first input was no way. The lamps had to be there, somebody had to push the button and reset it.

If you push that button, you reset all of the lights which were lit, reported lit, together with the ones which were reported not lit. They call come on at the same time, they all reset with the same button. So you cannot reset 15 lamps and have the other two lit. It doesn't work

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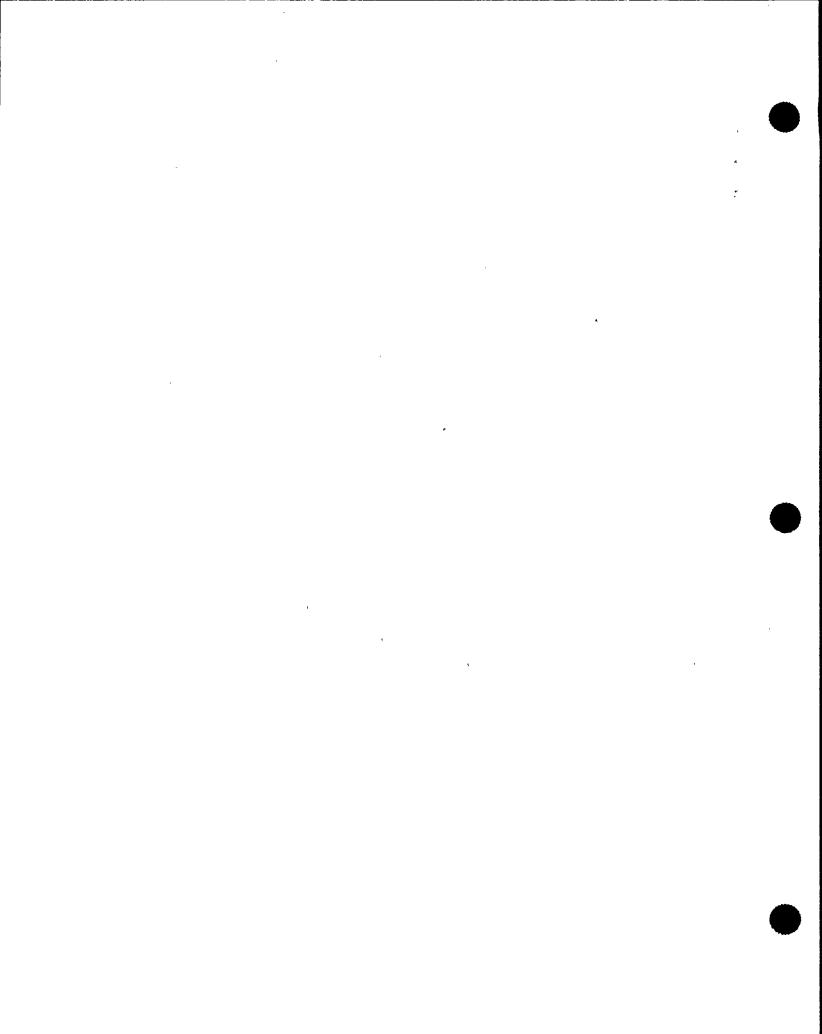
1 that way.

So we said, gee, you know, since the lamps on the A-14 were still lit and the lamps on the A-21 were not, the lamps had to go away somehow. How can the lamps go away? Well, the only -- component failures were ruled out. You cannot have the same component failures on five modules and five modules are doing the same thing at the same time.

8 So we just said, hey, you know, to have a chip 9 here or there or something went bad, forget it. There was 10 no repair required. That means all units went on-line by 11 simply being restarted.

Then Mr. Bill Zuke, I think some of you have 12 13 mentioned, he says, you know, Rudi, he said there is something like an SCR latch-up, there is something which can 14 latch-up the logic without getting actually a signal to do 15 We looked into that while we were still on the 16 so. conference call and said, well, how can that happen; we have 17 a printer circuit board which is about 16-inches long or 18 thereabouts, there is a ribbon going from here to there, I 19 would have to have -- and I think the test showed ten volts, 20 but we thought between five and six volts. I made that 21 22 statement on the phone.

If I had a voltage difference on that ribbon from here to here of at least five volts, we thought at the time, it could happen. But what would not have happened is that



the latches would latch. You would have to have a trip and you would have -- after the trip, the lamps would have gone away and you wouldn't have known what was going on.

Let's say the SCR latch-up time was staying put. Then you had to switch down or off the controls, the control power supplies completely in order to get an outage. But there was no report of such a shutting down of the control modules, the control logic.

9 Matter of fact, it's not something you can easily 10 overlook because, number one, you have to shut the module 11 down or, if it's already down, you have to wait for the DC 12 link to bleed off. If you restart the unit while the DC 13 link is still up, you'll probably have a combination 14 failure. So you wait for the DC to come down to about 30 15 volts. Then you can restart the unit.

16 So it's not something you can do in the haste of going through a scenario and forget about it. So we took 17 the transcript and we searched it and there was no mention. 18 19 When we came to decide, we questioned the personnel, we said was the logic reset. Why do we have to reset the logic, we 20 pushed the reset button. I said, well, what did you do 21 after you pushed the reset button. Well, we started the 22 unit back up and it came back up. 23

24 So there was no resetting taking place. For that 25 reason, we discarded the idea of the SCR latch-up of the

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gates, which is the trip signal and what gave you the lamps on the A-14. All this was going through in haste. We were still on the conference call. I said, gee, folks, I cannot really -- all I'm saying here is we're just trying to, off the top of our heads, find a scenario which could cause the peculiar -- if it would have been a commercial situation, we would have said you're all full of -- you know.

8 The lamps were there. You just didn't -- you know 9 -- you just reset it and then you thought, gee, God, I 10 should have done this and that. But this wasn't the case. 11 We were talking about reliable personnel, we were talking 12 about more than one team which looked at it, so we did not 13 consider -- we took as a fact that the A-21 lamps were not 14 there.

The only other way, if the SCR latch-up can be discarded now, is, well, what else is there peculiar to the lamps. They all power with five volts. The only five volts in the whole system is to power these lamps. It comes from a five-volt power supply on the A-21.

So if, on all five units, the five volts would have gone away and stayed away for the whole period of time three teams looked at it, and then after pushing the button, all of a sudden they were there again, we just -- not reasonably, with any academics and even practical reasoning, we could come to a conclusion that that would be a

1 possibility.

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2 So this is where we were. My statement, and I 3 think it's on the transcript of the last meeting, was, 4 folks, I have to consider it academic, it doesn't really do 5 me any good to search for it for another ten years because 6 we will never find out.

7 There is no way I know of, and if there are any 8 experts elsewhere which can look at it, you're never too old 9 to learn. But what I have to my command in the development 10 lab in the Systems Test Department, I just can't do it for 11 you. If I cannot duplicate a failure, no explanation would 12 suffice. Show me, don't tell me, and I cannot do that.

For that reason, I suggest that to -- I don't know to what extent there is a need for explanation of the incident down to an understanding. This is where we ended up, that I said, you know, at this point, I say to myself let the powers to be and the experts will look into that some more.

All I was interested now is in how can I help you to improve the situation, not to prevent a scenario like this and give you a guarantee in writing and my paycheck, although it's not that big, but simply say what could we have or what would we do, what can I do today to help you, us, in order to improve the situation.

What I said to myself, well, the philosophy of an

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UPS, as I explained at the beginning of my dissertation
 here, is not to ask for something to work which doesn't work
 before an incident, but take the risk away.

For that reason, I was suggesting the change of 4 5 the A-27 board to say let me -- you always have to start on ' the bypass because the inverter isn't there. So if we say 6 inverter preferred, it was a bad choice of words. You have 7 8 to have the preferred supply to be the bypass or some others, like -- the other ones, you have to use a DC 9 converter off the battery. But it has to be other than the 10 11 output of the UPS.

Now, the battery supply in the commercial systems is not that reliable that we can work off the DC to power our power supplies. In your case, different story. So what Is ay to myself, if that K-5 would switch right away after the inverter is brought up and becomes available, you've got to switch at one time or the other.

Either you stay on bypass and you switch when you need it or you go and switch right away, then you stay there. This was the reason why I suggested the change, that the K-5 were not working would be -- the importance of it would diminish; again, not as a single point failure, together with a dead battery, two failures you've got to have, two or three.

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You've got to lose the power for a reason, the

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transformer failed, you had a bad battery, and to decide why
 to switch at that period of time. So I can take that risk
 away. I can say, okay, I have the getaway car running,
 ready.

5 Now, you would have detected the bad battery 6 because if you started up the unit and you wanted to go from 7 bypass to UPS, you may or may not. Chances are that you 8 would not have to take the -- unfortunately, the problem is 9 that you cannot detect the battery, you cannot measure a 10 dead battery unless you discharge it.

The open circuit voltage can stay up to roughly two volts per cell, even on a very poor battery. You have to put some load to it and see how fast the battery voltage collapses.

Normally, we are doing that twice a year. In our 15 commercial contracted maintenance procedures, we go in twice 16 a year, every six months. We go on maintenance bypass. 17 That means we switch the load actually around the whole UPS 18 and go through and check out everything. So we never had in 19 the past a battery which wasn't load tested either twice a 20 year or at least once a year, because some customers 21 objected to the twice a year for the simple reason that they 22 did not want to come off the UPS twice a year. 23

They said once a year we have a general maintenance period. Some during a long weekend, they had

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from 2:00 in the morning on Saturday till maybe Sunday.
 There was always some window where we could go in.

We never could at these installations -- and customers get over-confident. Nothing has happened to them for three years to say, well, why should I shut down twice a year. This is basically the way that the situation is still.

Now, can you design -- okay. As far as what you 8 see in the manual was already describing the Navy style, 9 unfortunately. We switched over, as I told you, to the Navy 10 style, which is redundant power supplies. The fact that 11 it's a relay K-1 and not K-5 is to keep off that --12 somewhere I have a schematic with me on that -- which has 13 two pairs of power supplies. Here it is. See, one, two, 14 three, four power supplies and the relay is a K-1 relay. 15

16 It's the same battery still, everything is still -17 -but this is actually the power supply plan which was 18 described in the manual which was supplied in 1985, and I 19 think my colleagues here from Field Service can go into why 20 it wasn't the right one.

MR. ROSENTHAL: I read this manual twice over the weekend and I'm not sure that I was reading the right manual.

24 MR. MACHILEK: On Page 210, you have a description 25 of the -- see, this one says here 817 K-1.

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1 MR. ROSENTHAL: Right. MR. MACHILEK: This is not your power supply. 2 MR. ROSENTHAL: So what is the manual for what's 3 in the plant? 4 MR. MACHILEK: This is what it should read. 5 MR. ROSENTHAL: And who else has copies of this? 6 7 MR. MACHILEK: Angela Freeman. MR. HESS: This is the one you sent up to Niagra 8 Mohawk, right? 9 MR. MACHILEK: Yes. 10 MR. HESS: She's in our Engineering Department. 11 Clarify your question, Jack. I don't think we got your 12 question. 13 MR. ROSENTHAL: So Niagra Mohawk had a manual. 14 MR. HESS: That's correct. 15 MR. ROSENTHAL: Which I think is this manual, or a 16 copy of it. 17 MR. HESS: I haven't seen it. Do you want me to 18 take a look at it? 19 MR. MACHILEK: This is a copy of the manual that I 20 brought and made a copy of. 21 MR. HESS: Okay. 22 MR. MACHILEK: This is the one which Mike gave me 23 24 when I went up. MR. HESS: Then this is the 1985 manual. 25

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That's the 1985 manual. MR. MACHILEK:

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MR. HESS: Okay.

MR. MACHILEK: You have to explain if it's needed 3 here or why the 1985 got into that. 4

MR. ROSENTHAL: What we're going to be talking 5 about today is the manual for the units that are in there 6 7 and the drawings for what's really there.

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MR. MACHILEK: Yes. The drawings --

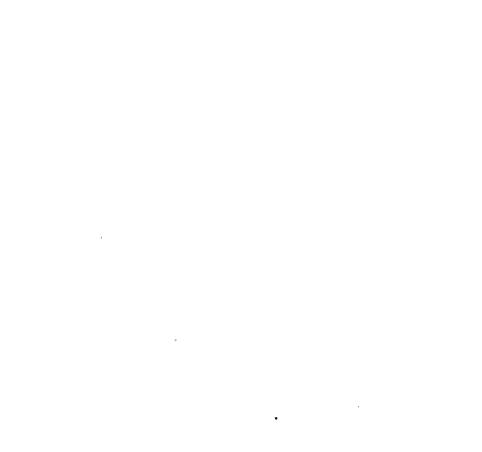
And I don't know if Niagra Mohawk , 9 MR. ROSENTHAL: had them. They have them now, I assume. 10

MR. MACHILEK: When I came to Niagra Mohawk, Bob 11 brought in a whole stack of drawings because you guys or 12 somebody wanted them. I looked at that stack and said, you 13 know, what are you doing with all these drawings and he 14 said, well, these are the ones we have to give to you people 15 16 and to the institute and what have you, so many copies.

So I said, you mind if I look at it, and we looked 17 18 through the drawings and about two-thirds of them were not 19 even the same equipment. They were 100-KW modules and God 20 knows what. I conferred with him and said, you know, is the documentation I have in hand the proper documentation, and 21 the answer was yes, that it was, except for some items which 22 we could not recover. There was in 1985 a request from the 23 plant to resupply a set of drawings. 24

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The problem was that the original drawings which



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were generated were not around no more. So we only had prints. The manual was there. So what somebody in that department which is filling the request for documentation just simply took the 1985 manual and sent it on to you. So what you have there was what we did build, in fact, in 1985.

6 MR. HESS: We don't know what they have on-site 7 from the original units. Were you able to locate anything 8 on the site?

9 MR. MACHILEK: In order to find out what the 10 manual says exactly which was supplied was the units, we 11 would have to rely on the plant to hopefully have one around 12 somewhere.

MR. ROSENTHAL: Over the weekend, reading the thing I realized -- it looked like a generic manual where it said if you're a 60-KW, but if you're 100-KW you'll have an extra transformer. I can follow through. And that doesn't -- okay, fine. But then I get to very specifics where it looks like you get a logic trip if the SCR firing logic, without lighting some of the other lights.

For something like that, you've got to know whether that is the manual or a generic manual when you get into specifics like that, or maybe -- but you do have the drawings with you of the actual installed units, right?

24 MR. MACHILEK: The drawings which were drawn on-25 site, identical to what the unit is. The manual does not

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1 reflect that.

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2 MR. ROSENTHAL: And you've got copies of the 3 drawings with you.

MR. MACHILEK: Yes.

5 MR. ROSENTHAL: Good. Why don't we take a five-6 minute break.

7 [Recess.]

8 MR. ROSENTHAL: As an intro to where we are going, 9 I have 90 percent confidence that the design changes that 10 have been proposed make the machine less suspectable to 11 spikes on AC supplies, et cetera. We recognize that we 12 can't reduplicate the event short of throwing a crowbar 13 across a major transformer in the plant. What we were doing 14 up at the site was really simulations at best.

When you toggled off the AC supply to the control logic you did see a little spike on the output of the supply even with fresh batteries. So it is of interest to us to learn as much as we can about the logic response of the unit so we can fully appreciate what we are fixing and what vulnerabilities might still be there.

With that, let me give you back the floor. MR. MACHILEK: What may be of value here is to speak a moment about what a battery is doing.

24MR. ROSENTHAL: What kind of battery?25MR. MACHILEK: Any battery. What you just

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described as having a little spike on it is what we refer to
 as a crack of the whip. If I may approach the board.

What you have on a lead acid battery is basically 3 4 your open circuit voltage would be 2 volts per cell. Your charge voltage is 2.5 to 2.17 volts per cell. This is the 5 constant voltage which comes out of the rectifier. 6 It doesn't work like that on a standard UPS. The reason why I 7 discuss it like a standards UPS is because the power supply 8 of the little UPS behaves like that. If you loose the 9 10 charge voltage, automatically the battery voltage drops down to 2 volts per cell. Unfortunately, it drops down a little 11 farther and recovers to 2 volts per cell. We call this a 12 crack of the whip. 13

The reason for that is that the series impedance was the battery. If you look at free flowing circuit, you have a little resister and a conductor and then you have your internal battery, your EMF, and then you have a little leakage, conductor, a resistor, and there is another leakage capacitor.

As soon as you have a charge curve in demand from the actual battery cell, you are deducting the voltage drop of the series impedance. If you go inside, you have a little plate, and then you have a little connection going up to the post and from the post there is a leak, which manifests itself in the sudden voltage drop and the spike.

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It recovers and stays basically at 2 volts per cell and then
 slowly decreases in voltage.

This behavior would include the large station battery as well. In your case, the reason why it is different is because you have another rectifier which really keeps the voltage. So you are not dropping down on the large station battery. You will not drop down to 2 volts as long as the other rectifier is keeping the flow voltage up.

9 We have two rectifiers in your case on the large 10 station battery.

MR. ROSENTHAL: Right. There is a separaterectifier.

MR. MACHILEK: There is a separate rectifier which
is on the other side of the auctioneering diode.

MR. ROSENTHAL: I don't know what its capacity is,
but I think that is moot.

MR. MACHILEK: It is of no consequence here.
The only difference in operation is that you would
stay up at 2.15, because the other charger supplies flow
voltage, whereas if you only had your own rectifier you
would lose that source. So you have a redundant rectifier,
if you will, installed in your system.

23 MR. ROSENTHAL: Our concerns with respect to this 24 event is that these spikes are short in time compared to the 25 time it takes relays to move and the shunt trips, et cetera.

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I don't know what the time scales of something like this
 with a spike is compared to the CMOS logic, which I take it
 is running at 180 kilohertz.

MR. MACHILEK: The power supply is monitored. The 4 CMOS logic is not affected by voltages below 16-1/2 volts. 5 If you would have gone with that spike below you would have 6 gotten an alarm which says your power supply is -- as a 7 matter of fact, it would shut down on you. In UPS design 8 you have to take the crack of the whip into consideration in 9 your window for the maximum/minimum voltage you can allow 10 the battery to operate, which includes the crack of the 11 whip, of course. Otherwise all the UPS would go down as 12 soon as you had discharge. 13

14MR. ROSENTHAL: Do you want to go on or do you15have a plan for today?

MR. MACHILEK: No. I'm here to explain or
describe or theorize anything you may want to hear.

18 MR. IBARRA: Can we go into the details of what19 that battery was supposed to do?

20 MR. ASHE: So far Rudi has given us a broad 21 overview of a very simplified diagram that we have here. 22 Maybe as best you can understand or perhaps some of your 23 people understand the actual wire connections to that 24 diagram, I think we can then move on to the details of the 25 A27 panel.

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MR. MACHILEK: The only difference here is that
 you have another rectifier sitting here, AC/DC.

3 MR. ROSENTHAL: That's external to your scope of4 supply.

5 MR. MACHILEK: Correct. The idea here was that 6 your own station battery is keeping the battery floating and 7 the rectifier of the UPS is prohibited from recharging the 8 battery.

9 MR. ASHE: How is the actual wiring done here, 10 here and out here? Is it delta? Is it Y? Is it grounded? 11 Is it ungrounded? The actual Nine Mile Point installation.

MR. MACHILEK: The input is a delta, Y, double delta with the Y, and the delta on the secondary. The input is a three-wire ungrounded. The only grounded three-wire system I know of is in Japan, which they call a wild leg delta. They are grounding one phase actually of the delta. I have never seen it in the United States or Canada.

18 MR. ASHE: So these are three wires, ungrounded19 delta input.

MR. MACHILEK: Ungrounded delta input.

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21 MR. ASHE: Fine. That's that one. Let's move to 22 this one.

23 MR. MACHILEK: This transformer is a delta -- I
24 don't know if I brought it or not.

25 I did not bring it, but that is also an ungrounded

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1 delta.

2 MR. ASHE: And the output? 3 MR. MACHILEK: The output is a Y with a floating 4 neutral. We ship it as a floating neutral. It is up to the 5 systems engineering, which would be Stone and Webster in 6 this case, to determine if that should be grounded and 7 where.

Generally the reason why we stay out of that is 8 9 because of what codes you have to meet. NEC 250 basically tells you that a power source to a building can only be 10 grounded at one point. In other words, if you come into a 11 building and you have a delta Y transformer, which most of 12 the building entrance transformers are, you have a wire 13 14 directly ground via neutral point to what they call 15 electrode or the main grounding point.

If you have an UPS, then you can consider that UPS 16 as separately derived power only if you never parallel the 17 two sources. Unfortunately, on a static transfer you do 18 19 parallel the two sources. By code you cannot ground that system here separately. You cannot have two ground points 20 and parallel the two systems or you are violating the code. 21 22 Therefore you have to take this ground point here, this neutral point, and bring it over to this one. This is to 23 24 meet the codes.

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If the ground electrode is connected to a ground

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grid or a main grounding distribution system meeting the definition of the National Electric Code, then you can of course connect that point to that system which is considered to be the electrode.

5 MR. ASHE: I think what you said is that the 6 output is a delta from the inverter.

7 MR. MACHILEK: Correct.

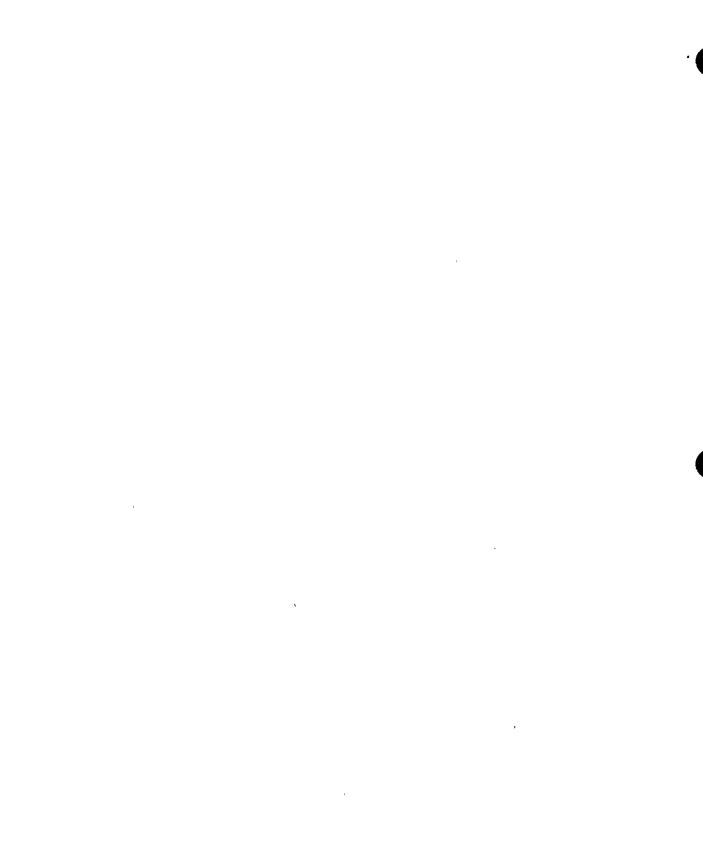
8 MR. ASHE: That ground is a straight piece of wire 9 that goes back to here.

MR. MACHILEK: This doesn't matter. Since this is
a delta transformer, you are isolated.

MR. ASHE: But how is the Nine Mile Pointinstallation, as best you understand it?

MR. MACHILEK: What we have here is another 14 This is this transformer here. This 15 transformer. transformer has to come to here. Due to UPS output it is no 16 longer your building entrance transformer; it is now this 17 transformer which constitutes the alternative source. 18 Therefore the neutral point of this one and the neutral 19 point of this one have to be connected together and grounded 20 only at one point, either here or here or somewhere in 21 It doesn't matter. between. 22

23 MR. ASHE: You are saying the output here is 24 grounded back here with respect to this transformer. 25 MR. MACHILEK: These two neutral points have to be



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1 connected together and grounded once. Whether here or here 2 or anywhere else, to the best of my knowledge and interpretation of NEC, is immaterial. 3 4 MR. ASHE: To the best of your knowledge, how is 5 it done at Nine Mile Point? MR. MACHILEK: This one is connected to this one 6 7 and this one is grounded. 8 MR. ASHE: All right. MR. STONER: Let me clarify something. I thought 9 you indicated that the AC source inputs were a delta. 10 11 MR. MACHILEK: Yes, sir. MR. STONER: According to the utility drawings, 12 13 the inputs are grounded Y's on the low side, which are the 14 source inputs both --MR. MACHILEK: Then whoever did these drawings 15 16 didn't know what it was. 17 MR. STONER: You have verified that it's a delta. MR. MACHILEK: I have known since 1962 they are 18 19 delta Y transformers. 20 MR. STONER: Inside your inverter, you mean? 21 MR. MACHILEK: Absolutely. MR. STONER: I'm sorry. I'm talking about the 22 23 source to the inverter. MR. MACHILEK: I wouldn't know. 24 25 MR. STONER: So you were speaking of the

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transformer in your UPS.

MR. MACHILEK: 2 Yes. MR. STONER: Fine. That's what I wanted to 3 clarify. 4 5 MR. MACHILEK: I have no knowledge of what goes on upstream from there. 6 MR. STONER: There is no drawing here. This is 7 the drawing only for the customers' transformer. 8 9 MR. MACHILEK: If you start from the 375 or whatever high voltage line that is, you have three 10 transformers before you get to this. 11 MR. STONER: I just wanted to be sure that we were 12 talking about the same thing. 13 MR. MACHILEK: We are not. This is the 14

15 transformer which actually is within the UPS, within the 16 box, and there are only three connection points.

MR. ROSENTHAL: That makes sense, because you go
delta Y, delta Y, delta Y. So you have got Nine Mile's Y
feeding your delta.

20 MR. MACHILEK: We coiled the transformer 21 distribution downstream only to that end, to assure 22 ourselves that the phase that was the ground on the high 23 voltage always was the phase that was the ground on the last 24 one of the transformers.

MR. ASHE: Did you actually take it all the way

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1 back up, though?

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MR. MACHILEK: Yes, sir.

MR. ASHE: You did?

4 MR. MACHILEK: At least as good as you can 5 establish from the drawings.

6 MR. ASHE: So the 575 is between A and C phase or 7 B and C phase or A and B phase?

8 MR. MACHILEK: Correct, 200 volts to neutral, or 9 199.6, or whatever. It is basically 200 volts. They 10 dropped down to 80 kilovolts. We took that ratio. If you 11 follow the whole distribution of all the transformers, you 12 end up with the same 200 to 80. That was the basis for 13 asking for the adjustment of the rheostat or VRAC.

MR. ASHE: Most of the loads as far as you know were 120 volt loads. So when you say 120 volt out here, three phase, what you are really saying is between a phase and neutral.

18 MR. MACHILEK: I don't think you have a four wire 19 distribution off the UPS.

20 MR. ASHE: For example, 1A, which powers a lot of 21 instruments loads. Isn't that 120 volts?

22 MR. MACHILEK: Yes, but you have a transformer in 23 between the UPS and that load.

24 MR. ASHE: What does this 208 mean, between where 25 and where?

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MR. MACHILEK: Phase to phase. If it would be a four wire system, it would be 120/208.

MR. ASHE: That is the way it is taken and used and then you go through a transformer if you need 120; is that the way it works?

6 MR. MACHILEK: That is correct. Or you could wire 7 the Y out and use it as a neutral.

MR. ASHE: Wouldn't it be easier to do that? MR. MACHILEK: Our system allows you to work it as

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10 a three wire system or a four wire system, floating or 11 neutral ground. We don't know how it is being used, so we 12 give you all the options.

MR. ASHE: If they have a ground and a neutral here, is that the same point? At this point. A ground and a neutral.

MR. MACHILEK: The ground and the neutral can 16 17 never be the same point except as executed in accordance with NEC. 18 That means the neutral is white and ground is If you have a distribution box on the wall, this is 19 green. 20 where the ground and the neutral can be connected together because that point is considered to be the point of the 21 ground electrode. But you are not allowed to connect the 22 neutral and the ground together in the box. 23

24MR. ASHE: Your box has a neutral.25MR. MACHILEK: My box has a neutral and it has a

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1 safety ground, which goes basically to the cabinet.

2 MR. ASHE: The neutral in your box connects where 3 in your box?

MR. MACHILEK: Nowhere. As shipped, it doesn't 4 connect anywhere. It is up to the systems designer, the one 5 6 who determines what the whole power system incorporating the UPS looks like to establish if he has to ground the neutral 7 or bring the neutral to another point which is grounded or 8 let them float. We have floating neutrals in cases where 9 all the loads are step-down transformers, like on 480 volts. 10 We distribute three phases and then we step down all the 11 12 loads to 120 or 208 isolation transformers, which only secondarily have an isolated ground for that system. The 13 reason we do that is because in large computer centers you 14 15 do not want a common ground between different missions or operations, and you isolate it that way. 16

Do you have a ground lug in your box? 17 MR. ASHE: MR. MACHILEK: 18 Yes. MR. ASHE: That connects where? 19 MR. MACHILEK: We don't connect it. Somebody 20 connects it. 21 22 MR. ASHE: But it is inside your box? MR. MACHILEK: Correct. 23 MR. ASHE: Connecting where inside your box? 24 MR. MACHILEK: To the neutral of the transformer. 25

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That means you have the transformer and out comes one, two,
 three, four terminals.

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MR. ASHE: I got you.

MR. MACHILEK: Unless we have a turnkey job, meaning we are also the installers, we do not get anywhere near telling you how to do things. The installer usually is responsible for the codeworthiness of what he is doing.

MR. ASHE: Very good.

9 MR. ROSENTHAL: Ultimately I want to learn what 10 the logic is.

MR. ASHE: I think we need to go to the A27 board and go through some of the details of how this unit isolates when that DC power supply drops down and show the signals why it isolates: CB1, CB2, CB3, all of them. And through the details of the A27.

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MR. MACHILEK: Then we need A27.

MR. ROSENTHAL: We will need copies of these
prints. I leave it up to you guys to designate those things
you consider proprietary or not. We will protect the
proprietary but we still want a copy.

21 MR. MACHILEK: This is A27, which was supplied 22 with the unit. The wiring of it was exactly like that.

23 MR. ASHE: Maybe I asked for the wrong thing. We 24 clearly understand this guy. No problem. What I think Jack 25 is interested in is the downstream logic down here and

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1 showing how it sends the signal.

2 MR. ROSENTHAL: Or you could start here and work 3 backwards.

I take it that you energized the shunt trip coils on CB1, CB2, CB3 to shed the loads.

6 MR. MACHILEK: You have to get A21.

7 MR. ASHE: When this voltage out here drops below 8 a certain value, we want to show how it isolates this guy, 9 this guy, and this guy.

MR. ROSENTHAL: Help me on this drawing a little hit. You energize the shunt trip to trip the breakers, right?

13 MR. MACHILEK: Correct.

MR. ROSENTHAL: These contacts here, the two K1's,
two K2's and two K3's, come from the 40 volts.

16 MR. MACHILEK: It's right here.

17 MR. ROSENTHAL: It's not these?

18 MR. MACHILEK: No.

19MR. ROSENTHAL: What is the difference between20this K1 and that K1? These are different relays, aren't21they? Or is in fact the same relay shown in two places?22MR. MACHILEK: No.23You will see here a dotted line.

24 MR. ROSENTHAL: Right.

25 MR. MACHILEK: That dotted line is describing what

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we call the A27A1 board. That relay on the A27A1 is 1 associated with its conduct on the A27A1. These relays 2 here, which are not within the confines of the printed 3 circuit boards, are actually hard mounted on the A27 panel. 4 5 So the K1 here and that K1 associate together. MR. ROSENTHAL: So these are to the motor 6 7 operators. MR. MACHILEK: You can take a scissors and cut 8 9 that. I understand that. 10 MR. ROSENTHAL: In order to open up CB1, CB2 and CB3 --11 MR. MACHILEK: Shunt trip it. 12 MR. ROSENTHAL: Which means that you close these 13 contacts, which takes the 40 volts from here. 14 MR. MACHILEK: And dumps it on the shunt trip 15 coils. 16 17 MR. ROSENTHAL: Are there other sources of electricity to the shunt coil? 18 19 MR. MACHILEK: No, sir. MR. ROSENTHAL: If that is the case, then you open 20 CB1, CB2, CB3 by closing these contacts, which means that 21 you do something to these relays. 22 MR. MACHILEK: Yes, sir. 23 MR. ROSENTHAL: You change the state of these 24 relays. 25

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54 1 MR. MACHILEK: Correct. 2 MR. ROSENTHAL: I am sort of like working it backwards at this point. These relays are sitting at plus 3 20 volts here and going off to something off this page. 4 5 MR. MACHILEK: Yes, sir. I don't know if these are normally 6 MR. ROSENTHAL: open or normally closed, but when you make up the logic to 7 change these states, you trip. So what goes off this page 8 if I am working it backwards? 9 MR. ASHE: Would it be easier to work it the other 10 way, though? 11 MR. ROSENTHAL: I'll leave it up to you. Would it 12 be better to work it backwards or forwards? 13 14 Similarly, I want to look at CB4 and the logic that makes CB4 work. If you want to go from the front back 15 or from the back front, it is up to you. 16 MR. MACHILEK: This is what we call the top 17 schematic. This gives you all the wiring which is between 18 the printed circuit board. A13 is the card cage, and load 19 20 division panel, and then the power supply panel A27 is probably somewhere right here. This is the A27 which we are 21

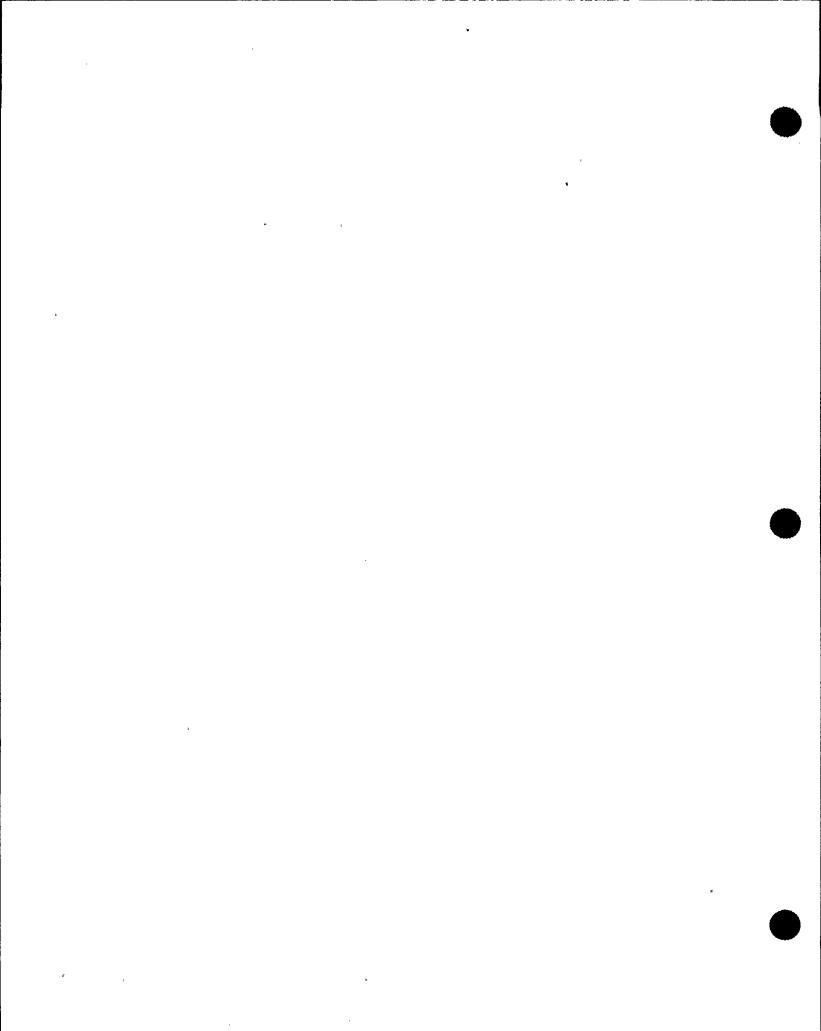
MR. MACHILEK: We are looking at what we call the

23 MR. ROSENTHAL: For the transcript, what are we

24 looking at?

talking about.

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top schematic diagram, Drawing No. D-110711102-77223.

The CB3 has its three main contacts, phase A,B,C. As you will see, the neutral comes directly from the output transformer neutral and is brought out to a terminal which is marked N. What you want to do with it is up to the user at this point.

The phase A,B,C, now we do have high-speed fuses on the output. The reason why they are are there, if you should have a short in the transformer itself, then one of those fuses will go if you try to transfer at the same time because then the power from the other side would go in.

MR. MACHILEK: No. You have got a motor operator. All the motor operator is doing is simply mechanically closing and opening the circuit breaker much the same you would do it manually.

MR. ROSENTHAL:

But those fuses didn't blow.

We have a shunt recoil. Energizing of the shuntrecoil will trip the break open.

Then we have auxiliary conducts, which are two types, two normally opened and two normally closed, and as you see, we are only using the two normally opened ones.

In order to find out what the shunt tripper is powering we have to follow wire 595 and 589. This 595 and 589 go to a plug, which is called A27P1. We should go directly to the A27P1 plug. Unfortunately we don't have the

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1 wire numbers on it. A27P1, 9 and 15.

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stream.

MR. ROSENTHAL: So we are talking about K3 that we 2 3 just followed and CB3. So we now went from CB3, the AC 4 output of the aux, and we followed that back to --MR. MACHILEK: Which means that you are coming 5 from plus 20, which if it is energized goes through the 6 coil, comes back and here and goes to the minus 20. So we 7 put 40 volts DC directly without any other interference and 8 put the trip voltage on here. 9 You will find a similar situation true for the 10 input in the battery breaker. 11 MR. ROSENTHAL: So now I have to make up the logic 12 for K1, K2 and K3. 13 MR. MACHILEK: That is correct. 14 MR. ROSENTHAL: They are sitting on plus 20 volts 15 and then they go off this board. 16 MR. MACHILEK: Since this is the A27A1, we have to 17 identify the plug. The plug is at J2, 9, 12 and 15. So we 18 go to A27P2, plug 2 and jack 2. There is always a plug and 19 20 a jack. And 9, 12 and 15. There is 9; there is 12; and there is 15. BBTR, OBTR, IBTR -- well, the "R" you have to 21 leave of. The signal is BBT, IBT and OBT. "R" simply says 22 it's a relay. 23 MR. ASHE: Okay. We are going to go back up 24

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MR. MACHILEK: Then 15 is 273; 12 is 272; and 9 is 2 274, and 274 was OBT, and there is IBT, and 15 is BBT. That 3 should jibe with what we have here.

4 MR. ROSENTHAL: Let me stop for a second. We were 5 looking at Drawing No. 110611334.

MR. MACHILEK: Correct.

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7 MR. ROSENTHAL: Now we are going backwards.

8 MR. MACHILEK: Now we have to follow those three 9 wires as they go into that wire bundle here, come up here, 10 and go to 272, 273, and --

MR. HESS: I think it's 274, not 774. It's 274,
which is right.

MR. MACHILEK: Now we have to take A13, the motherboard. If we take those three, 9, 12 and 15, we established that 9 is K3, 12 is K1, and 15 is K2. What we were saying here was that corresponds with plus 20.

MR. ROSENTHAL: These are just small relays with
 100 or 200 millisecond strobe time or something like that?
 MR. MACHILEK: Correct. Because we are switching
 a total of probably 2 milliamps at the outside.

21 MR. HESS: You are on J3.

MR. MACHILEK: It says here A13P3, and since the plug goes into a jack we have to look for an A13J3 on the A13 motherboard. A13 is the card cage and everything is plugged into the motherboard. Those connections are now

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1 made through OBT, right here, IBT, and BBT.

Now you are on your own because you have to follow
the printed circuit. The BBT, for instance, goes to the A1;
the IBT goes to the A1 right besides it; and the OBT goes -

6 MR. HESS: It goes nowhere because it didn't 7 shadow well.

8 MR. MACHILEK: Wait a minute. Let's go slowly.
9 MR. HESS: We'll find it.

10 MR. MACHILEK: Let's get the A1 and the A20.

MR. ROSENTHAL: So that goes to the motherboard and then on to the individual cards?

MR. MACHILEK: That is correct.

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MR. HESS: This one here, Rudi, is IBT and then this one is IBR, and this is pin 11 on the A20, which is the GBR.

MR. MACHILEK: Right here. The input breaker, IBT, goes to A12; the battery breaker goes to A13; this goes 19 to A20, pin 11. We are there.

A1, 2 and 3 incorporate the shunt trip, right here; input breaker shunt trip goes to a transistor driver output. This is the output of that logic against ground. In other words, we take the plus 20 volts and go directly over a transistor driver to ground. The controller is telling you once the K3 is closed and other conditions are

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correct there are other conditions which are tripping that
 relay.

MR. ROSENTHAL: Here we are going to find all the logic that causes ultimately CB1 to open.

5 MR. MACHILEK: The same thing should be true from 6 No. 3. There you have a transistor driver; ground against 7 plus 20 powers that relay. The same as you will see under 8 A20.

9 MR. ASHE: Can we back up and see what saturates 10 this guy right here? Obviously if this guy goes to 11 saturation, you pick up the relay. Can we show reduced 12 voltage out here causes this guy to saturate?

MR. MACHILEK: You would have to go to A21. The
question is what portion of the circuity tells this
transistor to saturate, right?

16 MR. ROSENTHAL: Right. In normal operation, and 17 also we can think in terms of reduced voltage.

MR. ASHE: Obviously we are saturating this guy, so we bring this guy. The collector here goes down to ground to protect the relay. What I think we want to establish in this drawing trace here is when this guy goes low we want to show how we saturate that transistor.

It may be easier to work this way. There must be something here that comes back into the front side of this transistor over here.

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1 MR. MACHILEK: Let's trace it. We are bringing it 2 over to J4. A27 J4; A27P4. We have the minus 20; we have 3 ground.

MR. ASHE: J4-8. Rudi, you come over here and you come straight over on a line to the A30 bypass panel.

MR. ROSENTHAL: Let's take a five-minute break. [Recess.]

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8 MR. ROSENTHAL: We are now on the record. Frank 9 Ashe.

MR. ASHE: Before we went off the record we had saturated Q1 on drawing number D-11007116877223. We were attempting to see how Q1 was saturated by tracing the signals upstream of Q1. Rudy, do you want to take over now?

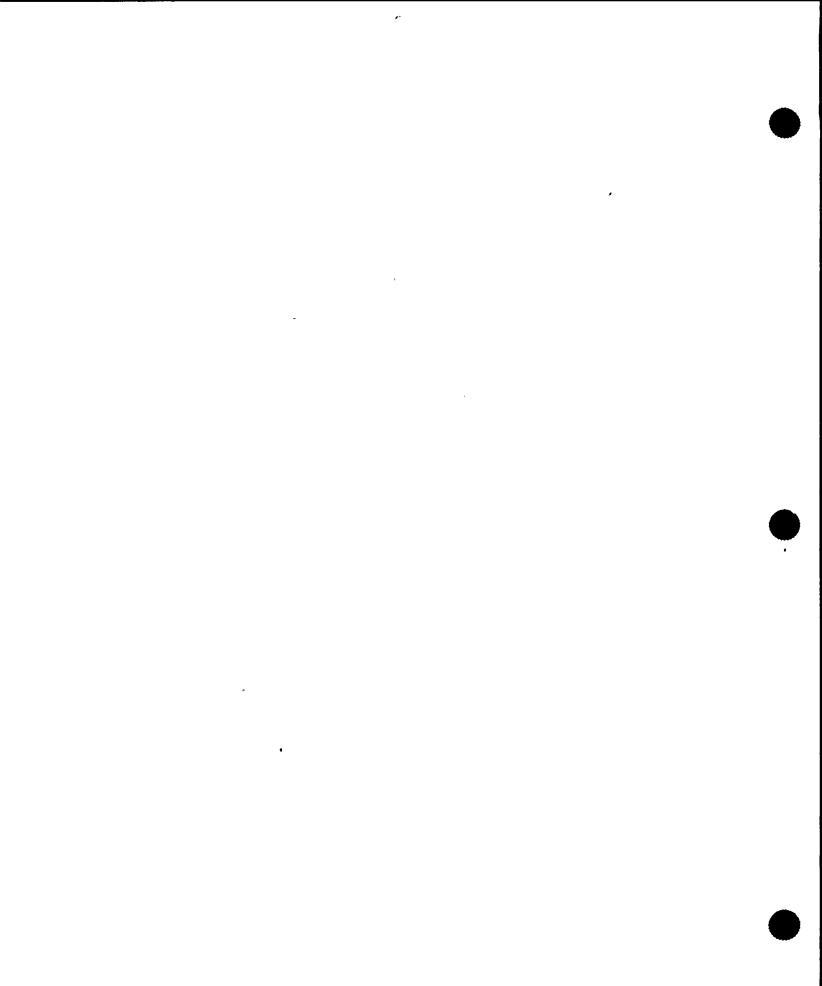
MR. MACHILEK: We went to the other end for a 14 15 moment and said the plus one to the ground and the minus one 16 is distributed throughout the cage door on the areas. On 17 the A18 board we have the plus one at the ground and the minus one and monitoring it over high position regulator. 18 There is some adjustment for the three points and will come 19 20 out with PSF. The PSF signal is brought over to the A21 21 PSF.

22 MR. ROSENTHAL: What is the function of PSF? 23 MR. MACHILEK: PSF, it monitors the control 24 voltage to be within maximum of 19 volts I believe, and a 25 minimum of 16. That's the adjustment range of that

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1 monitoring.

2 MR. ASHE: Excuse me. Is that monitoring both 3 sides there, plus with respect to neutral and minus with 4 respect to the --

Minus, plus. If either one of the 5 MR. MACHILEK: two would for instance go below 16 and one-half volts it 6 would issue a PSF signal which would go over -- comes in 7 here -- and switches the latch but uses a Q output which 8 does two things. Number one, it brings the light on the A21 9 board which says power supply failed. Number two, on a 10 separate circuit over a gate which simply detects also the 11 frequency and the voltage on the frequency. It is just we 12 use the same one for both. 13

14 MR. ASHE: That's AND gate there.

15 MR. MACHILEK: Right.

MR. ASHE: How do you get this guy again?
MR. MACHILEK: This one it gets from PSF comes up
here and sets the latch.

19 MR. ASHE: Right. We got that one. MR. MACHILEK: We got this one. 20 That's one signal going to the --21 MR. ASHE: 22 MR. MACHILEK: This is one signal. MR. ASHE: How do we get this guy? 23 They are just together because there 24 MR. RANSOM: are not enough inputs on this gate over here. Either one 25

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1 of these going --

This is not MR. MACHILEK: Either one of the two. 2 3 this plus two, it's either the one or the two. 4 MR. ASHE: That's a NAND, n-a-n-d. MR. MACHILEK: Either one, yes. Giving you number 5 б one the light, which is the light on the A14 which says logic failed, and giving you the trip signal over to the 7 8 number three to the --9 MR. ROSENTHAL: Trip light on A14. MR. ASHE: This is SSTR and has to go back over 10 11 here somewhere. 12 MR. MACHILEK: The SSTR --MR. ROSENTHAL: It changes SSTR from high to low 13 or the other way. 14 15 MR. MACHILEK: And the SSTR --MR. ASHE: This drawing right here somewhere, 16 17 right? MR. MACHILEK: No, the SSTR should go directly --18 you have to trace that back. The transfer from one point to 19 20 the next. MR. ROSENTHAL: From here we decided that it had 21 22 to go to that transistor, C1. MR. MACHILEK: C1, yes. SSTR, goes to the trip 23 relays -- you have to trace it because I don't know how it 24 comes in. The SSTR goes to the -- we have to locate the 25

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1 mother board and comes out --

2 MR. HESS: The mother board on the top print. MR. MACHILEK: It comes out of the A1 off the A21 3 and I think it goes to the 4 MR. ROSENTHAL: The A23 and the A21. 5 MR. MACHILEK: It gives you a leg off and gives 6 you this CB 1, 2 and 3 trip. 7 8 MR. ROSENTHAL: That corresponds to Q1 going to 9 ground. MR. ASHE: You have it to SST1 here but we have to 10 make the relationship between this guy and Q1 saturated. 11 12 Then, if we can do that, that's it. MR. ROSENTHAL: No, because this is monitoring the 13 voltage; right? 14 MR. ASHE: Yes. The Q1 has to saturate it, so 15 16 that has to --MR. ROSENTHAL: We have to get to Q1. 17 MR. ASHE: Right. 18 MR. ROSENTHAL: Also, this should have lit -- what 19 other thing should it have lit? 20 MR. HESS: It also ties over to B 834. 21 22 MR. MACHILEK: Yes. MR. HESS: This is 163, wrong one. 23 MR. MACHILEK: We still have to come over to the 24 Al board. I can't understand where this SSTR comes over 25

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here. I have to get the signal -- therefore, I have to come 1 2 in here somewhere, and I cannot spot it. Where is the --MR. HESS: It also goes under the TB bar too. 3 MR. ROSENTHAL: Isn't this PIN 23 on some 4 5 connector? MR. HESS: That would be the plug in connector, 6 7 Is that the A21 card that you have? Jack. 8 MR. ROSENTHAL: Yes. It's the A21. A13, A21 9 card. That comes off and it would come off on 10 MR. HESS: J8 which is the SSTR command. 11 12 MR. ROSENTHAL: It says 23 here. MR. HESS: That's PIN 23. 13 MR. ROSENTHAL: PIN 23 on connector J8? 14 15 MR. HESS: No. That's the plug in PIN. 16 MR. ROSENTHAL: Right. 17 MR. HESS: You plug the board in and that comes off that -- that coincides with this PIN right here. That 18 19 comes off the board on an SSTR which comes off of here, which is J8. J8 is over here, which is right -- that's SSTR 20 21 right there. MR. ASHE: That comes in here somewhere. 22 23 MR. HESS: Yes. 24 MR. ASHE: Is that what it does? MR. HESS: It doesn't show a wire coming off of 25



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2 MR. MACHILEK: We have three latches here now, one 3 for each breaker.

MR. HESS: That's right.

5 MR. MACHILEK: We have to set the latches, it's 6 that simple. This is UPS okay -- input breaker closed, 7 okay. This is logic command. The shunt trips --

8 MR. ASHE: Basically, all we need to do is make a 9 relationship between SSTR and over here somewhere.

10 MR. MACHILEK: Yes.

11 MR. ASHE: It looks like by the way of this thing 12 over here.

MR. MACHILEK: Yes.

MR. HESS: SSTR also comes off the A13 P5connector which is right there.

MR. IBARRA: Hold it. That's a PIN number, right?17 Isn't that a PIN number there?

18 MR. HESS: What breaker are you looking for,19 Bernie?

20 MR. MACHILEK: We have to get a signal to trip 21 those three characters, CP1, CP2 and CP3.

MR. HESS: There's SSTR, off the TB1. As you look here it's tied in there. It's tied in there and it's tied in there.

MR. MACHILEK: What way are they going?



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1 MR. HESS: That come back up -- that follows the MR. MACHILEK: That means with this three there, 2 648. 3 that's why I came --4 MR. HESS: That's right. 5 MR. MACHILEK: How do they come in here now? MR. HESS: You find it on that side. In fact, I 6 7 found it on the mother board up here. Let me fold this out here. 8 MR. MACHILEK: You have to see where we come back. 9 That means we get the SSTR --10 MR. HESS: You tie SSTR, so SSTR ties over here on 11 12 the A34 card here. MR. MACHILEK: Yes, this is fine. That's where 13 14 the transfer, but we also have to go -- this is the one that I am looking for. Where does it go. 15 16 MR. HESS: It goes in right there. 17 MR. MACHILEK: SSTR on 13 of P5. MR. HESS: P5 13, mother board. You want mother 18 19 board? 20 MR. MACHILEK: Yes. MR. HESS: Five. SSTR. 21 MR. MACHILEK: SSTR, right. 22 MR. HESS: There is also an SSTR connection off of , 23 the A21 card. 24 MR. MACHILEK: This is the A21. I am looking at 25

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the A1. We have to split it somewhere. It goes to the A21 1 2 -- it comes from the A21. It goes on to what --3 MR. HESS: Down here we split it up, off here. 4 You split coming down. MR. MACHILEK: I don't know how we did it here. 5 Ι 6 don't know how we did it. 7 MR. ASHE: Would it be better if we go off the record and try to figure this out. 8 There's a lot of blank space on 9 MR. ROSENTHAL: the tape right now. Other than wrestling papers and people 10 11 going on. 12 MR. ASHE: We can stop it. Let's stop it. Let's go off the record. 13 MR. ROSENTHAL: [Discussion off the record.] 14 MR. ROSENTHAL: Okay, let's go. Do you have it? 15 MR. MACHILEK: It changes the mother board from an 16 SSTR to a UPT. The question was, where is it happening? 17 18 MR. ROSENTHAL: We are back on and Rudy is talking. 19 MR. MACHILEK: The SSTR on the A21 which is over 20 here, goes from here to the A20 boards. On the A20 board it 21 22 comes in on -- where does it change to --MR. RANSOM: Right here on A21 it's STR. That is 23 right where it changes, right there. 24 MR. MACHILEK: SSTR PIN 23, all right, is 25

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statically connected in 53 on the A20. You see that is
 called a UPT.

3 MR. ROSENTHAL: Now we have UPT --MR. MACHILEK: It's the same --4 5 MR. ROSENTHAL: On drawing D-110071196. 6 MR. MACHILEK: This is where it comes in and 7 It trips the output breaker if other conditions can trips. also trip it, right? Either one of those ones is tripping 8 it, and one of those is the UPT. Also, it comes in on the 9 K1 as a UPT and trips number 1B input breaker at the same 10 point. Breaker and input breaker is tripped on UPT signal 11 off the A1 and off the output breaker. 12 MR. ROSENTHAL: By design then, we have now 13 14 followed through that a low voltage on the control power supply should -- MR. MACHILEK: No, low voltage on the logic 15 16 bus.

MR. ROSENTHAL: On the logic bus should result in
tripping of --

19MR. MACHILEK: Tripping of all three breakers.20MR. ROSENTHAL: Right. Now, we go to --21MR. MACHILEK: It also goes to the A34 -- do we22have an A34. What we have to show here now is that -- is it23SSTR or SSTR comes in the A34 and does all kinds of things24now.

Such as?

MR. ASHE:

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1 MR. MACHILEK: Well, we should end up in a gate in 2 a logic that says that if a bus is available -- this is a 3 trip signal. If a bus is available -- let me see how we are 4 going to do that. Transfer ready to bypass and this one 5 comes from either -- now we have to tie it into the SSTR, 6 okay? That means we have to walk ourselves --

7 MR. HESS: We have to walk ourselves all the way8 through.

9 MR. MACHILEK: Which one is it which we are 10 getting down here. This one -- this, if closed, and coming 11 out of here, go over to the 4066 and if it is selected, and 12 coming through there.

MR. ROSENTHAL: That's if the selected, you mean the auto select?

A lot of conditions have to be --15 MR. MACHILEK: number one, it checks if the CB4 got to be open in the first 16 place, okay? That means that if somebody goes and goes to 17 CB4 for instance, it would disable everything. If the CB4 18 is open and if the bypass sensing -- BC CA is showing that 19 number one, the voltage is within the window and the 20 frequency is okay and we are coming I believe from -- we are 21 in sync -- now we have to bypass -- that is reset -- the way 22 this is drawn out you can't -- coming up there and this is 23 in the UV/OV transfer -- which transfer are we looking for, 24 UPS, right? 25

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1 If we get an UPS -- this is the UPS --2 MR. HESS: That's an output. 3 MR. MACHILEK: This is the output. MR. HESS: Here is your SSTR right up through 4 5 here, Rudy. That comes up through the --6 The TP25 --MR. MACHILEK: 7 MR. RANSOM: I think what it does is, it comes in 8 through here. 9 MR. MACHILEK: Yes, I am trying to find my way 10 through here. 11 MR. RANSOM: Right here it's saying okay, we want to trip the breaker but we are looking to see if --12 MR. MACHILEK: We need a command to the -- I am 13 14 looking for the command to the CB4. If I get a one here I 15 got a static switch on, all right? This one is giving me the conditions if the bypass breaker is in fact open if I 16 don't have a load down. This is in the input, and this is 17 the output. 18 MR. RANSOM: Right here is the critical bus 19 sensing. We are also looking at the bypass fault sensing 20 21 back through here. This signal down here is going to try to hold off this signal if we are at tolerance, and this signal 22

is the signal that comes off of here which comes back toyour SSTR.

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MR. MACHILEK: Okay. Here we go.

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1 MR. RANSOM: It comes back through to your SSTR. 2 MR. MACHILEK: Yes, 4066. MR. RANSOM: That is going to hold it off if your 3 bypass is not available or not in sync with your critical 4 5 bus. MR. ASHE: In terms of time, how long does it take 6 it to make up its mind? 7 8 MR. MACHILEK: One hundred-twelve micro seconds. MR. ASHE: Once it makes up its mind that you are 9 10 out of tolerance. 11 MR. MACHILEK: Yes. MR. ASHE: How long does it hold there? 12 MR. MACHILEK: How long does it hold there? 13 14 MR. ASHE: Right. 15 MR. MACHILEK: It holds there until the bypass breaker has closed. The bypass breaker tells them it is 16 closed then we remove the signal. In other words, the CB3 17 18 does not go open until the CB4 is closed unless bypass is not available and the CB4 is open. 19 MR. ASHE: Once it decides that the bypass is not 20 available --21 22 MR. MACHILEK: Once it is not available --23 MR. ASHE: Very quickly. MR. MACHILEK: If it decides the bypass is not 24 25 available you will never get a transfer signal out of here.

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1 MR. ASHE: What I am saying is, what is the 2 minimum time it can hold that?

MR. MACHILEK: That is not available?

4 MR. ASHE: Suppose that one instance of time the 5 bypass isn't available but for whatever reason it creeps 6 back up and readjusts, and everything comes back.

7 MR. MACHILEK: Once it becomes available -8 MR. ASHE: Right. Right away?

9 MR. MACHILEK: Then you get it a sync signal, okay 10 sync signal, and then it waits until it is synced. Once the 11 sync is confirmed, then you get the third condition which 12 says that you are in sync which allows you to advance a 13 command. You are checking the voltage, okay, making sure 14 that the voltage is within plus - minus ten percent.

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MR. ASHE: Right.

MR. MACHILEK: You are checking the frequency which says the frequency is within one-half a hertz. If these two conditions are right, then you wait until it is synced. If you have a sync confirmation, that means that if you are within seven degrees of each other -- okay -- then you release the third condition and from then on it takes you 120 micro seconds to close the static switch.

If you takes you one-half hour to sync, then you know that it simply isn't -- that the conditions are not given. · · · · · · · · · ,

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1 MR. ASHE: How long -- it resets immediately. 2 There is no reset. It is not the MR. MACHILEK: light, it is simply a gate. 3 4 MR. ASHE: I understand. If you come back in sync 5 such that your criteria met, it will permit --6 MR. MACHILEK: Immediately to transfer. 7 MR. ASHE: Right. MR. MACHILEK: If the transfer is still desired. 8 9 That means -- you know what I mean. 10 MR. ASHE: Right. MR. MACHILEK: If you get an SSTR and all the 11 12 other conditions are right, you have 120 micro seconds and 13 you are on bypass. 14 I am asking all these questions really, MR. ASHE: 15 because I think these units went out of sync just prior --16 after the transformer fault. That's why it wouldn't 17 transfer. They locked out. 18 MR. MACHILEK: No. 19 MR. ASHE: Just prior. 20 MR. MACHILEK: You lost voltage. The question could be asked why didn't 21 MR. ASHE: they transfer. Why didn't they transfer to maintenance when 22 you had a maintenance good. What I think happened was, when 23 24 we got the fault these units picked that the maintenance 25 supply was no good, it locked out the transfer and it held



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that lock out because it wasn't any good. The voltage
 decayed and the unit tripped out. That's why they lost the
 bus. Is that a fair assessment of it?

MR. MACHILEK: I would suggest to go the other way. The UPS was running. The voltage suffered a decline of the phase speed, which means that it is phasing off. No problem. It's running on battery now. The bypass voltage now suffers a decrease in voltage which causes the power supply to go out of limits.

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MR. ASHE: Right.

11 MR. MACHILEK: Which issues the trip signal. But 12 the fact that the voltage has to decrease first before you 13 get the trip signal means that it is assured that the bypass 14 wasn't there at the time you got your trip signal.

MR. ASHE: That's right. You are actually saying the same thing. The units lost sync prior to tripping.

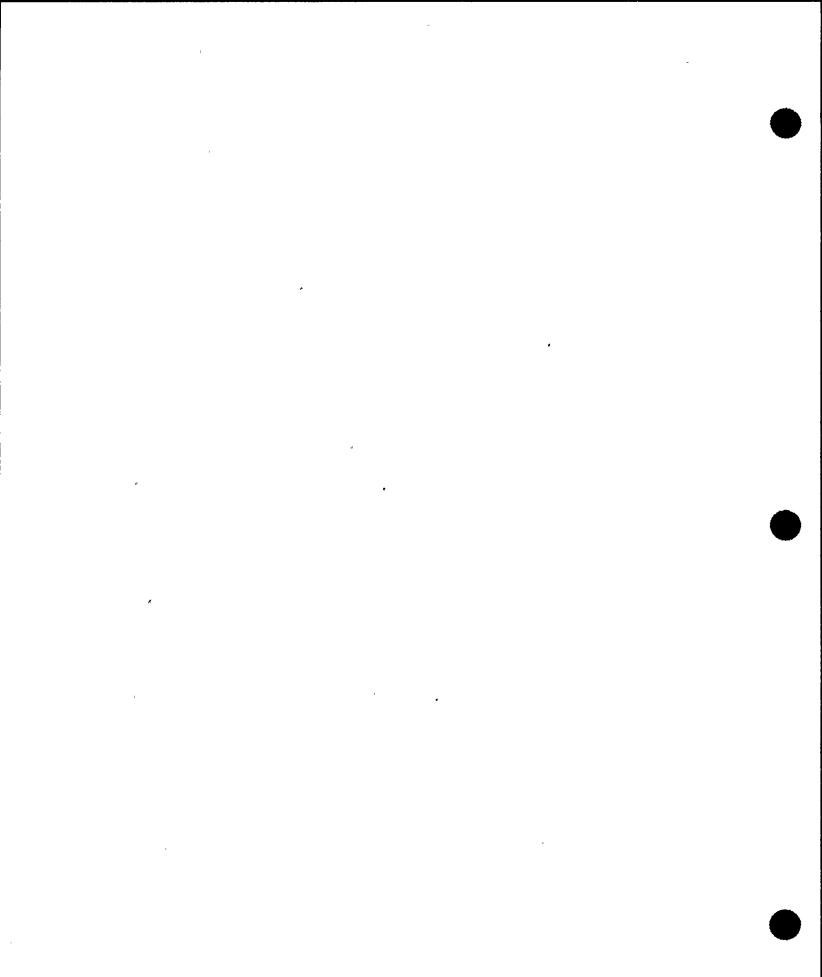
MR. MACHILEK: What does this have to do withsync?

MR. ASHE: To me it lost sync prior to tripping.
That's why --

21MR. MACHILEK: You did not lose sync. The voltage22decreased.

23 MR. RANSOM: What do you call losing sync, locking 24 out?

MR. ASHE: Prior to the event you were probably in



sync, and by in sync your three criteria -- difference
 criteria --

4 MR. ASHE: Your maintenance supply were met so it 5 will permit a transfer.

Delta --

MR. MACHILEK: Right.

MR. MACHILEK:

7 MR. ASHE: When the B phase fault occurred, I 8 think the electronics picked this up right away and said 9 hey, this maintenance source is no good. I cannot do 10 transfer.

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MR. MACHILEK: Right.

12 MR. ASHE: Subsequent to that, the voltage decayed 13 and isolated the unit.

MR. MACHILEK: It happened at same time. It's the same voltage. It's the same voltage. I suggest the Delta V is really the one which locked them out because as the voltage decayed there is no reason to go out of sync. A phase B reaction of voltage does not change the frequency of the --

20 MR. ASHE: Right.

21 MR. MACHILEK: Therefore, if you were in sync --

22 MR. ASHE: It was amplitude.

23 MR. MACHILEK: Yes.

24 MR. ASHE: Yes, voltage difference.

25 MR. MACHILEK: The amplitude locked yourselves

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MR. ASHE: Right.

MR. MACHILEK: As soon as you passed the ten percent -- as soon as you decrease below 90 percent it said no more transfer.

6 MR. ASHE: I guess what I am trying to get to is 7 the order which this occurred. I am saying I think, these 8 units lost sync prior to tripping.

9 MR. MACHILEK: Why do you say lost sync? 10 MR. ASHE: Because I think your electronics picked 11 it up --

12MR. MACHILEK: Why should it lose sync?13MR. ASHE: Let me say --

14MR. MACHILEK: You have one voltage and you have -15-

16 MR. ASHE: I'm sorry.

17 MR. MACHILEK: You have another voltage. Why

18 should it lose sync?

MR. ASHE: I am saying that I think we are having problems with the word "sync", what sync means. It blocked the transfer prior to the unit trip.

22 MR. MACHILEK: Correct.

23 MR. ASHE: Okay. So, we are saying the same 24 thing.

25 MR. ROSENTHAL: By the way, this no longer looks

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• • • like a 60 cycle sine wave because it has all the crap on it
 now.

3 MR. MACHILEK: It doesn't matter. As long as this 4 coincides, that's all it looks at. 5 MR. ROSENTHAL: Right. MR. ASHE: A signal was generated to preclude 6 7 transfer prior to the unit's tripping? 8 MR. MACHILEK: Right. Prior, we mean may be a 9 circle or -- right. The time constant it takes for the 10 output capacities of the power supply to --MR. ROSENTHAL: Let me go back to CB3. We took 11 12 that as an example where we said that you had to apply

13 voltage to the shunt coil to open this nice big break.

14 MR. MACHILEK: Correct.

MR. ROSENTHAL: You had to apply that early enough, before the power supplies went dead, or there wouldn't have been any power to in fact open CB3.

18 MR. MACHILEK: That is correct.

MR. ROSENTHAL: I am advised that that is typically maybe like five cycles that you had to apply the current to the shunt coil.

22 MR. STONER: Do you know how long it is for that 23 breaker?

24 MR. MACHILEK: It takes about 50 milliseconds for 25 the blades to actually open. A few cycles, I would say, at

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least two or three cycles. It wouldn't matter. 1 2 MR. ROSENTHAL: Two to five to --3 MR. MACHILEK: Right. MR. ROSENTHAL: To a 48 volt nominal coil you 4 5 normally apply 40 to it. You had to put some sensible 6 voltage on that, or that breaker wouldn't have opened -which we know it did -- for a couple of cycles. 7 8 MR. MACHILEK: Right. MR. ROSENTHAL: When we were following the under 9 voltage sensor we didn't see any latches, right? They were 10 11 all large gates. MR. MACHILEK: No. The power supply which isn't 12 latched -- if you lose the power supplies then you do not 13 14 latch. MR. ROSENTHAL: It was PSS --15 16 MR. MACHILEK: If you lose the voltage it causes -17 MR. ROSENTHAL: It's coming in but there's no 18 19 latches here. 20 MR. MACHILEK: Oh yes, sure. MR. ROSENTHAL: I'm sorry, that's a latch. We 21 just decided on a micro second level. 22 23 MR. MACHILEK: Yes. MR. ROSENTHAL: Nano seconds and this RC here, 24

25 micro seconds. These lights then --

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MR. MACHILEK: They come immediately after the 1 2 latch has been --3 MR. ROSENTHAL: Right. We got some of them on some of the units. I remember seen an under voltage/over 4 voltage load. 5 6 MR. ASHE: That's right. 7 MR. MACHILEK: Different --8 MR. ASHE: He's referring to the as-found data 9 which I think Wayman is familiar with. Perhaps as recorded 10 data than as-found. MR. MACHILEK: What we do not know is how fast the 11 voltage actually decayed from the 200 kilovolts to the 80. 12 It just didn't close that --13 MR. ASHE: Wouldn't the oscillograph on a high 14 15 side show some rate there? MR. STONER: I don't think you can take that as an 16 17 indication of what was happening on the low side. MR. MACHILEK: There was some decay time I assume, 18 right when the transformer failed. 19 20 MR. STONER: Decay time? MR. MACHILEK: Of the actual voltage. 21 MR. ASHE: Reduction in voltage. 22 MR. STONER: The reduction was almost 23 24 instantaneous. MR. MACHILEK: Almost instantaneous. 25

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MR. STONER: Constant.

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2 MR. ASHE: Physical insight, and I am not an --3 MR. MACHILEK: You do have --4 MR. ASHE: Three-quarters of the cycle I think it 5 dropped ten percent, and when you got four fault current 6 flowing to the step function down --7 MR. MACHILEK: We did the three test. 8 MR. ASHE: Repeatedly. We demonstrated these units. 9 10 MR. MACHILEK: You know, it was the -- there is 11 enough capacity in the output of the power supplies --12 MR. ASHE: That's a question that I had. Do we 13 have a blow up diagram of the power supplies in here? 14 MR. MACHILEK: No. 15 MR. ASHE: That is a transistorized regulator. 16 It's a linear power supply. It is MR. MACHILEK: 17 not a switch power supply or anything like that. It's 18 simply a --19 MR. ASHE: Transistor regulated. 20 MR. MACHILEK: Yes. It's a transistor regulated 21 filtered power supply. 22 MR. ROSENTHAL: You just decided that you have to squelch Q1, Q2 and Q3 in order to make those circuit 23 24 breakers pop. MR. MACHILEK: In order to make the circuit 25

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1 breakers.

2	MR. ROSENTHAL: You have to do that
3	MR. MACHILEK: You have to have enough
4	MR. ROSENTHAL: Cycles.
5	MR. MACHILEK: You have to consider here that

6 the shunt trip, even if the 40 volts decay considerably, the 7 shunt trip still would be effective, you know. The trip 8 comes from the fact that the logic cannot stand anything 9 less than six and one-half volts. You can shunt trip with 10 considerably less voltage -- the current goes up, okay?

11 MR. ASHE: What was the design intent of that trip 12 to isolate like this? Obviously, the logic would reduce 13 voltage and cannot function properly. Would it destroy the 14 unit or would it do something else?

MR. MACHILEK: It would cost you probably eightfuses.

MR. ASHE: A few SCR's or a few other proponents? 17 It shouldn't. It should not. 18 MR. MACHILEK: MR. ASHE: If the fuses act faster than --19 The current limiting fuses 20 MR. MACHILEK: protecting the semiconductors -- the switching SCR's -- it 21 is really a question of who is protecting whom, you know. 22 MR. ASHE: Are the fuses thermal? 23 24 MR. MACHILEK: The fuses are fast acting. 25 Instantaneous.



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MR. ASHE: Fast acting thermal, right?

2 MR. MACHILEK: Instantaneous. They have --3 MR. ASHE: They are faster than SCR's is what you 4 are saying.

MR. MACHILEK: They should protect the SCR.

6 MR. ROSENTHAL: We followed one circuit to the 7 power transistor that I raised earlier and we can start on 8 the next one.

9 MR. ASHE: Would it be helpful if you perhaps 10 trace it out beforehand, do you think?

11 MR. MACHILEK: What do you want to trace, to be 12 exact.

MR. ASHE: I think what he was trying to say was that he wants to go through every way you can get isolation from the -- CB1, CB2, CB3 isolated. We traced one. We know for a fact that when the DC voltage was dropped it repeatedly tripped on all of the units.

18 MR. MACHILEK: It is relatively easy. Why I am 19 saying that is, you have to get an SSTR -- from here on we 20 know what happens, which is tested.

21 MR. ASHE: That's right.

22 MR. MACHILEK: Once we got a logic output here we 23 tripped --

24 MR. ASHE: Right.

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25 MR. MACHILEK: The question is, how many ways can

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1 we do that, right?

2 MR. ASHE: Right. That's three --3 MR. MACHILEK: We can do that one, two, three, four, five, six, seven ways. Any inputs to that gate here 4 will --5 6 Basically what we have to say is how many of those . 7 inputs are trip --8 MR. ASHE: Triggered. 9 MR. MACHILEK: I did a working analysis, and if 10 you permit me to just -- we said you have all the inputs which are latched. This is the trip sequence initiation 11 12 which is all what you see down there, okay? MR. ASHE: 13 Okay. MR. MACHILEK: Then we have beside the A21 we have 14 15 other inputs which can actually trip the units, okay. Now, 16 what I say then, since I didn't have any lamps which told me what it was, I tried to establish for instance the AC under 17 voltage -- if you go down there -- I rule out as being a 18 possible source because it's ten second time delayed and it 19 seems that the whole thing was only --20 21 MR. ASHE: Cycles. MR. MACHILEK: Seven or ten cycles or 12 cycles. 22 23 This would never have come into the picture. The overload

is ten minutes time delayed so we can rule these two out,okay? Rule out because the event only lasted 200

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milliseconds, so no way. Those ones, logic failed,
 frequency failed and fuse failed would have required a
 repair. You don't get any of those without having logic
 elements going bad on you.

5 MR. ASHE: The point is, you can't bring the unit 6 back up with some of that stuff wrong.

7 MR. MACHILEK: No way, because you have to fix 8 something. You have to change or fix whatever. I say to 9 rule out all down stores and store it without repair. That 10 means you push the down store button which no reset and no 11 latches, and it was back in operation. It was just a matter 12 of getting that latch reset.

I say over temperature needs reset of thermal relays in the legs. That means the over temperature comes from thermal relays which are all mounted on the heat sinks of the switching legs. In order to get rid of that you have to push in the button to reset the over temperature.

MR. ASHE: That's important. If the unit trips
out on over temperature, it will not reset itself
automatically.

21 MR. MACHILEK: No.

22 MR. ASHE: You have to manually go there and push 23 it in.

24 MR. MACHILEK: Reset. Once they are all reset,
25 then you can reset it --

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1 MR. ASHE: If it trips out on over temperature 2 though, does it open all the breakers, CB1, CB2 and CB3?

MR. MACHILEK: Oh yes, it's a trip signal that 3 comes out the same. We rule that out because nobody said 4 5 anywhere that they had to go in and set thermal relays, okay? Circuit board interlock, that's another one which 6 comes. If the circuit boards are not all plugged in 7 properly then we have one circuit which simply runs in and 8 out and one out the other -- if it's not plugged in it 9 doesn't let you start up. In other words, if you go and 10 pull a printed circuit card while the unit is running you 11 get an instantaneous trip signal. I ruled that one out 12 13 because it wouldn't reset.

14 That left me with the logic power supply fail 15 alarm before this. I say suspect, because it is direct 16 connection to the maintenance source which could explain the 17 simultaneous fail in all five UPS systems.

MR. ASHE: All right now, key question.
 MR. MACHILEK: That was only a logic deduction,
 and I am --

21 MR. ASHE: These are the only guys that can give 22 you the kind of isolation that was actually experienced? 23 MR. MACHILEK: Right.

24 MR. ASHE: Those are the only ones. There are no 25 more.

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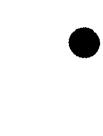
1 MR. MACHILEK: No, sir. I tell you here which 2 ones are latched and which ones are not latched. Also, what 3 is doing what. For instance you see this latched one is 4 giving you a trip. The alarm reset, of course, acts on over 5 flows. It is important that if you push the alarm you 6 cannot reset one of the three different sources of trips.

7 MR. ROSENTHAL: In the manual, I thought that I 8 saw if the SCR legs aren't firing right or aren't getting 9 the right instructions to fire, then I would get a light.

10 MR. MACHILEK: Then you get fuse blowings and you 11 get a fuse fail alarm and trip. You cannot restart the unit 12 without fixing it. Big time maintenance -- intervention you 13 have to make. Everything worked fine. Later on some 14 atmospheric or phenomena which I cannot find anybody to give 15 me a rationale I can test against to duplicate against.

This was all done prior to knowing anything about the batteries, okay? As soon as I learned the way the dead battery is, I said gee, maybe I am on the right way with my determination. I would have gone in -- as soon as I saw the manual I thought we got it. Then I looked at the A27 and confirmed that it was exactly like the module, there was no help here.

23 Unfortunately or fortunately -- whatever you want 24 to put it -- every circuit worked the way it was assigned to 25 work. It shouldn't have done all of that.



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MR. ROSENTHAL: At the same time that PSV is 1 coming down -- whatever that you run to this chip .--2 3 MR. MACHILEK: No, this works on 12. 4 MR. ROSENTHAL: Okay. MR. MACHILEK: Only the lamp is on the 12 volts. 5 6 MR. ROSENTHAL: The five volts to the lamp is coming down --7 See, this --8 MR. MACHILEK: 9 MR. ROSENTHAL: This latch is coming down. MR. MACHILEK: No, it works on 12 volts. 10 But the 12 volts is coming down 11 MR. ROSENTHAL: 12 too, isn't it? 13 MR. MACHILEK: No. Where did this 12 volts come from? 14 MR. ROSENTHAL: MR. MACHILEK: It wouldn't latch if I don't put --15 if there is no voltage there. We know it latched. 16 17 Otherwise, it wouldn't get a trip which is latched and 18 requires a reset. 19 MR. ROSENTHAL: Play that again. I apologize. Just repeat what you just said. 20 MR. MACHILEK: The lamp works on five volts, only 21 the lamp. The latch going through to the A14 and to the 22 trip is a completely different circuit. If you lose the 23 five volts you lose the lamp, but the rest of the circuit 24 still works. 25

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88 1 MR. ROSENTHAL: We are assuming by virtue of 2 knowledge of our design -- your knowledge --MR. MACHILEK: We know by knowledge that the 3 4 latches latched. 5 MR. ROSENTHAL: How? 6 MR. MACHILEK: Because the lamps, which are on the 7 A14 -- these two lamps here -- there is one lamp here which says trip. There is one lamp here which says logic. 8 This is both red. These two lamps, they are coming off here. 9 10 MR. ROSENTHAL: Which says inverter logic type A14. 11 MR. MACHILEK: On A14 and then we have a trip 12 light on the A14. Trip light on A14, these are the two 13 lights. These two lights, they can only stay on and 14 requiring reset if the latches -- which latches were, I 15 don't know because we didn't have the corresponding --16 17 MR. ROSENTHAL: There is no latch over here. The 18 latches are simply these RS --MR. MACHILEK: Simply those RS latches, yes. 19 20 MR. ASHE: What is the explanation? What if the unit had no logic lamp, this guy here, and no trip --21 MR. MACHILEK: After it had tripped -- after it 22 had physically tripped -- which means an SSTR logic came out 23 24 of here, the two lamps came on and were on, were stored. None of these lamps got lit. 25

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MR. ASHE: One-D unit is different, in that there
 was no logic lamp on the data sheet only for the 1D.

3 MR. ROSENTHAL: Let me back up a little bit. 4 Based on our interviews they go down in one UPS. I am still 5 not sure what was done on the first UPS. They then decide 6 to manually close CB4, and it's our understanding then that 7 the -- they dispersed and don't hit any more switches, they 8 just closed the other CB4's.

I am not sure exactly what was done, and I think my guys may know better than me, on the first of those units. But then the other units, I think that they adjusted CB4 so that the data recording which is about two hours in the event and then reconstructed on the others -- on the four others -- ought to be pretty good and little bit -- we could argue all day what on the first one.

16 Which is the first one they go to, Frank? Is it 17 1C or Id?

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MR. ASHE: One C.

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MR. ROSENTHAL: One C.

20 MR. MACHILEK: One C, after ram reset and normal 21 start sequence system operated without need for a UPS. One 22 D, same thing. One A, after a ram reset normal start up 23 stayed one, closing to CB1 input breaker caused upstream 24 breaker in the panel to trip. That happened twice in a row, 25 so they decided that there was something wrong in the

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1 rectifier section of the UPS and it was left on bypass.

A worker request, 162319 was issued for its
repair.

4 MR. ROSENTHAL: Since then we know it was the 5 actual breaker.

6 MR. MACHILEK: Then there comes UPS 1B after a ram 7 reset and normal start sequence, the UPS power conversion 8 module operated without need for a repair. The retransfer from bypass did not work because of a defective CB3. Work 9 request 138173 was issued for that repair. None of the two 10 11 dissimilarities with the other three had anything to do with the actual event, because the CB3 being flaky was known --12 13 MR. ROSENTHAL: Beforehand.

MR. MACHILEK: Beforehand, and the charger
breaking doesn't matter.

MR. ROSENTHAL: Can I take an aside. These are nice sized breakers, all right?

18 MR. MACHILEK: Yes.

MR. ROSENTHAL: Either they were flaky beforehand, or we broke them in the course of testing. I know the plant manager talked like you are breaking my units by testing them. It seems to me that these breakers ought to be good for many cycles.

24 MR. MACHILEK: Two hundred-fifty.
25 MR. ROSENTHAL: Two hundred-fifty cycles.

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MR. MACHILEK: Yes, sir.

2 MR. ROSENTHAL: They are not. Or, they saw a fair 3 number of cycles over the years.

4 MR. MACHILEK: Or, they are just not holding up 5 the way we expect them to.

MR. ASHE: When you say --

7 MR. ROSENTHAL: We were there on one occasion when 8 the thing tripped on over temperature. We were just 9 standing in front of the unit and it tripped out. That over 10 temperature is on the SCR leg heat sink, as I understand it. 11

MR. MACHILEK: Are you talking about the scenario when I was there when we tested? We broke a gate and then we got an over temperature.

MR. ROSENTHAL: That wasn't a trip. It wasn't a
trip. Maybe it was the next day. We were just there.

MR. MACHILEK: We were 18 20 board. We got an
over temperature and we couldn't reset it.

19MR. ROSENTHAL: This was another time.20MR. MACHILEK: Another time, okay.

21 MR. ROSENTHAL: Subsequent. The thing just 22 tripped out, and I assume it -- it was in auto reset and it 23 must have cooled down and sometime goes back on to --24 MR. MACHILEK: If you had an over temperature you 25 have to reset. If you get an over temperature and none of



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the button needs resetting then you probably have a U4 chip
 failing on the A20 boards. That's a guess. It might be a
 U6, either one of the two.

MR. ROSENTHAL: What I am wondering is, if over time this unit has automatically switched to its maintenance supply as designed and is in the auto reset mode and switches itself back onto the preferred AC --

8 MR. MACHILEK: If that would happen, you would get 9 a stored alarm that says that happened. In order to get rid 10 of the horn you have to physically push the one silence 11 button. Otherwise, the unit will sit there and blare at 12 you. You have a guard in that room, or somebody must hear 13 if that alarm goes off.

MR. ROSENTHAL: Why wasn't the horn blowing when we were tripping the units out, Frank, when we were intentionally tripping the units?

17 MR. ASHE: It was sometime.

18 MR. ROSENTHAL: It was.

19 MR. ASHE: Sure.

20 MR. MACHILEK: You say sometime?

21 MR. ASHE: Yes, sometimes it was.

22 MR. MACHILEK: Each time you should get an alarm.

23 MR. ASHE: Maybe it was each time. Most times --

24 MR. ROSENTHAL: Do you recall hearing a horn.

25 · MR. ASHE: Yes, lots of times.

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MR. ROSENTHAL: That systems guy is pretty good at
 hitting the button.

3 MR. ASHE: You have to push the button to silence 4 the horn. I can't say -- most of the time when the unit 5 tripped out there was a horn. That's the way I recall it.

6 MR. MACHILEK: I believe the units you have being 7 built ten years ago, if you got an alarm and you silenced 8 the horn button prior to resetting the alarms -- all right? 9 The lights, you have to reset separately. You silence the 10 horn and then you reset the lamps.

11

MR. ASHE: Right.

MR. MACHILEK: If you silence the horn and then other alarm came along before you reset the lights, you did not get the horn again. Today, you do on the new equipment, okay? If you silence the horn and another alarm comes the horn comes on again, okay? At that time it was not going that way.

18 MR. ASHE: Cycling the breakers 250 times, is that19 full load cycle?

20 MR. MACHILEK: It doesn't really matter, they 21 mechanically fall apart.

22 MR. ASHE: Making and breaking is not the problem 23 with that. What is the real problem here?

24 MR. MACHILEK: The real problem is that a breaker 25 -- historically, okay -- is not intended to be switched a

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lot. If you have a lot of switching you use a contact where
 you lose control means. So, a breaker basically is designed
 to stay put for a long period of time such as the branch
 distribution of whatever you have, okay?

5 If you have a situation like a bypass breaker like 6 the CB3, there comes a customer who wants to see 50 7 switchings in test in the factory and wants to see 50 more 8 once it is in store. That means you are exposing -- you are 9 doing so much testing that only -- for instance, on surface 10 security, 6.2 megawatt, 20 modules large system, okay.

I made then change all the fuses after we were doing a finish testing, because we had to show five circuit tests in the factory and five short circuit tests on the -each time you subject a fuse to near melting current it degrades itself, it compromises itself. After one or two months beyond the normal current all of a sudden the fuse goes and you don't know why.

I had this problem. You see, we started the units up and I had what they call modality failures, I lost fuse here and there. With 20 units like almost every day a fuse, I had them change all the fuses. Circuit breakers ditto -- we exercised this General Electric Circuit breakers. We had 52 breakers there, we had to service all 52 breakers after we were doing testing.

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There is a mechanical exercising of a breaker with

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no other -- sometimes doing something to the breaker, okay,
 molded case breaker specifically.

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MR. ROSENTHAL: These aren't molded case.

MR. MACHILEK: They are molded case.

5 MR. ROSENTHAL: Let me see if I got this. We were following how does CB3 trip, and we decided that you had to 6 close K3 and K3 had to close because Q1 saturated, and Q1 7 saturated off an SSTR signal on this drawing; that the trip 8 9 light on A14 came on; that the inverter logic light on A14 came on that is consistent; but that, none of these lights 10 11 came on. I thought that we got an under voltage, over voltage light on one of them. 12

MR. MACHILEK: That was on the A34 board which is
 the transfer board.

MR. HESS: That's the horizontal.

16 MR. MACHILEK: The horizontal, yes.

17 MR. ROSENTHAL: Okay. At some point let's go to 18 that board and see what turns on that light.

19 MR. MACHILEK: Which one is that?

20 MR. ASHE: The OV/UV.

MR. ROSENTHAL: The OV/UV, the horizontal lights on the upper left-hand side. We can take a break. Let's go off the record.

24 [Discussion off the record.]

25 MR. ROSENTHAL: Can somebody explain just the

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96 normal path to light these lights, because I am really a 1 2 nuclear engineer and this is not --3 MR. MACHILEK: Okay. MR. ROSENTHAL: I got five volts here to an LED. 4 MR. MACHILEK: That is correct. You get -- this 5 б is the 12 volt power supply. MR. ROSENTHAL: I have five volts, right, and five 7 8 volts may be in fact degrading volts, right? 9 MR. MACHILEK: Yes. MR. ROSENTHAL: Plus five though the LED, through 10 the diode to ground -- how? It has to come back through 11 12 here -- no. This is now changed state, right? MR. MACHILEK: Yes. As long as the latch is on, 13 the light is on. 14 MR. ROSENTHAL: Right. This PIN goes from high to 15 16 zero? MR. MACHILEK: That's right. That is correct. 17 This is an inverter? 18 MR. ROSENTHAL: 19 MR. POHIDA: Buffer. MR. ROSENTHAL: 20 Just a buffer, okay. Then, what 21 is switch one? If you put a ground on the --22 MR. MACHILEK: 23 MR. ROSENTHAL: Is this a lamp test? MR. MACHILEK: Yes. 24 MR. ROSENTHAL: That's the lamp test. 25 Now, what

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is the story with -- I am sitting at -- this switch is
 normally in this position. I have plus 20, the voltage
 dropped here across the zenar and across the transistor and
 plus 12.

5 MR. MACHILEK: This is at the 20 volts level. 6 MR. ROSENTHAL: That's at 20 and this is at 12 --7 this K1 -- energizer.

8 MR. ASHE: This is the collector on up through 9 here and that's normally closed, right through here. When 10 this guy saturates K1 --

MR. ROSENTHAL: Which means that contact is open. MR. ASHE: All that's doing is just monitoring the 20 volt supply, it looks like to me. What is it doing other than that?

MR. POHIDA: I think it might just be a delay,
monitoring and then also a delay.

MR. MACHILEK: All this is doing is, you are deenergize K1 if you are testing the lamps.

19 MR. POHIDA: Right, that's all it does.

20 MR. MACHILEK: That's all it does.

21 MR. ASHE: It breaks that and returns back and 22 puts this whole thing back into circuit. The only way to 23 change this guys state is through here, isn't it?

24 MR. MACHILEK: Yes.

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MR. ASHE: That's ground, so this point has to

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raise or lower in order to get this guy to change in the
 normal.

MR. POHIDA: It just gets around through K1.
MR. ASHE: All it really is doing though, K1 never
changed state and nothing happened down here.
MR. MACHILEK: Your main -- you prevent a reset if

7 you lamp test, right?

8 MR. ROSENTHAL: In this case the plus 12 is 9 decreasing.

10 MR. ASHE: I don't know where you get these plus 11 12 and plus 5 decreasing.

12 MR. ROSENTHAL: If the 20 is coming down --13 MR. POHIDA: I think you may not lose your 12 14 immediately. Is there a voltage regulator -- a voltage 15 regulator could hold the voltage about a minute and one-16 half.

MR. RANSOM: It will hold it down to about 13.
MR. POHIDA: You won't necessarily lose your 12
immediately.

20 MR. MACHILEK: We know we went below 16.5 but we 21 don't know how far.

22 MR. ROSENTHAL: The one constant here is the 23 voltage across the zenar.

24 MR. MACHILEK: If that whole circuit wouldn't be 25 in there I don't know why -- all they do is they disconnect

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1 the --this is shown in a discharge position and that means 2 that it is normally open. If he pushes the lamp button he 3 grounds the reset, right?

4 MR. ROSENTHAL: I guess the question is, what 5 would have happened --

6 MR. MACHILEK: That's the lamp button. This 7 prevents you from unstoring the lamps if you make a lamp 8 test.

9 MR. ROSENTHAL: The only issue that we heard 10 postulated was did K1 -- did this relay change state.

MR. MACHILEK: It didn't unlatch the latches,
because we would have lost the lamps which are held by the
latches.

MR. ASHE: Actually, the only purpose of that
relay is after you do a lamp test --

MR. MACHILEK: If you have an alarm when you do a lamp test you don't want to unlatch the latches because after you let the lamp test go you want to have the same alarm still there.

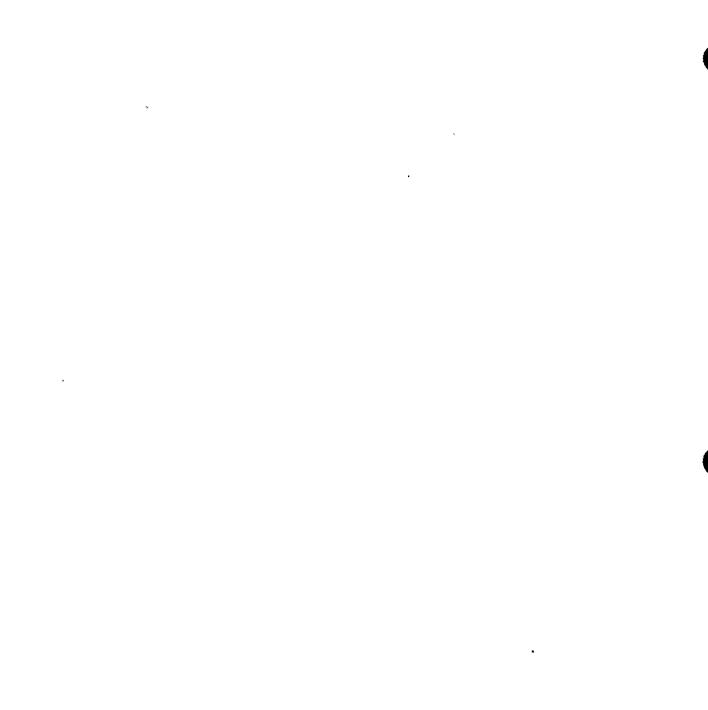
20 MR. ASHE: It seems like if you are going to try 21 to build an argument around here that some kind of way you 22 reset these guys due to this decay of voltage here, then why 23 didn't you reset these guys up here when they originated?

24 MR. ROSENTHAL: That's what the two of them are 25 saying. There is no other latches up there on these.

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MR. MACHILEK: No, sir. This goes directly to the 1 lamp and to the ground. You have the A14 to show them? 2 3 MR. HESS: Right here. You want the print? 4 MR. MACHILEK: Yes. 5 MR. MACHILEK: Which one was it, UPS trip, right? 6 MR. ROSENTHAL: In order for that light to be on two hours later, I need the logic to not have changed state 7 and the power to have been restored. 8 9 MR. ASHE: Right. MR. ROSENTHAL: I need the logic -- for 200 10 milliseconds you need the power back to 200 milliseconds. Ι 11 12 need the logic not to have changed state. MR. ASHE: Right, okay. 13 14 MR. ROSENTHAL: When I get down on the 12 volt 15 level here with the regulated power supply, are we 16 postulating that this 12 volt in fact didn't degrade in the course of the 200 milliseconds. 17 MR. MACHILEK: I had hoped that the generator 18 logic during this subsequent tests, that we will get an 19 abnormal lamp indication pattern of some sort. 20 To suggest something is wrong with --21 MR. ASHE: I had hoped, because I was --22 MR. MACHILEK: 23 MR. ASHE: Possible explanation. It didn't 24 happen. MR. MACHILEK: No, we couldn't make it happen, 25



1 let's put it that way.

2	MR. ROSENTHAL: Unfortunately, if I had it to do
3	over again, I think I would have gotten 12 dual trace
4	oscilloscopes from the plant when we were doing this test
5	and we didn't, for better or worse.
6	MR. IBARRA: Do you mean the tests that you all
7	have done?
8.	MR. ROSENTHAL: Up at Nine Mile.
9	MR. MACHILEK: We tried to reset out of I don't
10	know if we took the logic off for a long period of time, I
11	don't know. If the logic was we turned the logic down to
12	like 50 volts and let it sit there.
13	MR. ASHE: That's right.
14	MR. MACHILEK: For a considerable period of time.
15	MR. ASHE: That was done on 1C and 1D.
16	MR. MACHILEK: Tried to have a transient behavior
17	off it.
18	MR. ROSENTHAL: Frank, you saw a test in which
19	they had fresh batteries and lifted the 110 volt AC lead.
20	MR. ASHE: Fresh batteries and they switched.
21	MR. ROSENTHAL: It was a test in which the logic
22	was living on the fresh batteries a couple of minutes.
23	MR. ASHE: No. There was some decrease of 120
24	volts down to the break fault in which the power supply no
25	longer regulates, which is about 96. Up until about 96

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volts the power supply tends to regulate pretty -- very good
 -- and held it up there 19, 20 or something. Below 96 volts
 it dropped off very rapidly.

With fresh batteries it tended to stabilize and still hold it up but it was decreasing, but it still held it up.

7 MR. MACHILEK: It goes from 2.15 down to two volts 8 per cell. You cannot have more than open circuit voltage on 9 the discharging battery.

10 MR. ASHE: That was the question that I wanted to 11 ask. How much current does it take at 20 volts to drop this 12 logic; does anybody have any idea?

Oh, yes, sir. I measured that when 13 MR. MACHILEK: I got back. When the unit was not running and wasn't 14 15 energized, the positive through 1.14 -- between 1.14 and 1.17 amps. The negative had .283 or three-tenths of an amp. 16 When the unit was running the positive through 4.44 amps and 17 that was under no load. The negative through 1.084 amps and 18 then we loaded the module full load. The positive stayed at 19 4.44 amps and the negative went from .084 to .092, which 20 means that loading or not loading the module has no bearing 21 22 on that.

MR. ASHE: Could you go back to the no load case. You first started off with no loaded it was 1.1 -something. Positive was what?

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1 MR. MACHILEK: With the unit not running. 2 MR. ASHE: Yes. MR. MACHILEK: One point one four. 3 4 MR. ASHE: One point one four. MR. MACHILEK: Amps positive and .283 on the 5 6 negative. MR. ASHE: Okay. Then, you went with the unit 7 8 running. 9 MR. MACHILEK: Yes. We started the unit up under no load, and through the output was 4.44 amps on the 10 positive and 1.084 on the negative. 11 MR. ASHE: Then, running. 12 MR. MACHILEK: Then, with loaded --13 14 MR. ASHE: Loaded. MR. MACHILEK: With loaded it had the same current 15 on the positive and the negative was 1.092. I don't know 16 that anything had changed. the question is, what would have 17 18 happened --That's the lamp button. 19 The relay, I placed it at really K-5 and found --20 per the data sheets, it should drop off between 65 and 20 21 percent, which means between 78 and 24 volts. Once we saw 22 on the lower end, I believe 45 volts were lost. 23 24 The 120 volts, if we applied a ratio of 200 kilovolts to 80 kilovolts, somehow we can theorize that the 25

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120 volts went down to 50. The one relay we tested was at
 45. So it would have stayed in at 50. The power supply
 input lost regulation at 96 volts and it would trip itself
 off at 84 volts.

5 Considering all the tolerances, it could trip 6 between 86 and 78 volts, depending on the control feature, 7 depending on the tolerance of the control. On the output, 8 the 16.5 volts is adjustable between 17.3 and 15.7. The 9 last observed state on the C unit, it tripped at 16.9.

MR. ASHE: How often is that adjustment made? You
11 have no idea?

MR. MACHILEK: We check that adjustment at every PM, at every maintenance, preventative maintenance check. I don't know how steady -- does it change?

15 MR. RANSOM: No.

MR. ROSENTHAL: What do you mean by every preventative maintenance check?

18 MR. MACHILEK: Under normal -- if we have a 19 maintenance contract.

20 MR. ROSENTHAL: What I'd like to do, whenever 21 you're ready, is to take one of the lights that did go on 22 and see how that would go on by design.

MR. ASHE: Right now. He wants to -MR. ROSENTHAL: I'm sorry. It went to the D?
MR. ASHE: No, no. We went through all of how you

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1 get to CB-1, CB-2 and CB-3. MR. ROSENTHAL: Which is the UPS that they went to 2 3 first? MR. ASHE: 1-C. 4 5 MR. ROSENTHAL: 1-C, not 1-D. MR. ASHE: In testing. 6 7 MR. ROSENTHAL: No, no. When they --MR. ASHE: 8 1-D. MR. ROSENTHAL: 9 1-D. MR. ASHE: Yes. 10 11 MR. ROSENTHAL: So let's go look at 1-C and some 12 light was reported lit. 1-A, 1-B, 1-C. And then let's follow that backwards. 13 14 MR. ASHE: Which is what we've already done, I 15 think. 16 MR. ROSENTHAL: No. Wasn't any of these lights lit? Not these. On the other -- on the horizontal --17 18 there's a ---MR. ASHE: On the A-34. 19 MR. ROSENTHAL: On the A-34 board, there is some 20 light that gets lit. 21 MR. ASHE: Is that UV/OV? 22 23 MR. ROSENTHAL: UV/OV. MR. ASHE: The as-found data, I gave that to you 24 the other day. You have it. No. The as-found data sheet, 25

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1 which really is right there, too. It's the same thing. 2 It's 1-C. 3 MR. ROSENTHAL: 1-C, 1-G. So the OV/UV light on -4 MR. MACHILEK: On C, on D and on G. 5 MR. ROSENTHAL: Okay. So why don't we go to that 6 light on the A-34 board and see what turns that on. If 7 somebody has a better suggestion, I'll listen. 8 MR. HESS: We're here. Go ahead. 9 MR. ROSENTHAL: No, no. We'll do it. 10 MR. MACHILEK: If you look at 1-D, you'll see 11 ov/uv. Wouldn't that suggest that this one is on A-34? 12 13 That would be A-21, right? MR. RANSOM: That is an alarm on A-34. 14 MR. MACHILEK: This would indicate that it did, in 15 fact. 16 MR. TERRY: But that's a suspect, Rudi. I think 17 it would be better to go any of the other four. 18 19 MR. JOHNSON: It obviously didn't transfer, 20 because they did it manually. That's just strictly recollection. 21 MR. TERRY: You've got the A-34? MR. MACHILEK: 22 MR. HESS: Where were we? Out put OV/UV? 23 MR. MACHILEK: OV/UV. It comes from a rectifier 24 here. Simply a level detector, that's all it is, 25

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adjustable. BCCA/AB and we're feeding that into a level 1 2 detector, come out to the lamp. MR. ASHE: What's feeding in here now? 3 MR. HESS: Critical bus loads. 4 MR. ASHE: What is that? I mean what senses that? 5 Just a resistor --6 MR. MACHILEK: Voltage transformer. 7 MR. ASHE: A voltage transformer. 8 MR. MACHILEK: Direct input from the voltage 9 10 transformer. MR. ASHE: Okay. Direct input from the 11 transformer. That's really simple then. 12 It's pretty straightforward. 13 MR. MACHILEK: Yes. You do the same with critical bus and bypass and compare the 14 two and that is the difference. 15 16 MR. ASHE: How the hell does that get there? MR. MACHILEK: You come in through the --17 I'm coming through there, through here, 18 MR. ASHE: I've got you. Okay. I've got you. Through the base of 19 ' this and then the collector. Okay. 20 I saw it before. 21 MR. HESS: 22 MR. MACHILEK: They are difficult to follow. MR. ASHE: Is the rest of these things like this, 23 24 just pretty much --25 MR. MACHILEK: Yes.

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MR. ASHE: Through these amplifiers and gates?
 MR. MACHILEK: There is no complicated circuitry
 involved, none which might be considered in today's computer
 age, microprocessors.
 MR. ASHE: This would be lost, though, if this

6 condition corrected from here.

7 MR. MACHILEK: If it works, yes.

8 MR. ASHE: In other words, whatever triggers this 9 input, if that goes back to the norm, this light goes out. 10 MR. MACHILEK: It might be broke, I don't know. 11 MR. RANSOM: The critical bus goes bad. So that's 12 why they came down and saw the lights on, because that 13 condition existed.

MR. ASHE: I don't know if I followed you.
MR. MACHILEK: If the maintenance bypass goes
away, this goes away. Of course, you have a voltage
difference, right?

18 MR. ASHE: Right.

19 MR. MACHILEK: More than plus/minus.

20 MR. ASHE: You're saying go away, but you don't 21 mean that. If the maintenance bus has degraded.

22 MR. MACHILEK: Same thing. If it goes down to 50 23 yolts from 120.

24 MR. ASHE: Okay. Right. Your point was what,25 now?

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MR. RANSOM: When the unit shut down, it flipped
 off. It didn't close the bypass breaker.

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MR. ASHE: Right.

MR. RANSOM: Which meant your critical bus voltage was zero volts. So if you're looking at the critical bus and the bypass switch then returned, you have the voltage difference.

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MR. ASHE: I've got you.

9 MR. MACHILEK: Each time you have a discrepancy 10 between the presence of the two voltages, yes, you get that 11 lamp.

12 MR. ASHE: So in theory, that should have been on 13 all five units.

MR. MACHILEK: Depending on when you looked at it because it's not latched. It's just a lamp. As soon as you bring the unit up and the output becomes available --

MR. ROSENTHAL: This data was taken at two hoursinto the event.

MR. MACHILEK: Consider the following. There were three different teams going down in a two-hour period. They all did something, right? They first ones did something, the second ones did something, the third ones did something.

Now, if you take all the accounts and you really go through with a fine-toothed comb, then selectively you can say that one makes sense, it's probably good, this one

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doesn't make sense, it's probably no good. Now, as soon as
 you do a selectivity in what is believable and what not,
 then you have to say I believe nothing or I believe
 everything.

5 But you cannot make a point either way in order to 6 support yourself or convince yourself of something, saying, 7 yes, you know, this is probably the right thing which was 8 recorded here, this one doesn't make sense, it's probably 9 not right.

We are talking about idiosyncrasies here, something which we believe cannot happen, but yet we accept that it did happen. With the knowledge and experience we have, we'd walk away from it and say, hey, forget it, it never can happen. But all we can say is to the best of our knowledge and ability, to analyze it or to duplicate it. We cannot make it happen.

MR. ROSENTHAL: Frank, the OV/UV on the A-34, the
horizontal strip of lights, doesn't latch.

19MR. MACHILEK: No, sir. It's not an alarm. It's20only an indication. It's a status indication.

21 MR. ROSENTHAL: Okay. Is it possible that people 22 are confusing OV/UV on the A-34 board with the under-voltage 23 with the lights on the A-21 board? There's an under-voltage 24 fast and an over-voltage light. Those are separate LEDs on 25 the A-21 board, right?

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MR. MACHILEK: Okay. The under-voltage fast is 1 2 not in operation. It's only for parallel units. The ACO voltage would lock, yes, sir, but it doesn't trip. 3 MR. ROSENTHAL: But it doesn't --4 5 MR. ASHE: Wait a minute. Why do you say it doesn't trip? 6 7 MR. MACHILEK: It would transfer, right? It looks like to me it sends a signal 8 MR. ASHE: 9 to the same place. MR. ROSENTHAL: If I detect an under-voltage here 10 11 MR. ASHE: I'm sorry. He's right. You're right, 12 you're right. No, it doesn't go to the same place. It 13 doesn't trip the unit. Over-voltage doesn't trip the unit. 14 MR. ROSENTHAL: Wait a minute. Over-voltage --15 I'm sorry. Over here, here, here, this gate, this buffer, 16 over here, up here, to here. Okay. It gives you a light. 17 18 MR. MACHILEK: It gives you two lights. 19 MR. HESS: That's the trip over here. It gives you light over here. 20 MR. ROSENTHAL: That's a trip light and that's a 21 logic light, but here is the actual trip. I'm sorry, I'm 22 being slow. 23 MR. MACHILEK: But you will get a transfer on the 24 A-34, which again cranks into the one because it opens the 25



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CB-3 eventually, the output after you have confirmation that
 the CB-4 has failed.

MR. ASHE: If you put full amp load on the three D-cell batteries, what is the load --

5 MR. MACHILEK: It goes through immediately and 6 from then on it decreases commensurate with the state of 7 charge. It's fully charged.

8 MR. ASHE: But you've actually tested it. 9 MR. MACHILEK: Well, I hope they did. They put 10 new batteries in it and let it run for a while.

MR. ASHE: No, no, no, no, no, no. I'm saying outside the unit, we reconfigure 3 D-cell battery packs, just like the plus or minus 20. Take an oscilloscope or something, put a full amp load on there and watch the voltage. Nobody's done a test like that, to your knowledge, right?

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MR. MACHILEK: No.

18 MR. ASHE: But they should be able to have full 19 amps in a very short period of time, no problem, right, 20 fully charged?

21 MR. MACHILEK: It should hold it for a minute. 22 MR. ROSENTHAL: I'm sorry. The under -- you said 23 one of these is not on that unit, under-voltage or over-24 voltage?

MR. HESS: I think you're talking about the

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1 parallel lights, the AC/UV fast.

2 MR. MACHILEK: What about it? MR. ROSENTHAL: It's not on the units there. 3 MR. MACHILEK: No, sir. No. This is only for .4 5 parallel operation. MR. ASHE: The under-voltage is the one that's not 6 They only thing they've got is the over-voltage. 7 there. 8 MR. ROSENTHAL: Could this have been on? What would have made the over-voltage? 9 MR. MACHILEK: Well, we had the other problem. 10 We 11 had a decrease in voltage, not an increase. I don't think if you short a transformer you'll get much of an over-12 13 voltage on it. 14 MR. ROSENTHAL: Okay. Let's pick another light that they're reporting. OV/UV doesn't latch. 15 MR. MACHILEK: It's a status indication. 16 17 MR. ROSENTHAL: OV/UV transfer. Voltage 18 difference. MR. ASHE: Am I saying something wrong here? 19 I'm not saying anything wrong, right? 20 If you have -- I don't 21 MR. MACHILEK: No. understand -- we have a transfer? 22 MR. ASHE: Transfer went on the same diagram. 23 24 MR. RANSOM: It does latch. MR. ASHE: Wait a minute. It does? Okay. A11 25

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1 right. He's right.

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2 MR. MACHILEK: That latch is the -- if you do 3 transfer, you maintain that.

4 MR. RANSOM: It won't stop the unit from running, 5 though.

6 MR. MACHILEK: No, no, no, no.

MR. ROSENTHAL: OV/UV transfer.

8 MR. MACHILEK: If it helps the statement, you can 9 take the A-34 out of the module and the module runs. It's 10 strictly a bypass control. It has nothing to do with the 11 operation of the module itself.

MR. ASHE: I think what Jack is trying to get to is a possible explanation for these lights. I think that's where he's going with this.

MR. MACHILEK: On the A-34, the only lamps which you want to have stored is that a transfer has taken place or a transfer command was given. The rest are status indications, saying that one voltage or one frequency is different from another one. But if that condition would go away, then the lamp would go away.

21 MR. ASHE: Why didn't this show up on all the 22 units, then?

23 MR. MACHILEK: It depends when you look at it, 24 what the exact situation was. Was the maintenance voltage 25 there or was it not there. Of course, once you try -- once

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a module goes on the internal oscillator, then it drifts 1 away from the bypass. Different speeds, it can stay there 2 3 or it can drift off. It's really hard to say. MR. ASHE: These reset bus tables, they're just 4 dual in-line pin ICs, right? 5 MR. MACHILEK: Which ones? 6 7 MR. ASHE: The reset bus tables, they're latching 8 9 MR. MACHILEK: Latches, yes. MR. ASHE: How many, eight pin, 16-pin, dual in-10 line pin? How many is on a one --11 12 MR. MACHILEK: Twelve. MR. ASHE: Twelve on one guide, right? Close, 13 14 some number thereabouts. MR. RANSOM: Twelve of the actual devices? 15 16 MR. ASHE: No, no. It would have to be 14 or 16. 17 MR. RANSOM: Sixteen. In terms of reset modules on 18 MR. ASHE: 19 that device, there's probably four. 20 MR. MACHILEK: Yes. MR. RANSOM: Yes. Sounds about right. 21 MR. ROSENTHAL: What's the voltage difference? 22 23 MR. MACHILEK: It means that the output voltage of the module, that the bypass voltage and the critical voltage 24 is different from each other. 25

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MR. ROSENTHAL: Does that latch? 1 MR. MACHILEK: No, no, no. It's an indicator. 2 It's like two volt meters to tell you what they are doing. 3 MR. ROSENTHAL: The voltage difference is that 4 5 light. 6 MR. MACHILEK: Yes. It comes and goes as the 7 situation changes. 8 MR. RANSOM: These two phases. 9 MR. ASHE: So that's AB phase, right? MR. MACHILEK: AB and -- all three, sum it up, put 10 an average to it and look at the DC signal, the level to 11 12 take that. MR. ROSENTHAL: They are saying that when they 13 went down to look at two amps, they saw an OV/UV light, and 14 we're saying that there's no latch, it's got nothing to do 15 16 with what happened at T-zero. MR. MACHILEK: Right. It's only an assumption to 17 do at the time you look at the light. 18 19 MR. ROSENTHAL: The voltage difference, same story, right? And the OV/UV transfer does latch. 20 MR. MACHILEK: It will tell you that you did, in 21 fact, get a transfer signal, which is strange, though, 22 because if you do get a transfer signal, if the transfer is 23 24 not executed, then you get a transfer fail alarm, which wasn't there. 25

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It's almost as wierd as if you switch the lights
 on in your car and the horn comes on.

3 MR. ROSENTHAL: I had something like that and the 4 stalk to the multi-function lever switch is a cable that 5 runs down inside the steering column, and it had abraded the 6 insulation and depending on just where the vibrations were 7 and whatnot, as you turned this on north, it would 8 occasionally -- the wipers would come on when you turned the 9 lights on, etcetera.

10 They had to pull the steering wheel. It cost me 11 100 bucks for a guy to pull it apart to put a piece of tape 12 on it because they addresed the leads wrong. That was an 13 inadvertant or a sneak circuit, right? And what's the 14 parallel here?

15 MR. MACHILEK: I don't know.

MR. ROSENTHAL: But there's a sneak circuit. MR. MACHILEK: But if we want to investigate for a possible problem of that sort, it would be -- what my problem is, it's an atomic power plant and all the things have -- it was a multiple happening at the same time. Any one of the happenings by itself would not have done anything.

The shorting of the transformer would not have bothered anybody. The batteries dead, by themselves, wouldn't have bothered anybody either. You see what I mean?

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1 MR. ASHE: Let's backup now. MR. MACHILEK: What was the coincidence of the 2 If you would have 3 dead battery and the loss of the Phase B. lost A or C, nothing would have happened. So dual failure. 4 5 It's inconsistencies in the reporting of lamps. 6 MR. ASHE: Let's flip that around. Let's say 7 fully charged batteries and take the same scenario. 8 MR. MACHILEK: Nothing happens. I wish I could 9 throw a --MR. ASHE: Are you saying with fully charged 10 11 batteries, the same Phase B short, this unit would have stayed up, the five units would have stayed up. 12 MR. MACHILEK: Yes. For the 12 cycles or whatever 13 it was, for sure. But this can be tested. This can be 14 15 proven. It's not -- we don't have to rely on anybody's 16 opinion here. This is very provable. 17 The only suggestion I felt was a good one is to switch the relay coil. 18 19 MR. ASHE: Correct. MR. MACHILEK: So that I'm going to inverter right 20 ' 21 away and I prevent switching later on. Are we covering all the bases with that? No, we don't, because if you lose one 22

23 power supply and you do not have a bypass at the time, it's 24 not in sync or God knows what, then you still would lose the 25 load. See what I mean?

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I want to make this 100 percent clear. That
 change improved the situation as far as that scenario is
 concerned.

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MR. ASHE: Sure.

5 MR. MACHILEK: A different scenario with different 6 combinations of problems at the same time could still get 7 you in trouble.

8. MR. ASHE: Yes. The fix is also dependent on the 9 inverter's voltage either being there or not there.

10 MR. MACHILEK: Also, I want to mention that if the 11 AC/DC converter in the other unit goes bad, you've had it. 12 You see what I mean? You lose it right away. Single point 13 failure. Just damned lucky that it never happened. Now, we 14 are not talking about --

MR. ROSENTHAL: We have had individual 1-E
inverter, the losses of the --

MR. MACHILEK: If you lose the power supply, and this is why we never considered a AC/DC converter, for that reason. It's a single point failure. We could not qualify it with the Army, Navy or Air Force because we can't get away from this single point failure syndrome.

If you lose that AC/DC converter, the logic goes away and you crash and you lose your output load.

24 MR. ASHE: You mean the Army has none of these 25 other kind of inverters? •

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MR. MACHILEK: The old ones. 1 No, no, no, no. The one with the DC 2 MR. ASHE: 3 converter on it. MR. MACHILEK: No, I don't say that. I said we 4 5 could not qualify it. MR. ASHE: In your case. 6 MR. MACHILEK: Yes. 7 8 MR. ASHE: In your case. The Army has a lot of things, 9 MR. MACHILEK: No. but so does everybody else because a lot of things are being 10 purchased on the open market by a local distributor, low 11 12 bid. It's bench stuff, right? 13 MR. ASHE: MR. MACHILEK: One of the reasons why the armed 14 forces particularly liked this type of equipment was because 15 everybody can fix it and we teach you how to. We have a 16 course which teaches you every circuit down to the component 17 leave, not only the subassembly level. 18 That means if you really want to understand our 19 particular system, come down to Raleigh and go to school. 20 21 Every circuit, every component, we teach you what it's doing, why it's doing it, and how it is doing it and what it 22 We have no secrets there at all. 23 is. MR. ASHE: Some of the people from NOM now have 24 25 gone down to the school you're talking about, right?

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1 MR. GRADY: We haven't been able to find out who 2 they were.

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MR. ASHE: Okay.

MR. MACHILEK: The ones which are still around haven't been there. But if you really want to understand it, you'll need two weeks -- a three-week course and you'll know as much as we do.

8 MR. ROSENTHAL: Let me take an aside before I come 9 back to this. We have seen random failures of converters 10 which we have attributed to pre-conditioning due to 11 temperature. But you don't expect five to all go at the 12 same time due to that sort of problem.

Nevertheless, since we're thinking about the logic, let's talk about temperature for just a second. The over-temperature trips of this unit, I take it, are really on the heat sink temperature.

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MR. MACHILEK: Right.

MR. ROSENTHAL: The chips there are -- they're not
mil spec ships, they're just chips, high quality chips.

20 MR. MACHILEK: 70 degrees C logic.

21 MR. ROSENTHAL: 70 C?

22 MR. MACHILEK: Yes, sir.

23 MR. ROSENTHAL: Centigrade.

24 MR. MACHILEK: Yes.

25 MR. ROSENTHAL: 70.

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MR. MACHILEK: 70. Which means that if you have a A0 degree C inlet temperature and a 15 degree C internal device, this is what our design criteria is. You have 55 degree logic. Because that unit is that tightly packaged, we have a separate blower on the controller itself.

MR. ROSENTHAL: On the card cage.

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7 MR. MACHILEK: Yes. Which the other units do not 8 have. Only the single cabinet has that and the 60-KW is the 9 only one we have in a single cabinet. Once you go to the 10 100-KW, you have two cabinets. It's much looser packaged.

The problem with the 60-KW is that you need an air exchange. You have to get the PTUs away from the module. It has a tendency that the air does not want to readily come out and simply dissipate. So we specify if we install it or if somebody asks, three times an hour air exchange, which isn't all that much.

The Army, for instance, or the Navy, if they don't use air conditioning, they have a plenum on top and suck the unit, exhaust the -- and the plenum has a little blower which makes up for the static pressure which is generated. But the reason why you don't get the heat out of the units is because there is really nothing which makes the heat come out.

24 Simply the temperature difference between the 25 inlet and the outlet, the blowers which are in there are

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really not blowing, if you want, or transporting the heat 1 away from the unit. 2 MR. ROSENTHAL: Now, the little batteries, the 3 four-year is based on 77 --4 MR. MACHILEK: 77 degree format, yes, sir. 5 MR. ROSENTHAL: And it's hotter than that in 6 there, isn't it? 7 MR. MACHILEK: Well, depending on the inlet air 8 temperature. One evening we were there, I would say it had 9 probably 80 degrees in there. 10 MR. ASHE: 80 degrees in where? Where the 11 12 batteries are located? MR. MACHILEK: In the room itself. 13 I was in that room and I would say it 14 MR. ASHE: was over 100 degrees in the room itself. I think that was 15 their problem at that time. The chillers or something like 16 that. Most times, it was probably --17 MR. IBARRA: It was hotter than 80 at any time. 18 MR. MACHILEK: But you have a 15 degree C internal 19 The filters were immaculately clean, so I don't 20 device. know if they have been recently changed. 21 MR. ROSENTHAL: Apparently that is in the PM 22 23 program. Yes. They were really -- I mean, MR. MACHILEK: 24 there was not a speck of dust in any of them. That was the 25

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first thing, when I felt the one panel, I said to myself
 maybe that I had filter obstruction. There was none.

3 MR. ROSENTHAL: Whether it was the original design 4 intent or not, to me, is irrelevant. What I'm seeing is 5 that for certain scenarios, the little batteries do play an 6 important role.

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MR. MACHILEK: Yes, sir.

8 MR. ROSENTHAL: And I don't have your design 9 change memorized, but I am under the impression that they 10 would continue to play as important a role, if not more 11 important.

MR. MACHILEK: Shouldn't play a more important role now. The reason why I'm saying that, while you're on bypass, you've got to have the load on bypass before you start up the inverter. So the load is on bypass and so is your power supply. Now you are ready to transfer. You bring up the module and run it.

As soon as the inverter output voltage becomes available, it switches over. If you cope while you are switching over, no problem because it's on purpose. So you just have to fix it and then switch it over.

22 Once you are on inverter output, you don't need 23 the battery no more.

24 MR. ASHE: You go to the face plate. You take 25 that little switch and you put it in auto restart. Now the

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unit goes off the inverter. For whatever reason, it 1 2 transfers. 3 MR. MACHILEK: Okay. You're in auto restart. MR. ASHE: 4 5 MR. MACHILEK: Yes, sir. MR. ASHE: It's going to try to go back. 6 7 MR. MACHILEK: Okay. MR. ASHE: The batteries have got to play a role. 8 MR. MACHILEK: Then you stay on bypass, you get in 9 10 a RAM. MR. ASHE: You know about it if it did make it. 11 MR. MACHILEK: Yes, but it doesn't bother you. 12 13 You do not lose the load. MR. ASHE: If the batteries were dead --14 15 MR. MACHILEK: You're on bypass already, right? MR. ROSENTHAL: No. He's saying you're sitting 16 running with dead batteries. You now have a fault in the 17 18 inverter. Your logic has to stay up long enough to execute 19 the transfer to the maintenance supply. MR. MACHILEK: But the UPS does not fail in 20 21 decreasing its output voltage. MR. ASHE: It has to go down to some value, right? 22 Wouldn't it go down to some value? 23 MR. MACHILEK: If an UPS trips, it's gone. 24 MR. ROSENTHAL: At least it's more apparent 25

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1 failure modes.

2 MR. ASHE: What's the purpose of auto restart and three tries to go back onto the inverter, then? 3 MR. MACHILEK: This is if you want to go from the 4 5 UPS to bypass. MR. ASHE: No, no, no, no, no. Auto restart means 6 you're going from the maintenance supply back to the 7 inverter, right? 8 9 MR. MACHILEK: Okay. MR. ASHE: I'm putting you in the same scenario as 10 you starting up the inverter. 11 MR. MACHILEK: Yes, sir. 12 MR. ASHE: Now, how do you get around the 13 batteries? 14 You're on bypass, okay? 15 MR. MACHILEK: MR. ASHE: Yes. 16 MR. MACHILEK: You want to auto restart. 17 18 MR. ASHE: Right. MR. MACHILEK: Now you give a command to go back 19 20 to UPS. 21 MR. ASHE: Right., MR. MACHILEK: You have no logic to do it with. 22 MR. ASHE: Are you saying the inverter output is 23 going to come up instantaneously? 24 MR. MACHILEK: No. Whenever it comes up, you 25

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switch over to inverter. If it doesn't come up, then you
 don't.

MR. ASHE: No. But the thing is it's not going to come up instantaneously. It's going to be a ramp-up, right? MR. MACHILEK: Okay.

6 MR. ASHE: So that's going to put you right back 7 to where you were starting up.

8 MR. MACHILEK: No. You're going upwards in 9 voltage, you don't come down.

MR. ASHE: Yes. I know you're going up, but there is a latch-up before that K-5 is going to pick up. It's got to be.

MR. MACHILEK: Yes, but the K-5 is on bypass all
the time.

MR. ASHE: K-5 is deenergized the way it is now, right?

MR. MACHILEK: The supply to the power suppliescomes from the bypass.

MR. ASHE: Yes, but when you flip to -- when you deenergize K-5, you reroute to supply. K-5 is deenergized. When you energize, it's from the inverter, right?

22 MR. MACHILEK: Correct.

23 MR. ASHE: So it means that when you're coming up, 24 unless the inverter brings it up instantaneously, the 25 battery is going to have to hold it a little bit while it's

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making the switch, right? Wait a minute. Am I making
 myself clear? Is that right?

3 MR. RANSOM: I understand what you're saying. You 4 transfer it off-line to an auto restart. The module shuts 5 off. As the inverter tries to come up, as the inverter's 6 making potential as it goes through the neutral point, the 7 relay is going to try to pick up, at which point the 8 batteries have to be there to handle the switch-over, just like if you had a utility failure previously. Then the , 9 control batteries will trip off. We tested it with the 10 11 control batteries. We put the .6 volt back in and tried it.

But, like you were saying, you were in bypass, so at that point, all you then have to do is find the -- it tries to come up and when it goes to switch over and shuts down again. You know there's a problem at that point, but you're not jeopardizing your load because you're in bypass.

MR. ASHE: Right. But I observed most of the
units, as I observed, were in the auto restart mode, for
whatever reason.

MR. MACHILEK: It wouldn't bother you.

21 MR. ROSENTHAL: When we were looking at whatever 22 drawing has the power supplies on it, the logic power 23 supplies, and we were looking at the battery discharge light 24 and the continuity battery discharge off-light or whatever 25 you call it, it's clear to us that that really isn't

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1 monitoring the battery while it's in standby, but rather
2 simply what's happening to the battery if the power supply
3 fails.

4 MR. MACHILEK: It really monitors the power 5 supply.

6 MR. ROSENTHAL: It monitors the power supply. 7 Okay. So if they --

8 MR. MACHILEK: Once the power supply is gone, then 9 it monitors the battery.

10 MR. ROSENTHAL: Yes, yes. Well, I'm sure that 11 these will be the most watched batteries in the nuclear 12 industry. Okay. But they're running at some elevated 13 temperature relative to that which you would associate with 14 their four-year life.

What kind of advice can you provide them on what to do with the batteries and when to change them out?

MR. GRADY: If you do a full-blown maintenance program on the system, then that's something you would check. We are shifting through our paper right now, so bear with us for a second.

21 MR. MACHILEK: Our contracted maintenance 22 programs, we do it every half-a-year, check the batteries. 23 MR. ASHE: Every six months, check it out. What 24 do you do, a load test on it? 25 MR. MACHILEK: Yes. ۰. ۰.

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1 MR. ASHE: Actual load test. That means you pull them, do a load test and if it passes, you put it back. 2 3 MR. MACHILEK: Correct. MR. ASHE: 4 Okay. MR. MACHILEK: There is unfortunately no other 5 6 way. 7 MR. ASHE: I'm just trying to understand. MR. MACHILEK: We have a lot of installations, 8 rather than go through a load test, we exchange the 9 batteries every half-a-year. 10 MR. ASHE: Frankly, I think that's --11 MR. MACHILEK: It cost you less money to stick in 12 13 six D-cells. MR. ASHE: Yes. Then it's a replacement program 14 rather than testing. 15 MR. ROSENTHAL: Okay. Well, look. This is a very 16 17 expensive meeting and we have all the people here. How can we learn the most about this thing, what's -- did we decide 18 -- okay. Let me go back to the basics. 19 20 I decided that the -- we know that the circuit breakers changed states, CB-1, 2, 3, and we decided that you 21 had to change K-1, 2, 3 on that first drawing we looked at. 22 That was the only way to do that. Then we decided that that 23 meant that you had to change the state of Q-1, Q-2, Q-3 on 24 the third drawing that we looked at. 25

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1 MR. MACHILEK: Right. Then we followed back one way of 2 MR. ROSENTHAL: changing the state of those power transistors was by 3 detecting a low voltage on the output of the larger power 4 supply, and we traced that all the way back. 5 6 MR. MACHILEK: Right. Let's go back to Q-1, Q-2, Q-3 and 7 MR. ROSENTHAL: say how else does this change its state, unless somebody 8 9 else has a better idea. How many ways are there to turn on 10 MR. MACHILEK: 11 a transistor who is between ground and the voltage. 12 MR. ROSENTHAL: Where's the drawing? We've got it out here on the table someplace. If you could advise me on 13 a better thing to do with the next few hours, let me know. 14 15 MR. MACHILEK: The fact that the signal which made it happen was latched and confirmed, I see -- it did turn 16 on, right? The breakers tripped as a response to it. 17 MR. ASHE: Right. I think what he wants to do, 18 19 though, is to back up. What other ways can we get that other -- we know we can get it on loss of logic DC power, if 20 the power decreases below the trip set point. 21 How else can Q-1 be turned off is what he's trying 22 to get to, I think. 23

24MR. MACHILEK: Turned off, you mean tripped?25MR. ASHE: Well, the thing is -- I think we agree

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1 -- we had to saturate these guys to pick up the relay coil.
2 Normally, they're sitting there, they're all cut off, and
3 then we trace through everything. But now what I think he
4 wants to do is how many other ways, other than low DC logic
5 power, can this thing be saturated. So do you want to trace
6 all of those guys?

MR. MACHILEK: All those ones which go in here.
MR. ASHE: Right. But I think he wants to trace
it to everything on the drawing.

MR. ROSENTHAL: Is there a remote load dump? I read it in your manual.

MR. MACHILEK: No, no, no. The load dump is -MR. ROSENTHAL: Like for a computer.
MR. MACHILEK: -- if you want to dump your load.
MR. ROSENTHAL: Right. But it would be -- right.
But it is not installed on this unit.

17MR. ASHE: Are you going to let us have a copy of18that?

MR. MACHILEK: Well, they've changed it around.
 MR. ASHE: That's right. By the way, you have a
 final report, though, addressing most of this stuff.

22 MR. MACHILEK: Yes. Yes.

23 MR. ASHE: That's all right.

24 MR. ROSENTHAL: I think what we will do is we will 25 ask Nine Mile for a report from Exide. T

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133 1 MR. ASHE: That's already done. It will be 2 finalized within the next day or so. 3 MR. ROSENTHAL: Okay. 4 MR. ASHE: Basically, that chart with all of those chips on there will be in that report, right? 5 6 MR. MACHILEK: Yes. 7 MR. ASHE: That's the key, I think, to what is 8 really -- what we're going through. 9 MR. ROSENTHAL: If we just trace that out. Input breaker control, that's a physical switch on the breaker, 10 unlike the -- is it racked in? 11 MR. MACHILEK: Input breaker, it would be a toggle 12 13 switch which would be in here, which would automatically 14 switch the breaker on. Yours is manual. 15 MR. ROSENTHAL: Battery breaker control, and you don't have it here. 16 MR. MACHILEK: No. It's manual. 17 18 MR. ROSENTHAL: I'm sorry. So this is like a universal board, as you were saying earlier. 19 20 MR. MACHILEK: Yes. 21 MR. ROSENTHAL: So are these contacts now floating? 22 23 MR. MACHILEK: It depends. MR. ROSENTHAL: Tied higher, tied lower. 24 MR. MACHILEK: Yes. Whatever the circuit will 25

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take. You cannot make it work without that. It depends if 1 2 the signal is lower or higher. MR. ROSENTHAL: What is this RCR-TCA-27? 3 4 MR. MACHILEK: This is an output that comes from -5 MR. ROSENTHAL: It goes into that. 6 7 MR. MACHILEK: It's a remote switch on the A-14. 8 MR. ROSENTHAL: So you don't have it. 9 MR. MACHILEK: No. MR. ROSENTHAL: We just traced this one. 10 11 MR. MACHILEK: Yes. 12 MR. ROSENTHAL: REM. Local A-14. What is that remote used for? 13 MR. ASHE: 14 MR. MACHILEK: This is if you want to remove it 15 from a remote location. MR. ROSENTHAL: You see your big computer burning 16 up. Local A-14. Local A-14. What does LCL stand for? 17 18 MR. ASHE: LCL? MR. MACHILEK: I think this is a local UPS off 19 switch. A-14, yes. 20 21 MR. HESS: Yes. It's UPS off right there. And 22 that's if you had -- the remote is off the A-30, you put remote switch off. 23 24 MR. MACHILEK: Yes. We don't have it. 25 MR. HESS: Local is the A-14 front meter panel

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where you can press UPS off, and that's on the pictures that
 I just gave back.
 MR. MACHILEK: The UPS on is the other button.

4 MR. HESS: There's a remote button for UPS on the 5 A-30, as you had a remote off.

6 MR. MACHILEK: But we don't have it. Two buttons. 7 MR. HESS: Two buttons, on and off. 8 MR. ROSENTHAL: So are some of those not used,

9 unconnected, floating?

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10 MR. MACHILEK: Yes.

11 MR. ROSENTHAL: Is this all C-MOSS or --12 MR. MACHILEK: Yes.

MR. ROSENTHAL: So you have some C-MOSS inputsfloating.

MR. MACHILEK: Except the transistors on theoutput.

17MR. ROSENTHAL: Do you run into problems with18having C-MOSS floating, oscillations or --

MR. MACHILEK: Well, they are protected. They are on -- I don't think we have any loose gates, if this is what -for instance, this is a gate input and it's protected.

22 MR. ROSENTHAL: So anything that's not used is --23 MR. MACHILEK: Yes. It should be a point higher 24 and have a protection capacity against ground.

MR. ROSENTHAL: Wait a minute. Now what we're

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saying is that the only way that you pop open CB-1, 2 and 3, 1 2 is from here -- is from the --3 MR. MACHILEK: UPT. 4 MR. ROSENTHAL: -- UPT which --5 MR. MACHILEK: Which comes from this --MR. ROSENTHAL: And UPT is SSTR. It changes 6 7 names, but it's a physical wire on the back plate. 8 MR. MACHILEK: Yes. MR. HESS: From A-21 to A-24, it changes. SSTR, 9 10 UPT. MR. ROSENTHAL: Okay. Now we decided that the 11 under-voltage to this gate should have seen an under-voltage 12 and tripped it. Which one was that? 13 MR. MACHILEK: Power supply failed. 14 MR. ROSENTHAL: FR is frequency? 15 MR. MACHILEK: Clock failure. 16 MR. ROSENTHAL: Clock failure. 17 MR. MACHILEK: Which is --18 MR. ROSENTHAL: Okay. It's right there. Clock 19 20 failure. Fuse failed. But we know that that --They require repair if that would 21 MR. MACHILEK: 22 happen. 23 MR. ROSENTHAL: OTA. MR. MACHILEK: The OTA goes -- it's not stored, 24 because you have to reset the buttons. 25

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1 MR. ROSENTHAL: FU is --MR. MACHILEK: 2 Fuse. MR. ROSENTHAL: Fuse blown. WF is a --3 MR. MACHILEK: It's freq failure. 4 5 MR. ROSENTHAL: Frequency fail. MR. MACHILEK: That requires a board change if 6 7 that happens. MR. ROSENTHAL: AC over-voltage. 8 MR. MACHILEK: Yes. That's a legitimate -- by the 9 way, AC over-voltage does trip. 10 11 MR. HESS: I thought we said it didn't. MR. MACHILEK: Yes. 12 13 MR. HESS: I thought we traced out how it didn't 14 trip. MR. MACHILEK: Well, let's trace it again, because 15 16 I remember where voltage was tripping on me. 17 MR. HESS: Over-voltage. MR. MACHILEK: Over-voltage comes up here, comes 18 there, comes there, all right. Over-voltage and power 19 supply failure comes in at the same one. 20 MR. ASHE: That's coming in through here. 21 It's a It's not the same. lamp through here. 22 23 MR. ROSENTHAL: Where is that over-voltage? MR. MACHILEK: I just thought it was. 24 MR. ROSENTHAL: Over-voltage. Where are you 25

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1 measuring the over-voltage? MR. MACHILEK: On the output of the module. If 2 the regulator goes haywire and you know your voltage goes 3 4 up. MR. ROSENTHAL: Logic failed. 5 6 MR. MACHILEK: Logic failed is a summary --7 anything you get --MR. ASHE: Wait a minute. Why doesn't that go --8 MR. MACHILEK: See, all of these go in here. All 9 of those are tripping, either/or. That means any one of 10 those is tripping. In other words --11 MR. ASHE: Maybe you're right on over-voltage. 12 Let's go back to over-voltage. AC over-voltage --13 MR. MACHILEK: Over-voltage comes out here, here, 14 15 goes here, and trips. 16 MR. ASHE: Provided this is met up, right? MR. MACHILEK: No, no. It says either/or. 17 It doesn't matter. 18 MR. ROSENTHAL: What is this 12-bit -- Bit 12, 60 19 20 Hertz. MR. MACHILEK: Which one is that? This is from 21 the down circuit. This would trip you if it comes in. 22 It results in a low under-voltage on the output of the module. 23 The voltage control oscillator is going haywire of you miss 24 the 12-count. You trip the unit before you see it on the 25



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1 output. It should go directly up to the trip without any --2 or is it. No, no, no, no, no. It goes over the -- it 3 goes over the -- it depends on what the over-load is doing. 4 This goes up to the countdown. That's where Yes. 5 they stuck it. This is only the 11 bits for the timing circuit. So you have the 1, 2 and 2-seconds timer. This 6 should be a frequency -- it's 94 Hertz, going down to the 7 timer. 8 That's not what I thought it was. They're summing 9 that together on the FRs. MR. ROSENTHAL: I know we've been over this three 10 11 or four times. I'm sorry. Okay. Here I've got chips, 12 right? MR. MACHILEK: Latches, yes. 13 MR. ROSENTHAL: Latches. And that itself takes 12 14 15 volts. 16 MR. MACHILEK: Right. 17 MR. ROSENTHAL: Which is coming from this power 18 supply here, right? 19 MR. MACHILEK: Right. 20 MR. ROSENTHAL: We have 20 volts, plus 20, 21 degrading here. 22 MR. MACHILEK: Yes. 23 MR. ROSENTHAL: Do we know anything about the 24 plus-12 volts here? 25 MR. MACHILEK: Well, as soon as the 20 volts

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degraded to 16.5, we shut down the module.

2 By design. MR. ROSENTHAL: 3 MR. MACHILEK: Yes. MR. ROSENTHAL: But in the time being, what was 4 happening to the 12 volts here? 5 6 MR. MACHILEK: Which time being? MR. IBARRA: The time it shuts down and --7 The time the unit shuts down? 8 MR. MACHILEK: I think he's talking the time that the 9 MR. ASHE: voltage degrades from whatever it's --10 MR. MACHILEK: If you start out at 12 and go to 11 12 16.5? MR. ROSENTHAL: Right. 13 MR. MACHILEK: It's almost instantaneously. 14 As 15 long as the power supply holds the voltage up, it's there, right? Once the power supply guits, you go on discharge 16 from two more cells and from then on, since the batteries 17 were pretty much dead, it decreased to .64 or something like 18 that. 19 But to shut the unit down, you can blink your eyes 20 fast enough to -- it's just, clink, and it's gone. 21 22 MR. POHIDA: Is the unit powered back up? After 200 milliseconds. MR. ROSENTHAL: 23 MR. POHIDA: Is there any consideration on power-24 up states, like what the modes will be of all these latches 25

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1 on power-up?

MR. MACHILEK: You have to push the reset button. 2 If you don't reset the latches, you cannot restart the unit. 3 MR. POHIDA: Even if you lose power. 4 MR. MACHILEK: Even if you lose --5 MR. POHIDA: The outputs won't toggle. 6 MR. MACHILEK: The outputs won't toggle. No, sir. 7 8 Except if you switch off the logic. MR. POHIDA: That's what you may have done. When 9 the 20 volts came down, if it got below, what did you say, 10 13 volts? 11 16.5. 12 MR. MACHILEK: MR. POHIDA: When do the 12-volt supplies start to 13 14 MR. MACHILEK: We don't monitor the 12-volts. 15 MR. TERRY: Rudi, doesn't that K-1 -- that's what 16 I'm asking about, that K-1. That K-1 relay --17 18 MR. MACHILEK: That K-1 is there --They'll reset the latches. MR. TERRY: 19 MR. MACHILEK: Well, it's there not to reset the 20 21 latches if you do a lamp test. MR. TERRY: But if it loses power, it will reset 22 those latches. That's why I asked about that. 23 MR. POHIDA: Well, what if you did lose your 12 24 25 volts?

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MR. MACHILEK: If you lost your 12 volts --

2 MR. POHIDA: What is the power-up condition of all 3 of the latches?

If you lost the 12 volts, then the 4 MR. MACHILEK: latches would -- no. You have to apply a -- you have to 5 As long as you do not reset, they stay where they 6 reset. 7 They are bi-stable. They're not like a computer. If are. you lose the logic, you lose the memory or anything like 8 It's like a toggle switch. 9 that.

10 MR. ROSENTHAL: We could just pull a manual and 11 look up the 4044s.

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MR. MACHILEK: Yes.

MR. POHIDA: So they'll power-up as they power14 down. Wait. Let me --

MR. ROSENTHAL: In order to -- I'm sorry I'm being redundant again. I thought earlier this morning we decided that you have to apply power to the shunt coils for two to five cycles in order to make the breakers change state.

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MR. MACHILEK: Right.

20 MR. ROSENTHAL: And there has to be some 21 reasonable voltage. That gives us a hint then about the 22 condition of the logic, that the logic had to change state 23 to initiate an open signal and there had to be enough 24 voltage and enough power left to actually open the shunt 25 coils, trip the shunts. Right? . , •

1 MR. MACHILEK: We are not collapsing all the 2 valves. They are linear power supplies. MR. ROSENTHAL: It's a sub-component that you 3 4 purchase. 5 MR. MACHILEK: Yes. It's a chip. MR. ROSENTHAL: Do we know the -- but if we go to 6 7 look up 4044 in a manual --MR. MACHILEK: We can review it, but I don't have 8 I can get parts lists of all the components. 9 it here. 10 That's no problem. MR. POHIDA: You said earlier that you probably 11 did not lose the 12 volts. 12 MR. MACHILEK: I do not believe you lost 12 volts. 13 MR. POHIDA: But we did diminish the 20. 14 MR. MACHILEK: The 20 -- we know that it ran to a 15 16.5, yes, sir. 16 17 MR. POHIDA: Is that a voltage regulator? MR. MACHILEK: It's a voltage regulator. 18 MR. POHIDA: How fast can that act to correct for 19 20 the 20 volts being pulled down? MR. MACHILEK: I don't know. 21 MR. POHIDA: What I'm wondering is the 12 volts 22 may have also dropped instantaneously. 23 24 MR. MACHILEK: It's possible. MR. POHIDA: You lost your logic. The voltage 25

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1 regulator, you just can't -- I don't think you can just put 2 a sine wave into it and get --

3 MR. MACHILEK: We maintained the latches because 4 the light stayed on and they are held by the latches.

5 MR. POHIDA: Did all of them stay on? 6 MR. MACHILEK: Yes. 7 MR. POHIDA: All the latches?

8 MR. MACHILEK: No, no. These two. Why they 9 didn't --

MR. POHIDA: I'm not 100 percent familiar with the event, but it seems as though you could have problems if your 12-volt supply and your five-volt supply -- well, the five-volt just runs the LEDs, I guess, but moreso the logic. If you have your 12 volts dipping down and then coming back up, you say you will not lose the latches.

16 MR. MACHILEK: Well, I don't --

17 MR. POHIDA: I think you might.

MR. MACHILEK: If you remove the power, you would
have to -- you have to ground the --

20 MR. POHIDA: You're also losing your inputs. 21 MR. MACHILEK: In order to re-circuit, you have to 22 ground the S terminal. If you don't, you simply don't 23 notice it. If you lose the 20 volts altogether -- I have to 24 look at the data sheet.

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MR. POHIDA: I don't know which latches were held,

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1 which ones weren't. The other thing that --

2 MR. MACHILEK: You're familiar with the 4044s. 3 MR. POHIDA: The other thing that bothers me --4 MR. ASHE: The 4044, that's the standard. Radio 5 Shack or any of these places have probably got the same 6 transistors as these guys do.

7 MR. HESS: Jack, you asked me earlier about some 8 of the things that we should talk about for Niagra Mohawk 9 and what they should be looking at. Then you went on to 10 another piece. Did you want to revisit that or did you want 11 to hold on that?

MR. MACHILEK: If it helps, five units were running for five years. We had one scenario we cannot fully explain. With normal maintenance, which we are doing for the industry as a whole, applied to it, we can say with high probability that we will not have any problem.

I don't know what much we can do else. If we had an inordinate amount of failures, normal operation, whatever, I don't know. I can probably see a concern, but it's really not there.

I would suggest it's none of my business, but to look at the other aspects of the obligation of the unit, classification of it, the maintenance level. These units turned out to be a hell of a lot more important than what they are perceived as.

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1 So there's a lot of things which can be done. A 2 maintenance bypass can be installed. The units can be half-3 yearly checked all the way through. We have roughly two-4 and-a-half-thousand units sitting out there in the field. 5 We have a good reputation in the marketplace. We're not 6 junk sellers. We usually don't even participate in low-7 dollar type deals.

8 MR. ASHE: Let me ask you something. How many 9 units like this were -- do you have a handle on that --10 MR. MACHILEK: We estimate around 700 prior to the

11 shipment of the five here.

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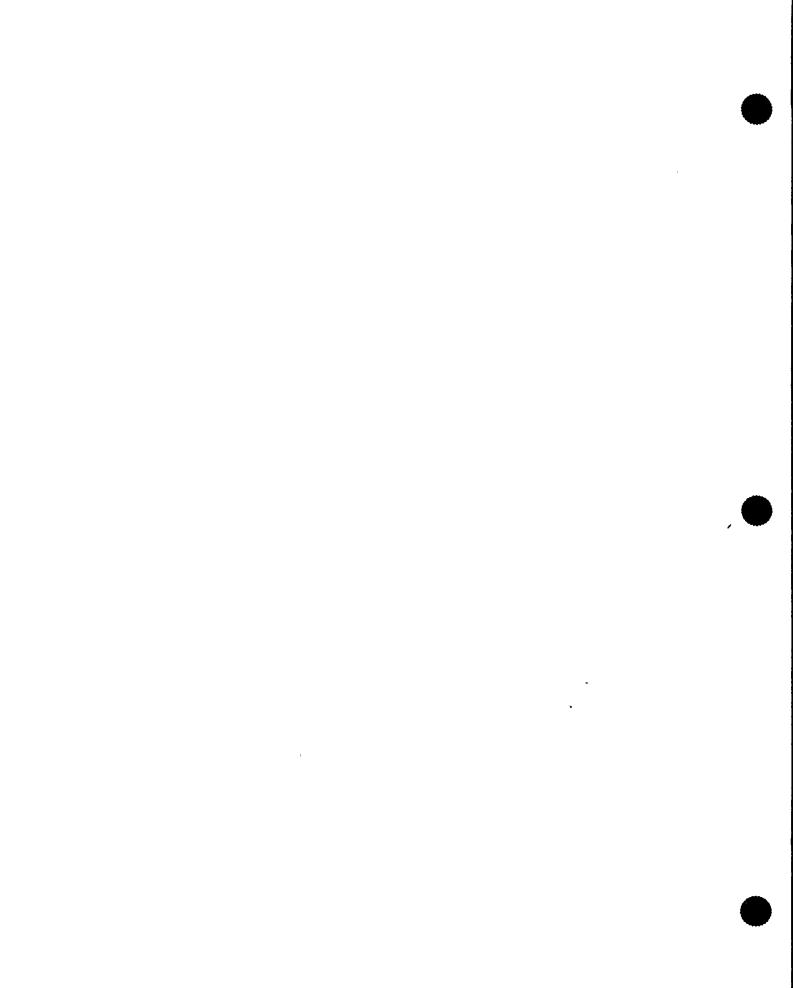
MR. ASHE: 75 KVA ratings.

MR. MACHILEK: No, sir. They all have the same logic. They all have the same -- the commonality is what the armed forces like, from 60-KW all the way up to 1000 or 800-KW. They all have the same logic, same circuitry, same everything; 68 percent commonality.

MR. ROSENTHAL: I know that the Reporter would like to take a break. So why don't we take a break and then when we get back, I guess the issues are, one, what could be done with respect to these units, that's one thing; two, a little bit more information on where else they're used and then by that time, maybe we'll come up with some more bright ideas.

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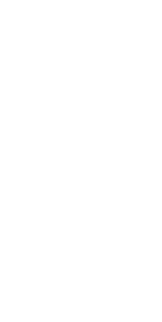
MR. ROSENTHAL: Your nickel.

2 MR. HESS: I'm sorry. I was waiting for Frank to 3 say go ahead and do your thing. What I'd like to do is put 4 in the record some recommendations that we have for Niagra 5 Mohawk, and we'll follow this up with Niagra Mohawk in a 6 full report to them shortly.

7 Under recommendations, I'd like to put number one, 8 Niagra Mohawk is aware that the current UPS systems 9 represents technology that is over ten years old. Exide 10 Electronics' current UPS systems represent three 11 technological advances and represents state-of-the-art power 12 protection. It is our recommendation that Niagra consider 13 replacement of the present systems with our present designs.

Recommendation number two, if Niagra Mohawk chooses to have Exide Electronics maintain the UPS systems at Nine Mile Point, we recommend our Powercare Preferred Service Package that covers all facets of maintenance, seven-by-24 emergency service, preventive maintenance inspections and modifications and parts.

Number three, if Niagra Mohawk chooses to continue maintaining this equipment, the following recommendations are applicable. Section A, inspect logic power control battery condition at least once every year. B, perform an annual preventive maintenance on UPS modules per manufacturer's recommendations or have manufacturer perform



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1 an annual site acceptance test.

C, obtain necessary product and technical
knowledge through an ongoing training program for Niagra
Mohawk maintenance personnel. Exide Electronics can supply
formal technical training programs at the Niagra Mohawk
facility or at the manufacturer's training center in
Raleigh.

8 D, as-built systems schematics diagrams must be maintained with equipment. These documents take precedent 9 over any other manual, text or verbal communications and 10 should be referenced during maintenance procedures. E, 11 we've got to replace all DC input filter capacitors in each 12 module. F, Exide Electronics stands ready to fully support 13 Niagra Mohawk in any service requirements. Niagra Mohawk 14 15 can call 1-800-84-Exide for service support should this be 16 required.

17 G, our last recommendation is peripheral equipment 18 that directly impacts the UPS operations should also be 19 under manufacturer's recommended maintenance programs. End 20 recommendations.

21 MR. ROSENTHAL: Are you worried about the circuit 22 breakers based on what you know now?

23 MR. HESS: Not knowing -- yes. I would have to 24 say yes. We're concerned about them. We can't tell how 25 many times they've been worked. The only way to really go

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1 in there would be to have somebody come in and take them
2 out, and I believe they're all sealed. No. They come
3 apart, don't they? They're just molded case. Have them
4 looked at and/or replaced. Throw them away probably would
5 be the best thing to do and put new ones in, knowing what we
6 know today from this meeting.

7 MR. ROSENTHAL: Rudi, we wanted to give you the 8 floor. Where are these units used? You have to expansive 9 in terms of the same logic or similar enough logic, 10 independent of the power rating.

MR. MACHILEK: About 700 we've come up with. They have identical logic. I wish you come to our plant and as you go through the production line, you see the same card cage being used. Sixty-eight percent of the subassemblies are commonality.

MR. ROSENTHAL: And at other nuclear power plants?
 MR. MACHILEK: Well, the only ones I was
 personally aware of was Yankee Atomic and Duke.

MR. ROSENTHAL: Yankee Atomic and Duke. But how
do we go about having to check your --

21 MR. HESS: We'll run a list. We can look through 22 our users list and determine which facilities have our 23 equipment.

24 MR. ROSENTHAL: I'd appreciate it if you'd do that 25 in general. That assumes you can.

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MR. HESS: Sure.

2 MR. ROSENTHAL: Those that are non-nuclear you can 3 delete from that list.

4 MR. HESS: Understood. You want a strict nuclear 5 application only.

6 MR. ROSENTHAL: Right. Now, I recognize that you 7 may not know the application.

8 MR. HESS: That's true and chances are we probably 9 don't.

MR. ROSENTHAL: With the understanding that the UPS may run the security computer or the UPS may run lights or whatnot, you may now know that, but I think we need to have that fairly fast.

MR. HESS: Do you want that faxed to you?
 MR. ROSENTHAL: Yes, please. We'll give you our
 fax number.

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MR. HESS: Okay.

18 MR. ROSENTHAL: So now we're back to drawings. 19 Are we? I'm down to either there's a sneak circuit or we 20 understand it. One or the other.

21 MR. ASHE: Maybe what we need to do -- what about 22 let's go over some of the timing as possibly related to the 23 event or what happened to the units. Can we do something 24 like that?

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MR. MACHILEK: In what respect, timing?

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1 MR. ASHE: Maybe what we need to do is suggest --2 just start with the guards and see how they generate a time 3 base.

MR. MACHILEK: It has nothing to do with nothing.

MR. ASHE: Has nothing to do with nothing. 5 MR. MACHILEK: There were no problems with the 6 switching, with the power. All the time clock is doing is 7 it determines what sequence of filing of SCRs. All units 8 started up. There was no repair, there was no damage. If a 9. clock fails, you would know it. You have -- well, you 10 wouldn't really because we have what we call a clock 11 watching circuit and as soon as we lose a beat, we are ready 12 to shut down. We don't wait on a disaster to happen in the 13 first place. 14

MR. ASHE: All right. How do you shut down?
MR. MACHILEK: On a clock fail.
MR. ASHE: All right. Maybe we need to go on
that. When you shut down, what do you do? You open the CB
breaker?

20 MR. MACHILEK: Same thing. SSTR.

21 MR. ROSENTHAL: But don't you --

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22 MR. MACHILEK: The clock fails and there is --23 MR. ASHE: Right. All that part is the same. 24 What about up here?

25 MR. ROSENTHAL: But don't you turn the SCRs off

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1 even faster than ultimately the circuit breakers will open?

2 MR. MACHILEK: If you don't turn an SCR on or off 3 at the exact precise time, you blow a fuse. You blow a fuse 4 because you would have a direct shortcircuit of positive and 5 negative on the battery. What you do is you simply switch 6 the parallel voltage on and off, and then you do the same 7 thing negative and you feed the transformers on the output.

8 MR. ROSENTHAL: In the manual, you said you've got 9 like a 12-step --

The transformers which are --MR. MACHILEK: Yes. 10 two of them -- and if you had an imbalance of the positive 11 and the negative, you would have a saturation effect, DC 12 saturation, and you would blow just about anything. 13 If you are a fraction of a millisecond off, you blow. Like we used 14 to say, when you are power switching, you are always a 15 16 millisecond away from disaster.

17 There was no problem in the power train in the 18 conversion of the DC to AC.

MR. ROSENTHAL: Yes. We understand that nothing failed and the units were restarted, etcetera, but it might be useful to educate us a little bit. In this event, the SCRs were turned off, right?

23 MR. MACHILEK: You simply turn all SCRs off. You 24 have to turn them off with a leg-off command.

25 MR. ROSENTHAL: Which comes from --

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153 MR. MACHILEK: Are we just passing time or --1 MR. ROSENTHAL: I'm just trying to understand. 2 3 MR. MACHILEK: -- do we want to have some analysis of the event. 4 5 MR. ASHE: Could we take about two minutes and just go over the gating of the SCRs in general. I think 6 that would be helpful. I agree with you. I don't think 7 this is so much relatable to the event. 8 9 MR. MACHILEK: GFM. 10 MR. ASHE: You have a GFM? A-9. We would really have to go through 11 MR. MACHILEK: the circuitry big time. 12 MR. ASHE: But I think we can just illustrate the 13 format a little bit without really going through a detailed 14 15 timing diagram and so forth. 16 MR. MACHILEK: Basically, what we have is six -we have 12 switching legs. 17 18 MR. ASHE: All right. MR. MACHILEK: Now, as you know, you can only turn 19 off an SCR if you have interrupted forward current. 20 In order to interrupt this forward current, you have to push 21 current backwards against the direction of current flow. 22 The way you are doing that is you are charging the capacitor 23 and you have accommodation SCR, a static switching element. 24 25 You should turn on and dump the capacitor charge backwards

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1 through the SCR and you turn it off.

2 Then, of course, in the next cycle, you have to 3 charge up the capacitor again. 4 MR. ASHE: All right. 5 MR. MACHILEK: The gate firing modules, as you see, you have -- it comes from the logic which turns on the 6 7 various -- you have the main resistors and you have the 8 accommodation, accommodating resistors. Each one is simply 9 taking the capacitor charge. The main -- this goes directly -- the connection out of here is feeding directly into the -10 11 12 MR. ASHE: Okay. I think we can --13 MR. MACHILEK: We would have to have the right schematic. 14 15 MR. ASHE: We'll look for the schematic. So pulse 16 comes out of here and goes into the gate zone. MR. MACHILEK: You have the gate command coming 17 18 here. 19 Which comes from the -- okay. MR. ASHE: 20 MR. MACHILEK: The leg switch-off -- see the leg 21 switch-off commands. 22 MR. ASHE: Yes. MR. MACHILEK: All the legs are getting a zero 23 here which turns off the main SCR. At this point, you have 24 25 a discharge capacitor. The accommodation SCR is turned on.

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The charge is done through the main SCR, which is turned
 off, and you do not get any more gate commands.

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MR. ASHE: Okay.

MR. MACHILEK: Should one of the leg switch-offs not execute, you blow the fuse. You see on the leg, you are directly between plus and minus DC. The two SCRs aren't serious. Should they ever turn on at the same time, for whatever reason, you have a shortcircuit positive.

9 You have a leg fuse which blows and the leg fuse
10 is not on here. The leg fuse is -- one, two, three, four,
11 five, six, one per leg pair.

12

MR. ASHE: Right there, yes.

MR. MACHILEK: You have the accommodating
capacitors, the chokes, accommodating chokes, and diodes,
standard leg, designed from the 1950s.

MR. ASHE: What is this guy doing here now?
MR. MACHILEK: This is the gate circuit.
MR. ASHE: Yes. This one right here. I know this

19 is the gate that goes in and --

20 MR. MACHILEK: Between gate and the five-six gives 21 you the firing circuit and this comes right out here. 22 Similar, you have a gate against here and then the same 23 thing, you have the accommodating SCR three, four and one 24 and two.

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The sequence in which the gate comes in up here,

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1 comes directly out of the A-8 pin. MR. ASHE: Eight and nine. 2 MR. MACHILEK: As you see, it's straight logic, 3 4 nothing --MR. ASHE: What kind of gate voltages are we 5 talking about here? 6 MR. MACHILEK: I believe it's 12, but I -- what we 7 8 used ten years ago. MR. ASHE: I think that's a broad overview of --9 MR. MACHILEK: Yes. It basically agrees with the 10 control oscillator, with the countdown circuits. 11 MR. ASHE: Is it actually discrete control or is 12 13 it --MR. MACHILEK: Or discrete. 14 15 MR. ASHE: It's discrete crystal control. 16 MR. MACHILEK: Discrete crystal control. 17 MR. ROSENTHAL: This goes to a logic fail. MR. MACHILEK: Yes. 18 MR. ROSENTHAL: Is that covered? 19 20 MR. MACHILEK: This is the one from the guard watcher. 21 MR. ROSENTHAL: Twelve bits, whatever? 22 The 12-bit is simply used as a 23 MR. MACHILEK: No. 24 timing signal for the timers, all these timers. See all these timers here, they are run by the 12-bit circuit. 25

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Now, in order to explain all that, you need timing
 diagrams.

MR. ASHE: Yes. They're too involved.

MR. MACHILEK: They give you the sequence of it.

5 MR. ASHE: I think that's an overview of how it's 6 really working.

7 MR. MACHILEK: There it is. There's the crystal 8 sitting right here, 1.47 megahertz, and then it goes through 9 the countdown circuits. We're counting it down until we get 10 the 60 hertz. We are watching the countdown, comparing it 11 against the standard and if we have discrepancies, then we 12 shut down on clock failure.

13 'MR. ASHE: What is this 100 --

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MR. MACHILEK: This is 1.47 megahertz crystal.
We're just counting it down.

MR. ASHE: Something that is relatable to this is 16 how does this thing bump up or change the frequency? 17 18 MR. MACHILEK: It doesn't and cannot. MR. ASHE: We saw it. 19 20 MR. MACHILEK: There's a crystal control, oscillator which is influenced by the circuit. 21 MR. ASHE: Right. How does that -- just go 22

23 through that, because I think that was somewhat relatable to 24 the event.

MR. MACHILEK: What the crystal control oscillator

is doing, the voltage controller oscillator is doing, it
 takes the synchromat and corrects it to be in concern with
 it.

How does it do that? Through voltage? MR. ASHE: 4 5 MR. MACHILEK: It's voltage-controlled. The voltage level is established by the frequency of the voltage 6 converter from the bypass directly compared to the frequency 7 which comes out of the countdown circuits of the clock. 8 And it corrects -- I'll show you how it corrects for the 9 10 incidents.

MR. ASHE: It does that in a period of what, about 2 30 or 40 seconds or so, depending on the ranges?

13MR. MACHILEK: It does it -- no, no. It does it14every 737,000 hertz level.

MR. ASHE: What kind of band is this thing operated in? For example, if you lose more than a few hertz, it won't bring it back into sync anyway, will it?

MR. MACHILEK: Yes. If you are 180 degrees other
phase, it brings it back.

20 MR. ASHE: No, no, no, no. Supposing the 21 frequency, for some reason, goes down to --

22 MR. MACHILEK: Internally?

23 MR. ASHE: No, no, no. The unit works fine. The 24 maintenance supply --

25 MR. MACHILEK: If the sync frequency is going .5

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1 hertz, we disconnect the sync.

MR. ASHE: ' So you lock out really. 2 3 MR. MACHILEK: You disconnect from the sync, yes. 4 We no longer let you influence us. 5 MR. ASHE: So it only rises and falls by that amount basically, because otherwise it --6 MR. MACHILEK: Plus/minus .5 hertz, that's it. 7 8 MR. ROSENTHAL: Based on your knowledge of the 9 design, number one, you know that the SCRs were fired as designed for however long --10 11 MR. MACHILEK: If one gets a little out of step, you blow down right away. 12 MR. ROSENTHAL: And you would know failures of --13 14 MR. MACHILEK: There was no repair, no 15 readjustment, at least not reported. MR. ROSENTHAL: And that's both from the rectifier 16 17 and the --MR. MACHILEK: And the worst -- the only repair 18 which -- two repair orders have been issued, one for the 19 circuit breaker on one unit, and I don't know what the --20 21 the rectifier -- it was a breaker problem. What is the maintenance cost you're 22 MR. ASHE: talking about on one of these units per year? 23 24 MR. HESS: The maintenance contract or the actual cost? 25

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MR. ASHE: The actual cost. Well, contract cost
 for one unit.
 MR. HESS: For one unit, it could vary from - you're talking about full coverage? There's a whole - MR. ASHE: Full coverage.
 MR. HESS: Full coverage.

8 MR. HESS: Three to 5K a year. Now, that depends

MR. ASHE: Ballpark figure.

9 -- that could be a guesstimate.

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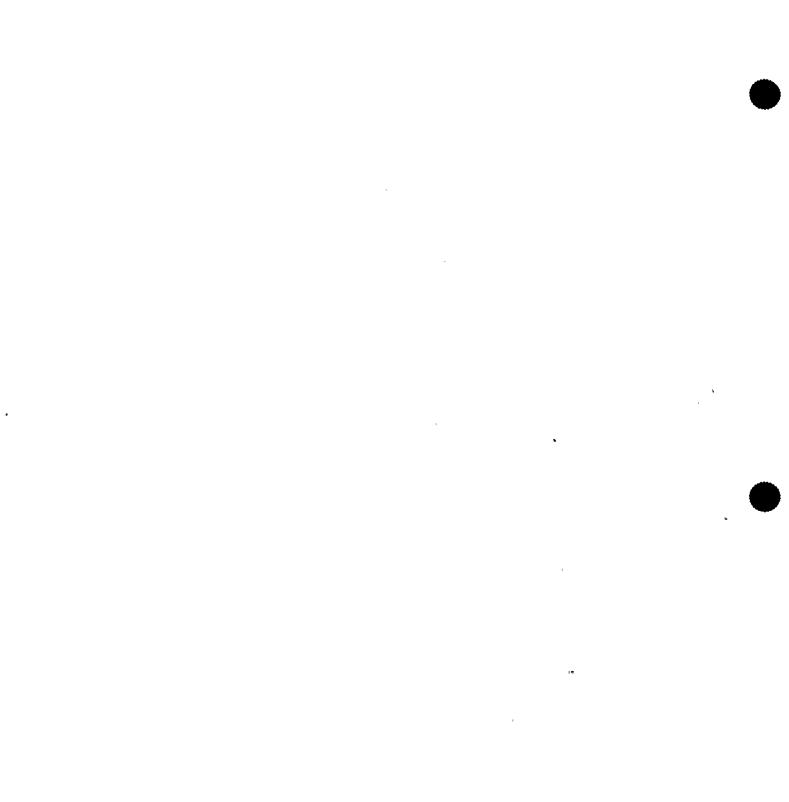
10 MR. IBARRA: Per unit.

MR. HESS: Per unit, yes. It would be per unit and that would be depending on what spares were maintained on-site.

MR. GRADY: That would include parts.

MR. HESS: Yes. What we normally do is a customer 15 has a spare parts package and then we work from that spare 16 parts package and replenish that to them underneath the 17 contract. So they have an ever present supply of parts. 18 MR. ROSENTHAL: When the AC input, normal input 19 degrades, as I understand the design, you turn off the SCRs 20 in the rectifier. 21 MR. MACHILEK: Correct. 22

23 MR. ROSENTHAL: At some point in this scenario, 24 this event, the SCR is -- were the SCRs on the inverter 25 turned off?



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1 MR. MACHILEK: No. 2 MR. ROSENTHAL: No. 3 MR. MACHILEK: Only when it shut down. 4 MR. ROSENTHAL: It was only following --5 MR. MACHILEK: You got the leg-off command. Lea 6 switch-off. MR. ROSENTHAL: And it gets the leg switch-off --7 MR. MACHILEK: Simultaneously on all 12 legs. 8 MR. ROSENTHAL: From where does it get it? 9 MR. MACHILEK: From --10 MR. ASHE: You knew he was going to ask that. 11 MR. MACHILEK: It's on eight or nine. 12 It ties in. It's over there on 12 and 13 MR. HESS: 14 it's tied in on the nine. This is the nine right there. 15 MR. MACHILEK: It's 20. MR. HESS: Yes. Which is tied in across down the 16 17 back here. MR. MACHILEK: It basically takes it -- if we get 18 an under-voltage -- there's the UPT, which is the -- see the 19 20 UPT? That's the same one which is coming out, this one here, the UPT. It switches off to three breakers, comes in 21 here, and it gives you a leg-off command, which is 22 transmitted directly to the K-5 module. 23 MR. ROSENTHAL: Let me see if I can get this 24 right. Because the fuses weren't blown and because the SCRs 25

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were not damaged, in the inverter, you know that it got a 1 leg switch-off. The leg switch-off came from which drawing? 2 3 From here, which gets its input from --4 MR. MACHILEK: UPT. MR. ROSENTHAL: One is UPT, which is the same --5 6 MR. MACHILEK: Yes. MR. ROSENTHAL: -- which is the output of SSTR. 7 8 MR. MACHILEK: UPS trip. 9 MR. ROSENTHAL: From the UPS trip or --MR. MACHILEK: Do you see UV? 10 MR. ROSENTHAL: I'm sorry. 11 12 MR. MACHILEK: Output voltage low. In your case, not used. This is only used on a parallel circuit. 13 MR. ROSENTHAL: Okay. Or --14 MR. MACHILEK: That's it. UPT is the only thing 15 which gives you a leg-off. 16 17 MR. ROSENTHAL: Okay. So that had to be --MR. MACHILEK: Yes. Everything is consistent with 18 19 operation. MR. ROSENTHAL: But that's an independent way of -20 - okay -- or supporting. 21 MR. MACHILEK: I understand. 22 MR. ROSENTHAL: Okay. So now let me try to 23 verbalize it. 24 25 MR. MACHILEK: Sure.

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MR. ROSENTHAL: And then you verbalize it better. It is my current understanding that, by design, the rectifier would turn off -- would be shut down on seeing bad input, that the inverter would be turned off by an SSTR signal only, and that same signal would end up opening CB-1, CB-2, and CB-3.

MR. MACHILEK: To the A-34 transfer circuit.

7 MR. MACHILEK: And give a transfer command.
8 MR. ROSENTHAL: To the --

MR. ROSENTHAL: To the transfer circuit.
MR. MACHILEK: The transfer circuit makes a
decision if or if not to execute that, depending on three
conditions; bypass frequency, voltage and sync.
MR. ROSENTHAL: But we know that that was also

15 effected by the original fault.
16 MR. MACHILEK: Correct. We would not expect the

17 maintenance voltage to be there, because it wasn't.

MR. ROSENTHAL: We follow back the SSTR signal and we decided that that had -- that the only probably way, other than a sneak circuit or something we don't understand, is that that would have come from a power supply failure input and then we followed that back to power -- to the logic power supplies which we know were powered off B-phase and saw the --

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MR. MACHILEK: Yes. Or that can be a verified

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1 test that duplicated --

2 MR. ROSENTHAL: The one thing that we don't 3 understand then --

MR. MACHILEK: Is the discrepancy with the --MR. ROSENTHAL: Discrepancy with the lights. On the lights, we decided that the under-voltage UV does not latch. So that the observation of that light was the time that somebody wrote down what they saw, which was at roughly two hours -- two or three hours -- two hours into the event.

MR. MACHILEK: I would really consider that as a
status indication rather than an alarm.

MR. ROSENTHAL: And that the voltage difference light does not latch as the UV -- OV/UV, but that the OV/UV transfer light does latch and may have -- and we don't know if that latched and lit at time T-zero or five, ten, 20 minutes or an hour into the event.

17 MR. MACHILEK: Right.

18 , MR. ROSENTHAL: Go on. What else do we know?
19 MR. MACHILEK: We know that we didn't have to make
20 a repair or adjustment and the units started up after the
21 alarms were reset.

22 MR. ROSENTHAL: Right. Let's break.

23 [Recess.]

24 MR. ROSENTHAL: Let's go back to UPS. What we 25 decided was it is not single failure-proof. . , • • ` ۲

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MR. MACHILEK: It is, because the power supplies 1 are a single point failure -- not a single point failure. 2 3 You've got to have something else to happen; namely, the maintenance has to get lost at the same time. 4 5 MR. ROSENTHAL: But we did decide that there are lots of redundancy in it. For example, if you lose the 6 7 rectifier, you have the battery. 8 MR. MACHILEK: Correct. 9 MR. ROSENTHAL: And if you lose the inverter itself, you have the maintenance. 10 11 MR. MACHILEK: Bypass. Bypass. So although it's -- so 12 MR. ROSENTHAL: there is a level of redundancy there. 13 MR. MACHILEK: The only time your redundancy gets 14 15 lost is if the redundant is if the primary source fails at the same time. 16 MR. ROSENTHAL: Wait a minute. Given the loss of 17 18 power supply, including the battery, with the dead battery, if the maintenance supply had been good --19 MR. MACHILEK: Nothing would have happened. 20 21 MR. ROSENTHAL: Then it would have -- what would 1 22 have happened? MR. MACHILEK: What would have happened? 23 Nothing, because the power supplies would have to be maintained and 24 you wouldn't know a thing. 25

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MR. ROSENTHAL: If there was some other fault in
 the power supplies --

MR. MACHILEK: If there's another fault in the power supplies, it would --

5 MR. ROSENTHAL: Or the card cage or something. 6 MR. MACHILEK: Then the UPS would have shut down. 7 It would have transferred to maintenance. It transferred 8 many times over the years, right?

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MR. ROSENTHAL: Yes.

MR. MACHILEK: And certainly the batteries didn't go bad. So the dead batteries, by itself, if nothing else happens with it, something specific happens with it, you would never in your life would have known that you have dead batteries.

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MR. ROSENTHAL: Okay.

MR. MACHILEK: Given the assumption that nobody 16 would have checked it. Now, we have to recognize it is 17 difficult to test, check or make a major investigation on 18 the modules since you have no way to power a flow. So I 19 don't -- probably, out of my own, I probably -- given the 20 difficulty to shut down a module and maybe not even getting 21 permission to do it, it is considered that maintenance at 22 times is falling short because of it. 23

I have to give you an example on the first Boeing installation we did in Vienna, not far from here, and we

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wanted to perform the first preventative maintenance, halfa-year after installation, and we were told no way in the world are they going to go off the UPS. We have to wait. Well, three years later we had the first PM. Nobody wanted to let the load get off the UPS. So if you want an enforced maintenance deficiency because of that.

And users are paranoid. Once you have an UPS
installed, you have a computer operation going, they simply
don't let you get off the UPS, period.

MR. ROSENTHAL: We have discussed how do we know that the batteries were not -- were discharged or not charged at the time of the event rather than after the event.

MR. MACHILEK: It was not a matter of -MR. ROSENTHAL: But I'd like to hear your
verbalization of why you believe the batteries were no good
at time T-zero.

MR. MACHILEK: Because of the amount of time it was operating in the elevated temperature environment, experts were indicating that the batteries probably were no longer batteries after one-and-a-half years after installation.

I hope it was confirmed that all five batteries were dead. Not that they couldn't get charged, they were simply incapable to hold a charge.

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There was one that was -- plus 20. It 1 MR. TERRY: 2 was half. The plus 20 volts. MR. MACHILEK: The plus was good? 3 4 MR. TERRY: Yes. Which unit was that, do you recall? 5 MR. ASHE: MR. TERRY: Gulf. 6 MR. ASHE: And you actually load tested that? 7 No. That's measured voltage. 8 MR. TERRY: 9 MR. ASHE: No-load voltage. That doesn't -- was the load test -- it wasn't load tested, was it? 10 MR. TERRY: No. I'm just talking about the as-11 found voltage. 12 MR. ASHE: Okay. No-load voltage will certainly 13 14 come up and that --MR. ROSENTHAL: But the as-found no-load voltage 15 measured roughly a week after the event was after the power 16 supplies had been re-powered three to five days earlier and, 17 hence, are effectively on a triple charge, are on a charger. 18 19 MR. HESS: Yes. Is there a blow-up diagram for the 20 MR. ASHE: power supply, PS-1 and PS-2? Do we have that someplace to 21 22 show the internals of that? It's a purchased product. A11 23 MR. MACHILEK: No. 24 of our drawings shows only the information necessary to procure it. We don't fix it or service it if it's broke. 25

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1 We simply replace it.

MR. ASHE: Well, how do we know what's in there? 2 3 MR. HESS: When you order one, it comes with a small diagram inside the box, if I remember correctly. 4 MR. ASHE: You don't retain any of the diagrams 5 6 like that? 7 MR. HESS: They're in the purchase part of it. MR. MACHILEK: We don't fix it. It's what we call 8 9 a non-repair subassembly. 10 MR. ASHE: What happens to the old unit you take out then? 11 12 MR. HESS: Throw it away. Who do you purchase that from, do you 13 MR. ASHE: 14 recall? I knew you'd ask that question and 15 MR. HESS: there's been a couple different vendors. Economate. We 16 have a list of vendors. Would you like --17 MR. GRADY: We have a drawing that lists the 18 19 vendors in the specs. 20 MR. ASHE: For the power supplies. Yes. We can send that to you. 21 MR. MACHILEK: MR. ROSENTHAL: Okay. That might be helpful. 22 23 Because if those power supplies have, let's say, big capacitors inside there, they have finite lives also. 24 MR. ASHE: I'm not certain that that's really 25

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1 This power supply appeared to act more as a true. transistorized regulator rather than a capacity guide. 2 MR. MACHILEK: It's a series -- it's a linear 3 4 series regulator, transistor regulator with filter capacitors on the output. The DC is being filtered because 5 it is --6 7 Right. MR. ASHE: MR. MACHILEK: That's why the capacitors are 8 9 there. 10 MR. ASHE: The output is across the capacitor. MR. MACHILEK: Absolutely. Yes, sir. Otherwise 11 we wouldn't survive with the power you had there, not even 12 on the normal charges. Capacitors are holding you up right 13 14 now. Okay. 15 MR. ASHE: MR. ROSENTHAL: I'm sorry. K-5 flips from one 16 state to the other. 17 MR. MACHILEK: The capacitor --18 MR. ROSENTHAL: The capacitor and the power supply 19 20 is what's holding you up. MR. MACHILEK: Yes. 21 MR. ROSENTHAL: Then I guess it would be good to 22 23 know what --MR. ASHE: So you have seen the diagram and you 24 know that's the way it is. 25

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MR. MACHILEK: No. I don't see the diagram. The power supply. Same power supplies which are on the pan which --

4 MR. ASHE: When you say on the output, what I'm 5 saying -- to me, what that means is between plus and the 6 neutral, you're saying that output is across the capacitor. 7 MR. MACHILEK: Correct.

8 MR. ROSENTHAL: That's another age-related 9 problem. Did you want to review the --

MR. ASHE: I'm saying the internals. The internals. It didn't seem like the data was suggesting that to me.

MR. HESS: As soon as we get back, we'll get you 14 -

MR. ASHE: You can do that, from the internals, If I'm saying. The internals. I'm talking about the one from the inside of the power supply.

18 MR. HESS: In fact, I think it's on the back of 19 the power supply now, they've gotten it. I saw one where it 20 was actually glued onto the back of it.

21 MR. ASHE: And you have one of those laying around 22 someplace, you think, or might?

23 MR. MACHILEK: At the plant.

24 MR. HESS: Let us take care of that. Let us get 25 one.

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MR. TERRY: Are you just talking about filter 1 2 capacitors across the power pack? They're external. They're internal. 3 MR. HESS: No. 4 MR. HESS: We will take that as an action item and get you a copy of the schematic of the power supply itself, 5 not the subassembly, which we already have. б 7 MR. ROSENTHAL: We know that large tantalum type capacitors, batteries, are age-related components. The 8 chips, hypothetically, have an infinite life. What other 9 components are there which you would consider age-related? 10 MR. MACHILEK: DC electrolytic capacitors which 11 12 are on the main DC bus. MR. HESS: That was called out in the 13 recommendations. 14 MR. ROSENTHAL: Go on. 15 MR. MACHILEK: That's it. 16 MR. HESS: Age-related like that. 17 MR. MACHILEK: Nothing else has a shelf or 18 operating life. 19 20 MR. ROSENTHAL: Wear-related rather than agerelated. 21 MR. ASHE: The diodes, you said that's a chip, 22 Is that just -- that takes the 20 volts? 23 too? MR. MACHILEK: Yes, yes. The output regulators 24 which are little chips. 25

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MR. ASHE: Is that just a resistive voltage - MR. MACHILEK: It's a transistor series regulator.
 MR. ROSENTHAL: That's a 7812. We could look that
 4 up.

5 MR. MACHILEK: Yes. They're all over the place. 6 MR. ROSENTHAL: What were you going to say? 7 MR. ASHE: I was going to ask Rudi to characterize 8 the whole thing very simply, starting from the transformer 9 rectifier, downstream propagation to the power supply, trip 10 of the units.

11 MR. MACHILEK: Okay. The loss of Phase B voltage 12 translated itself over the areas Delta Y transformers to 13 show up as a Phase II voltage reduction all the way through, 14 including the 100-volt switch we use for control.

15 The effects of the voltage reduction on the 16 rectifier input was that the rectifier phased off. The inverter continued to operate on the main station battery. 17 18 The supply to the control power supplies reduced itself from 19 120 to roughly 50 volts. The drop-out voltage was, I 20 believe, 45 on those relays. So we did not switch over, 21 which starved the input to the power supplies and they lost 22 regulation, reduced the output DC voltage and the batteries, which were not able to hold up, decreased their voltage on 23 the load to below 16.5 volts, which caused an UPS trip 24 25 signal to be issued, which was properly executed.

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1 The transfer to bypass signal was not processed 2 because the bypass was not of the quality acceptable to the 3 circuit, and the load was lost.

MR. ROSENTHAL: Break.

[Recess.]

6 MR. MACHILEK: It can be shown that if you, for 7 instance, simply take the power supply pan, the A-27, and 8 you supply it with voltage and you monitored the load of the 9 power supplies with four-amp and one-amp, respectively, 10 which is the normal draw, then you can really demonstrate 11 what would happen.

12 If you reduced the input voltage to the power supplies, was switched to power supply availability from one 13 input to the other, all that can be duplicated and shown 14 what's going to happen. The draw is a constant draw. So 15 even if you simply put a resistor float on here which draws 16 about four amps or thereabouts, draws about one amp or 17 18 thereabouts, then you can direct it to break it. And what 19 will happen is given the capacity of the battery and the 20 discharge current of four and one amps, you can directly 21 calculate or get from the manufacturer the voltage decay over time, and whenever you hit 16.5 volts, that time, you 22 will be able to support the operation of the UPS without any 23 24 other supply.

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You will see, if you do that, that it is

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considerably longer than the 12 cycles of voltage we're actually experiencing. Given that, which can be demonstrated, tested and shown, you can make the conclusion that if the batteries would have been good, you would not know that anything happened. MR. ROSENTHAL: I think that's it. [Whereupon, at 5:10 p.m., the meeting was concluded.] 

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## **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: Nine Mile

**DOCKET NUMBER:** 

PLACE OF PROCEEDING: Bethesda, Maryland

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

Mary C. Lark

Official Reporter Ann Riley & Associates, Ltd.

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