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PUBLIC MEETING

Nuclear Regulatory Commission
One White Flint North
Rockville, Maryland

Wednesday, November 24, 1993

The Commission met in open session, pursuant to notice, at 9:00 a.m., Ivan Selin, Chairman, presiding.

COMMISSIONERS PRESENT:

IVAN SELIN, Chairman of the Commission
KENNETH C. ROGERS, Commissioner
E. GAIL de PLANQUE, Commissioner

STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

SAMUEL J. CHILK, Secretary

KAREN CYR, Office of the General Counsel

JOE COLVIN, President and CEO, NUMARC

BILL RASIN, Vice President and Director, Technical Division, NUMARC

P-R-O-C-E-E-D-I-N-G-S

9:00 a.m.

CHAIRMAN SELIN: Good morning, ladies and gentlemen.

This morning the Commission will be briefed by representatives of NUMARC on the Thermo-Lag fire barrier test program. The meeting this morning is a follow-on to the briefing that the Commission received from the staff on October 29th when they discussed the status of actions to resolve the various Thermo-Lag issues.

I cannot emphasize enough the importance of fire protection as it relates to operating reactor safety, although of course the barriers are only one element of fire protection.

The Browns Ferry fire in 1975 sensitized the Commission properly to the importance of fire protection. That fire demonstrated design deficiencies in instances where electrical cables have insufficient separation. This is really a very important issue. In nuclear power plants we have the principle of redundant independent system
s such that if something affects one of the emergency systems the other emergency system should continue to operate. However, it turned out that the cabling from

these systems in many cases was commingled in such a way that a fire would knock out both systems or all the trains simultaneously.

As a result of the Browns Ferry fire, the NRC regulatory work culminated in promulgation of Appendix R in the early 1980s. This appendix made clear that the preferred solution was one in which there would be physical separation between the cables of the supposedly independent systems such that a fire or another event would not be expected to knock out both systems. In the absence of separation, we would accept barriers that would withstand a fire for one hour if that was also coupled with fire suppression techniques such as automatic systems to put out the fire. In the absence of separation and in the absence of fire separation, we required a three hour barrier such that a fire would not simultaneously attack both sets of cables and would give the plant personnel enough time to detect and fight the fire.

The Thermo-Lag fire barriers, which we discuss here today, are an important element in the fire protection system. These barriers are widely used in operating reactors. For instance, 23 of the currently operating reactors utilize a one hour fire protection barrier. Fifteen reactors possess only

three hour protection barriers and 40 more reactors have a combination of both one hour and three hour fire protection barriers. So, this is a problem or an issue that is very broadly affecting the industry.

The NUMARC group has been pursing a testing program for Thermo-Lag fire barrier issues on behalf of the utilities for some time. These tests involve experiments on the effectiveness of the insulation under a variety of conditions. The Commission's previous meeting exposed certain differences of opinion between the positions of the NRC staff and NUMARC. These are fairly technical differences but very important, including the placement of heat sensors which will be referred today cryptically as thermocouples, but they're just devices to measure temperature, and also test criteria for associated conditions.

So, we're particularly pleased to have NUMARC provide information on the nature of the test program. However, I wish to stress that the Commission's concerns go beyond the test program and we're concerned whether there is any test program that could lead to timely resolution of the fire barrier issue on a generic basis or whether we will have to resort to plant by plant solutions to this problem.

We're interested in exploring the basis for your technical position today and especially we're interested in your plans for future actions intended to resolve the urgent matter.

We are particularly concerned about the lack of an obvious clear path to satisfactory resolution of the fire barrier issues. We need to be looking for an approach which would achieve effectiveness comparable to that which would be achieved through separation of the cables. Now, we know that this is hard to do in existing plants, but there are other possibilities such as spray systems, fire retardant materials or more complicated fire barriers. In fact, the NRC staff is now initiating efforts to prepare letters to obtain each nuclear utility's plans either to restore the required fire resistant capabilities of barriers or to identify alternative actions.

In fact, this morning, Mr. Colvin, if you care to comment on any of these broader issues, the Commission is prepared to hear your comments.

I understand that copies of your viewgraphs are available at the entrance to the hall to the public.

Commissioner Rogers?

Commissioner de Planque?

Mr. Colvin, the floor is yours.

MR. COLVIN: Thank you, Mr. Chairman. Good morning.

We are pleased to be here with you today and try to brief you on the industry's fire protection program and in particular on the aspects of the Thermo-Lag testing program and the various parameters as you articulated. We also appreciate the Commission's rapid response to our request to meet with us and do so on the eve of Thanksgiving at such an early hour. So, thank you very much.

CHAIRMAN SELIN: Let's hope you don't offer us a turkey, Mr. Colvin.

MR. COLVIN: Yes, sir. We did take that into consideration in preparing the briefing.

(Slide) Can I have the first slide, please?

In opening the discussion, I'd like to just mention -- to start out on a little broader scale and talk about the industry fire protection program and then move directly into Thermo-Lag. But I wanted to make sure the Commission recognized that the industry is looking at the fire protection issues in a much broader context, to look at not only the

testing and the qualification of Thermo-Lag barriers, but also the other fire barrier materials and the elements of those because we and the staff have some potentially similar concerns vis-a-vis other non-Thermo-Lag materials, and also to try to respond to the staff's proposed changes or potential proposed changes on Appendix R and moving that into the performance-based area.

So, in response to that, one of the things we decided to do is establish an executive level working group, much in the same context that we have in the maintenance area and license renewal and so forth to try to bring the policy level discussions and involve the senior executive leadership of the industry to do so. We're taking those steps. As you indicated, the staff on Friday -- we briefed the staff and had discussions at a senior management level of the staff and agreed with Jim Taylor, who was the EDO at that time, to establish a high level policy working group and have senior management meetings on a regular priority. We would use that process of this working group along with the NUMARC staff to have those senior management meetings.

(Slide) Second slide, please.

Moving into the Thermo-Lag test program,

I think it's important to realize that in looking at Thermo-Lag we're really not just going off to do some experiments and tests in Thermo-Lag. Really what we have to do, what we've come to believe we have to do is, in fact, complete reestablish the technical and licensing basis necessary to qualify these fire barrier materials. That causes the program to be very broad in scope and also a very complex issue and that's what we'd like to, through the presentation today, provide a little bit of insights on that.

(Slide) Next slide, please.

Some of the conclusions that we reached, and as a result of why we felt we needed to take this broad program, really are indicated on this slide. First, all the Thermo-Lag tests, except for those recently conducted by the Texas Utilities Company, really have been concluded to be indeterminate because neither the staff nor the industry has the information necessary to qualify those fire barriers in either a one hour or three hour rating as required by Appendix R of 10 CFR 50.

Secondly, the existing fire barriers were installed to differing and changing installation requirements. So, when we try to look at those and apply the test results from the past, we have an

element of concern for both how it was installed as much as whether that application can be then taken and applied in other specific applications.

Third is that the tests have shown that we have really two elements. That is the thermal performance issues related to the fire barrier material and secondly the structural issues that relate to how that fire barrier material is applied and whether it can sustain itself throughout the duration of these tests or even, more importantly, throughout a fire if we had a real fire at the plant.

There are other structural issues which we will discuss. There are other issues relating to safety and the fact that the Thermo-Lag and the weight applications also give us some problems with respect to seismic analysis and other safety requirements of the Commission, we will address that very briefly throughout the presentation.

The other thing that has come up is that there is an ampacity question on what is the derating that we would have to take into effect on the ampacity of the cables, the current carrying capability of those cables, by the addition of either more fire barrier material and having that be acceptable and tested properly throughout a fire. So, the second

point of that is how do you apply those derating and those ampacity derating values in a specific application. So, that's part of the program.

The fifth issue is really that the Thermo-Lag has been questioned to whether it is combustible or not. In fact, we did a testing program -- Bill will talk about that very briefly today. We'd be happy to respond to questions -- but through the Underwriter's Laboratory to test the combustibility of the Thermo-Lag material itself and then try to take steps on how one would take that into account throughout to meet the Appendix R requirements.

Lastly, the generic test program that we are trying to design really has to encompass as broadly as possible the specific applications that we have within the industry to reasonably envelope those and take full advantage of the generic elements.

(Slide) So, today, what we'd like to do -- next slide, please -- is kind of outline for you the Thermo-Lag test program, how we would see applying the results of that program in specific licensee applications. I'd like to talk to you briefly about the test results that we've seen through phase 1. There have been a lot of successes in this program. There's still a lot of work to do in this, but we have

made some progress in the testing and it's given us some real insights into this material and its applications.

We would like to talk to you about a couple of the test acceptance criteria issues and in that regard they do get very technical and our intent is not to ask the Commission to come to some decision on these. We recognize that you have asked the Advisory Committee on Reactor Safeguards to get involved and we are supporting that with the staff to kind of bring these issues to resolution. But we'd like to try to give you some insights as to why we have been stubborn in this area and why those issues are so important to the success of this program.

Lastly, I'd like to provide a few conclusions.

So, with your permission, I'd like to turn the discussion over to Mr. Rasin and I'll come back for the conclusions.

MR. RASIN: Thank you, Joe.

(Slide) May I have slide number 5, please?

Fire protection, as you've noticed, Mr. Chairman, we're trying to keep in perspective the fact that the fire barriers are one element of fire

protection in a regulation that, in fact, is a defense in depth approach, first concentrating on the prevention of fires and then going on with detection and prompt suppression and then finally followed up with the protection of equipment if the fires are not extinguished and that's where we get into the fire barrier question.

The regulation again, as you pointed out, requires one or three hour fire barriers, depending on whether they are combined with fire suppression systems. However, we have to keep in mind also that these fire barriers are unrelated to any actual plant fire loadings and, in fact, are based on a rating from a combination of industry standards and NRC staff acceptance criteria.

Typically for these fire areas in the plant we have a low fuel load, typically less than 20 minutes in most applications, which is far below the typical testing criteria. I will add, however, there are a few areas in the plant that, in fact, approach that testing criteria and there are some areas that do require special attention with these barriers.

There has been no actual fire in a plant that has ever come close to challenging these barriers or the criteria by which they are tested. The NRC

staff has recognized the actual fire hazards in many cases on a plant-specific basis by granting exemptions by specifically considering the load.

CHAIRMAN SELIN: Before you go on, this last point, I think, is really important. We do not require one and three hour separation. We say if you are to use a generic solution based on the material, that's what is required. I think we all understand those are surrogates for plant by plant safety analyses, so that if all else fails we are quite content to look at the plants on a specific basis based on the loads in that plant and any threats in that plant.

One of the main questions facing us is whether there is, in fact, a generic solution or whether there will be, in most cases, little alternative to a plant by plant --

MR. RASIN: Yes, sir. That is an important element, Mr. Chairman. While we realize that, one of the reasons that we have been pursing the generic program is simply looking at the most expeditious path to resolution. The resources required by the NRC staff to do this plant by plant review, barrier by barrier review for thousands of barriers, in fact, I believe will lead to a very long-

term solution to the problem which none of us want. So, that's why we continue to believe that a generic approach can get us most of the way there if properly applied.

(Slide) May I have slide number 6, please?

With respect to the Thermo-Lag material itself, Thermo-Lag is the predominant cable raceway fire barrier material used in the industry for compliance with Appendix R. We have a very large scope of installation within the industry. I've shown a breakdown here between conduits and cable trays in one and three hour applications in terms of linear feet across the industry just to show the very, very large usage of this material.

As Joe noted, all previous tests have been declared indeterminate by the NRC staff, meaning that the details of the testing are not sufficient for us all to conclude that those tests serve as an acceptable regulatory basis for Appendix R compliance. That is why a successful test program has to aim for establishing a basis for the requalification for compliance with this material. If this program were simply to show in various applications that Thermo-Lag will work to serve its function, it would be a rather

easy test program. But, in fact, we are trying to look for the most expeditious way to return a complete regulatory confidence in the application of this material within the plants.

(Slide) Slide number 7.

With respect to the fire barrier test program, our purpose is to assess the Thermo-Lag performance for representative plant cable raceway installations and we have identified a combination of baseline applications, meaning applications exactly as installed in the plants, a set of proposed upgrades using Thermo-Lag itself, and a set of upgrades that uses the Thermo-Lag in combination with other fire barrier materials.

The scope of the program to date is 17 test configurations which we have undertaken in two phases and it may be that further tests may need to be undertaken based on the success of the tests in the first two phases and an opportunity through what we learn here to show that a few more tests may, in fact, expand the boundaries of what can be generically tested and applied.

Let me explain a little bit why we took the two phased testing approach. Early on in this definition of a test program the supplier of Thermo-

Lag came forward to several utilities with some proposed fixes for Thermo-Lag, some upgrades, that he thought would be responsive to this problem. We felt that individual testing of those configurations would not lead to the industry-wide confidence and credibility necessary and yet we saw two advantages to those tests. One, quite honestly, the vendor was willing to completely foot the bill for them, which we thought was much to our advantage. Secondly, it provided an opportunity for some testing and some data on three hour fire barriers which none of the previous testing has spoken to.

So, for that reason we agreed to undertake a phase 1 testing that centered on vendor recommended upgrades to the barriers.

The phase 2 tests is more appropriately the industry program where, in fact, that phase will test a combination of baseline barriers or currently installed barriers and also some industry proposed upgrades to those barriers.

(Slide) Next slide, please.

There are many attributes of the installed configurations that affect Thermo-Lag performance. As Joe pointed out, there are really two issues with Thermo-Lag. One is simply the thermal performance, is

there enough Thermo-Lag, enough thickness of it, to adequately perform its function. But two, is it installed in such a way that it maintains its physical integrity throughout the fire test so that, in fact, the Thermo-Lag is held in place in the proper perspective to perform that function. The original Texas test that indicated some of these problems did have problems like joints opening up where the Thermo-Lag was joined and that is a further complication of the problem.

Some of these attributes such as material thickness speak directly to the thermal performance. Many of the others, such as pre-grouting of joints, direction of structural ribs, internal panel supports, et cetera, really speak to the structural question of the fire barrier performance.

CHAIRMAN SELIN: Before you get off this page, Mr. Rasin, I'd like your views on two related questions. The first is are you trying to build a model that talks about the effectiveness of Thermo-Lag as a function of these parameters or are you trying to find some dominant solution that says that over the whole range of pre-grouting of joints and a couple of these other points that one could be confident in the Thermo-Lag?

MR. RASIN: I think I'll explain that a little better when I get into how one would apply the test results. But, in fact, to reference it for regulatory qualification, we think you have to deal with what you have and match that up to an appropriate test. We have not found a set of tests we could do that we thought answered all those questions on a generic basis without plant-specific justification of that installation.

CHAIRMAN SELIN: That gets to my second point. Some of these would be obvious, like what raceway dimensions will be and the unsupported span distance, but questions like pre-grouting of joints or particularly the grouting that is hidden, are these determinable in a particular installation in a non-destructive fashion?

MR. RASIN: They're determinable by the instruction or the installation instructions that a utility used which, as Joe pointed out, did change over time. But each utility knew what instructions they installed the material to. So, they --

CHAIRMAN SELIN: But you couldn't physically go out and inspect the -- talk about grouting. That's the one I'm most concerned about. Do you physically go out and inspect an installation

to say the spaces have been filled in under the surface or not? You would have to go back to some logs to see what the installers said they did?

MR. RASIN: You would have to go back to your original installation instructions. Inspecting them, once they are installed, becomes a very difficult task. In fact, would likely require in damaging the barrier to the point you'd have to replace it anyway.

CHAIRMAN SELIN: Okay.

MR. COLVIN: Just one other comment on that, Mr. Chairman. I think that the point that -- Bill is going to address a number of the questions you might have on this, but I might say that we know a lot about the variability of these specific issues as they are independent variables in the equation. The real thing that we don't know is how they all work together and that's why we need to do these integrated tests. When you go into -- and you'll see the test application as we go in there, you can see the various combinations of these elements that we've put together to try to get some range of application and data on this. So, I think you'll see how that comes together in a few minutes.

(Slide) May I have slide 9, please?

At the start of this program we conducted an extensive survey of the industry where we actually gathered the design information on the Thermo-Lag configurations in the industry and analyzed that to a significant degree to determine what variation in the parameters that we had and also to define a test program that we felt would, in fact, be referenceable by the largest number of configurations.

We analyzed these survey results for the broad parameters that we have listed on the previous page and the real challenge in this program is to properly bound these factors with a reasonable number of tests, but not to get so overly conservative that, in fact, the test fails, in which case you haven't bound anything with that test.

(Slide) Next page, please.

The next slide shows a cartoon of a typical test configuration and I wanted to explain this to you to show that while we have what would appear to be a relatively small number of tests, in fact each test does look at a very large number of these parameters. The test configuration that's shown here is used for either 36 or 24 inch cable trays and in this configuration we are, in fact, testing a lot of things. For instance, just from a geometrical

point of view, we have vertical runs of the cable trays, we have U bends of the cable trans and we have horizontal runs of the cable trays.

Moreover the fabrication techniques used on the right-hand U bend and vertical rise are different than the fabrication techniques used on the left-hand U bend and vertical rise. With respect to the upgrade, you can see that we have tested the use of stainless steel tie wire for the structural integrity on the right-hand portion. We've used stainless steel banding on the left-hand portion. In all cases, we have used post-buttered rather than pre-buttered joints because, in fact, that has shown to be the most problematic structural problem from the previous testing.

So, from this one article --

CHAIRMAN SELIN: Translate that to English.

MR. RASIN: Yes. Buttering is actually preparing the joints of the Thermo-Lag by application of what's called a trowel-grade material. It can be done before joining those joints together to form a nice smooth seal and then press them together and hold them together or, in fact, the material can be put together and then the joints ladled with this trowel-

grade material after they have been put in place and joined. The latter case is what we refer to as post-buttering.

CHAIRMAN SELIN: That's a greater problem?

MR. RASIN: Yes, sir.

CHAIRMAN SELIN: And therefore if that is found to be satisfactory, then the pre-buttered joints would be included?

MR. RASIN: Yes, sir.

So, in conclusion, what I'd like you to draw from this slide is, in fact, while there are only 17 tests, you can see that we're gaining a tremendous amount of information from each actual test that's run. it's not just a simple matter of testing one configuration.

(Slide) Now, on the nest slide I'd like to talk a little bit then about how one would go about using this on a plant-specific basis and why such a generic program can, in fact, address many of the configurations and we think the great majority of the configurations within the industry.

This chart speaks in terms of commodity, which I have to tell you is a term our contractor came up with for this. I don't know if I like it or not. But basically what it refers to is a specific

geometric configuration of Thermo-Lag and a rather discreet configuration. For instance, commodity 1 represents a straight run of conduit. Commodity 2 is a junction box. Commodity 3 is a large cable tray with a horizontal run and commodity 4 is what's called an air drop or a cable drops from one element, which in this case is a conduit, and joins an existing cable tray somewhere in mid-span.

Now, obviously, this is not an uncommon configuration in an actual plant, but you will not see us conduct any test that you can identify as looking exactly like this. On the other hand, we have run tests of straight run of horizontal and vertical conduit. We have run tests of junction boxes in various physical configurations and we have run, as you can see, many configurations of cable tray and air drops. So, what one does to apply this in a plant-specific basis would be, in fact, to break down the existing plant configurations into these commodity groups, reference these commodity groups based on a comparison of the existing plant parameters to the test parameters and then correlate this to a specific test to show that, in fact, for that piece of this fire barrier this material can be referenced to a specific test and qualified and with confidence show

that all regulatory requirements are met.

So, that's how we see a specific test program actually being applied and this is a very, very important of understanding the whole program. The test program by itself is not going to solve the problem. You've got to look at the application of that program.

(Slide) Next page, please.

COMMISSIONER ROGERS: You're saying that in every plant the applications -- or in any plant, let's put it that way, in any plant the applications of Thermo-Lag would fall into these four commodity groups. Is that right? There are none outside that. Is that what --

MR. RASIN: Oh, no, I wouldn't say there are none outside that. In fact, that's a good lead-in, Commissioner, to page 10 of the slides. We believe that this program will bound a significant percentage of the plant cable raceway installations. There has been some consternation that we've been able to put an exact number on that and I'll explain to you a little on the next slide actually why that is difficult to do at this period of time. But our feeling is that we are talking somewhere in the 70 percent range. It may be a little less, it may be a

little more, depending on a few factors.

This program will not address large unusual shaped enclosures. For instance, we know that there are some applications of Thermo-Lag where there are things like small cabinets or perhaps even a pump enclosure that's made of Thermo-Lag. They are very specific. We made no attempt to address those.

We are aware that there are some places where Thermo-Lag is actually used in the form of a wall between two rooms or between two areas of a room. Those again are very specific applications. We have made no attempt to address those in this testing program.

Finally, we have to say we have seen some very strange configurations even for raceways, that at this time it's not clear whether this program would or would not address and whether one could break them into commodities that would easily match up with the tests. It's likely that you would be able to qualify maybe 80 percent of the run of a particular cable tray, but in one area you had a very weird configuration that you just could not justify to these tests. In that case then a specific test would have to be done or some other approach taken.

We are developing an application guideline

which will be a very thorough explanation of who one goes about applying these test configurations within the plant and returning the barriers to a state of regulatory compliance. We have previously told the staff that it's every bit as important that we have dialogue in their review of this application guideline as it is the testing program because, in fact, the amount of installations that will actually be bounded by this program will depend very heavily on the staff's agreement with this application guideline and its approach.

(Slide) That is one of the reasons, continuing to page 11, that at this time, even though we have all the physical information and could sit back in our offices and count up in our own minds the configurations that will be covered, we are reluctant to do so and give a number until we've had significant dialogue with the staff on this application guideline.

CHAIRMAN SELIN: I'm sorry. Let me see if I understood. Even if you did have or even though you do have?

MR. RASIN: We do have.

CHAIRMAN SELIN: You have details?

MR. RASIN: We have the design material that we collected, in fact, to design the test program

to make the test matrix that we thought enveloped a majority of the industry configurations. But until we have agreement that the approach we're on for the application and for this commodity approach to qualification is acceptable to the staff. Such a comparison will be only our opinion and would require a lot of work that wouldn't be productive right now.

CHAIRMAN SELIN: Does that include a reactor by reactor survey of how much of each of these four building blocks there is and how much the special figurations there is?

MR. RASIN: We have all of that information. We have concentrated on the cable raceways. I do not believe that we have at hand in our office all of the special configurations. Let me turn around and get a nod or a shake to see if that's correct. That's correct. We do not have in-hand design details on all of these special configurations.

CHAIRMAN SELIN: But that seems to imply that the information the staff is thinking of asking for in these 50.54 letters is available at the plants. They've done most of that at least to answer your surveys.

MR. RASIN: That is correct, most of it, yes.

CHAIRMAN SELIN: Okay.

MR. RASIN: We believe that at the end of our program, once having completed the tests and reviewed those test reports with the staff, having come to a conclusion and agreement on the application guideline, that at that point in time we will have the material available for each utility to use to select the best alternative to achieve full compliance through one of the following methods. I will say missing on here, because we've concentrated on the problems, is using the test to show that installed configurations are adequate. We believe for a large number of one hour barriers we may be able to do that as they exist.

However, the alternative will be for problem areas to upgrade the barriers, to install other types of barrier material, to seek an exemption request based on the fire loading coupled with the qualified performance of the existing barrier as referenced in some of our tests, to reroute the cables or, in fact, to install suppression systems to turn a three hour barrier into a one hour barrier.

I will caution though. I think there has been an impression after the test of the three hour barriers to jump to the conclusion that, okay, we

ought to make them all one hour. But I'll again return to the fact that all Thermo-Lag tests have been declared indeterminate and therefore while we may technically be very confident that a three hour barrier will perform a one hour function, in fact it is no better qualified in a regulatory compliance sense than any other barrier at this point in time. Therefore, the testing program must continue, whether that approach is selected or not.

COMMISSIONER de PLANQUE: Do you consider this list of alternatives an exhaustive list or just the best possible options?

MR. RASIN: Oh, I would be reluctant to consider it exhaustive. I think they are the more obvious options with just a reading of the regulation.

COMMISSIONER de PLANQUE: Okay.

CHAIRMAN SELIN: Really there isn't -- I mean there isn't much more you can do logically. You can fix the barrier, you put in a new barrier, you get an exemption, you go from a three hour to a one hour by putting suppression or you just separate the cable. I mean it's logically hard to imagine that that isn't pretty exhaustive.

MR. RASIN: Yes, I would agree with that, but there are engineers in the utilities much more

clever than I and I wouldn't want to rule out any really clever technical solutions at this time.

CHAIRMAN SELIN: I'm as nervous about clever engineers as I am about clever accountants. But we'll let you go on.

MR. RASIN: Actually more worried about clever licensing managers than engineers.

(Slide) If we could go to page 12, please.

I'd like now to talk briefly about the phase 1 test results. Of the configurations we tested, I have listed here those configurations which we felt exhibited satisfactory performance in all respects, including meeting the NRC's proposed criteria with the exception of the differences we have, which we will discuss later.

CHAIRMAN SELIN: So, this page is to be read that if the NRC accepted your views as to what the cable loading ought to be and where the censor should be placed, that you believe that the statements on this page are true.

MR. RASIN: Well, they exhibited -- from a technical point of view they exhibited complete satisfactory performances. The barrier remained intact. There was no breach. The cable temperature

remained within the specs as we measured it and the visual inspection of the cable afterwards showed absolutely no damage to the cable whatsoever.

So, satisfactory in a technical sense. In a regulatory sense, yes, if the staff accepted the acceptance criteria that we have used for this program, there should be absolutely no question of the regulatory compliance of these configurations.

COMMISSIONER de PLANQUE: But these were all done according to your acceptance criteria?

MR. RASIN: Yes. Yes. That's correct.

(Slide) On page 13 we have a second set of the phase 1 upgraded configurations which, in fact, exceeded the temperature limits in the final one to 13 minutes of a three hour test, with the exception of the last one which was within a few minutes of a one hour test. Again, these configurations had complete integrity of the barrier and visual inspection showed absolutely no damage to the cable. However, even with our criteria, the temperature values actually specified by the staff, with which we don't have a disagreement, were exceeded at a few discreet locations within the test and therefore have to be called from a regulatory standpoint a failure, although from a technical standpoint the barriers

obviously performed very well.

The final two configurations at the bottom of these phase 1 upgrades did not demonstrate satisfactory performance either in a technical or regulatory sense.

CHAIRMAN SELIN: Mr. Rasin, would you go back to this middle class?

MR. RASIN: Yes, sir.

CHAIRMAN SELIN: You didn't say this and I'm not trying to put words in your mouth, but listening to what you're saying it would suggest that even these tests, although they didn't meet the temperature, the test could be useful in helping a specific utility demonstrate that their particular configuration and their fire loading would, in fact, be appropriate for an exemption request. Is that a fair conclusion?

MR. RASIN: I don't think I'd make that general conclusion with all three of these. I believe two of the three we could probably make an argument for detailed review and discussion by the staff and a determination as to whether they were acceptable or not. Also, they could form the basis for an exemption request showing that they far exceeded the existing fire load. There's at least one of these tests which

we are not prepared even to make that argument at this time.

CHAIRMAN SELIN: Which is the third one? The one for which you're not prepared to make that argument.

MR. RASIN: The first one, the three hour aluminum cable tray with "T" section. In that case, we actually had some water intrusion when we did the hose stream test. So, even though the barrier performed all right throughout the test, after it was over and we did the hose stream, there was some leakage of water which led to some other problems. Whether that is a function just of the arrangement we had with the test location or whether, in fact, it is a problem for an actual installation, we haven't determined yet.

I just wanted to point out that ever since we've completed these tests we've been reviewing them. It is not a small task to do this. The typical configuration I showed you before has approximately 300 thermocouples when constructed and instrumented to meet the standards and the criteria that the staff has on the barriers. So, the basic criteria that we've used, if there's any one of those thermocouples anywhere that exceeds this temperature criteria, then

the test is not a clean pass and is put on hold. Going back and deciding now what the real physical situation was with that barrier then becomes quite an intensive task. What we have done to date is not to press that point, not to engage the staff in arguments over this is good even though we had this exceedence because what we really want is a nice set of tests to where we do not have to use all the resources to do that, they're just clearly referenced. Whether we return to some discussions on particular tests at some point in the future, I will leave open, but that's not our intent at this point.

COMMISSIONER de PLANQUE: But the temperatures were okay up until between one and 13 minutes short of the time?

MR. RASIN: That is correct, they were all below the specified temperature criteria up until that time, at which typically there was one thermocouple that exceeded somewhere in the test configuration that temperature.

COMMISSIONER de PLANQUE: What's the accuracy of the thermocouples?

MR. RASIN: That's a good question.

COMMISSIONER ROGERS: Oh, they're pretty good.

COMMISSIONER de PLANQUE: They should be pretty good.

COMMISSIONER ROGERS: They're very good. It's the best way there is.

MR. RASIN: They're very accurate within one degree. However, that's within the temperature range of the pass/fail. What we have found is that when you do get into an exceedence where you get the higher temperatures, even though the temperature right with the cables may be okay, we're unwilling to rely on those thermocouples once we get up into the 500 or 600 degree range.

(Slide) Page 14, please.

For some of these test results, we have taken the approach in the design of these for some fairly conservative baseline installations and we believe that they have contributed to the failure. For instance, we've used minimum material thicknesses based on our survey of the industry for these applications and we've used the most limiting construction attributes. This was carefully considered based on a desire to bound the maximum number of installed applications. Basically what this says in this test we may have pushed too far trying to envelope things and by backing off a little bit on the

criteria we may leave out a few percent of the existing barriers, but in fact be able to show that the rest of them are qualified.

That's one of the tradeoffs that we have to make in this text matrix, is a careful consideration of how far do you go to bound a certain number in a given configuration without pushing so far that you fail the test and, in fact, have bound nothing. I think in phase 2 we'll probably learn, get a little smarter, but we may also find there that we pushed a little too far to envelope.

COMMISSIONER de PLANQUE: Is there a question of density in addition to thickness? Has the material always been made in a uniform way?

MR. RASIN: There have been questions raised with respect to Thermo-Lag both on chemical composition and the density or consistency of the Thermo-Lag. In the test program we are receiving the Thermo-Lag direct from the manufacturer. However, we have independent chemical analysis of all the Thermo-Lag received for each test. So, we will have a consistent set of parameters. When we get to applying that to plant-specific configurations, I think the chemical questions will be easily answered. We still have to ask ourselves whether we have concerns we have

to do something special about with respect to the density.

Finally, with the phase 1 test program, my people and the consultants assure us that the failure mechanisms we have observed are well understood and that therefore we can't take those into account in the phase 2 program and hopefully not make the same mistakes twice. We will have to see how, in fact, that comes out.

We have done significant redesign of the phase 2 test program as a result of what we've learned in phase 1. In fact, just during this month those designs are proceeding and we plan in December to construct the test articles for phase 2, apply the Thermo-Lag which needs a 30 day cure time before testing and then in January we will proceed with the phase 2 tests.

COMMISSIONER ROGERS: Excuse me. Just on that failure mechanism is well understood. That's a very important statement. I'm trying to make sure I understand what it says. Does it suggest that there were deficiencies in some way that in the ideal installation application of Thermo-Lag might not have led to a failure? In other words, what are these mechanisms that you're considering? One of the

questions is Thermo-Lag itself, whether it can do the job even if it's properly installed and so on and so forth. Are these mechanisms that you're talking about here deficiencies from the idealized application of this material or what?

MR. RASIN: Commissioner, the failure mechanisms here, I think, relate to the direct application of the Thermo-Lag as done in the industry for specific configurations. I don't believe at this point there is a question on whether Thermo-Lag can in fact perform the function that it's supposed to perform. Whether, in fact, it is applied correctly and in adequate thickness to perform that function in every situation is a question.

For instance, on our tests of conduit, we found that the thickness of Thermo-Lag specified for various sizes of conduit, particularly the smaller sizes, is in fact just not adequate. Therefore the installed configurations for certain sizes of small conduit would need to be upgraded in the industry.

In other cases, we have found difficulties with the construction details for very large cable trays. For instance, for a 36 inch span without any internal support, the Thermo-Lag on top tends to sag. So, while it performs this function --

COMMISSIONER ROGERS: Let me come back to that first example.

MR. RASIN: All right.

COMMISSIONER ROGERS: You say it was not thick enough.

MR. RASIN: Yes.

COMMISSIONER ROGERS: To me that's saying that if it were thicker you think it would have worked.

MR. RASIN: Clearly.

COMMISSIONER ROGERS: Well, what's the evidence for that? How do you know that?z

MR. RASIN: Well, I think some of the -- let me ask my consultants back here.

COMMISSIONER ROGERS: It seems to me that's very much related to the question of whether the material itself will do the job.

MR. RASIN: Well, for one instance, on the test articles that we have done with these upgrades, I can tell you that the biggest factor of the upgrades in phase 1 is the addition of greater thickness of Thermo-Lag material. So, for particularly the three hour configurations that we have shown here, it was felt even before the testing that the existing thickness of the Thermo-Lag would result in an

unsuccessful test. So, the upgrade was, in fact, to put a greater layer of Thermo-Lag atop what already existed. So, we put the article exactly as it would have existed in a plant, bounded by our conservative parameters, and then we applied an additional layer of Thermo-Lag as an upgrade that would be done in a field situation and ran the test. Many of these tests, as you saw, were successful under that situation. So, obviously the Thermo-Lag must have been working.

There were also some previous tests and I'm reluctant to say much about the details because I don't recall them. But I believe even in some of the Texas testing done in conduit, that the thickness on various sizes of conduit was explored. But I would have to check the details on that. We will also have that in the phase 2 testing where, in fact, the approach we're taking there with the industry proposed upgrades is to test an existing baseline configuration and then immediately afterwards test the proposed upgrade to that configuration. So, we will have a direct comparison with how does it perform as installed and how will it perform with the designed upgrade. So, we should have some very definitive information on those questions.

COMMISSIONER ROGERS: Okay.

MR. RASIN: (Slide) Slide 15.

I'd like to speak to some of the conclusions that we have drawn based on what we've learned so far in assessing the phase 1 testing. Obviously these could be subject to learning a little bit more in the future. But at this point in time, we believe that one hour upgrades can be successfully demonstrated through such a testing program as ours. By one hour upgrades I mean those that could be practically considered for installation in the plant.

Not on here, but let me comment. We have not had any information until we entered the phase 2 testing, but we believe that a significant number of the existing one hour barriers will probably prove satisfactory for their situation.

With respect to three hour barriers, it's clear that upgrades are likely to involve more extensive retrofits for most existing installations and, in fact, will be difficult to install in the field. At the same time, we feel it's premature to conclude that three hour upgrades cannot be successfully developed mainly because we do have some industry proposed upgrades in the phase 2 part of the program. I remind you the phase 1 was only vendor recommended fixes. Also we're gaining more experience

with this testing program where really we're testing to a new more stringent set of criteria than has ever been applied to these fire barriers before. Our real challenge is to identify those upgrades that are real practical solutions for installing in the plant to return to compliance.

CHAIRMAN SELIN: You're going to go through some of these test results that you have?

MR. RASIN: Sir?

CHAIRMAN SELIN: You're going to continue into some of these other charts that you have in the back, aren't you?

MR. RASIN: Yes, I was planning to.

CHAIRMAN SELIN: The question I had on the three hour barrier and maybe it's too early, not in the presentation but in the test, to answer that, is do you see any reasonable hope that you can get three hour results on a generic basis as opposed to getting the building blocks so that a specific plant for a specific configuration could claim that they have three hour separation?

MR. RASIN: Yes. We still see some hope for that in different configurations. For instance, on conduit where it may be a matter of just adding an additional layer of Thermo-Lag, which doesn't have to

be all that thick, it may well be very practical. For something like a large 36 inch cable tray where in fact the additional material being added is fairly heavy and affects the ampacity and your seismic calculations, then that may be a difficulty. However, we're also -- in phase 2 we have some proposed upgrades that involve using a combination of other material along with the Thermo-Lag that may provide yet a practical solution.

It's also important that you look on a plant-specific configuration. We may come up with an upgrade that's very easily installable at one plant and one configuration, but where in another place there just is not the room to apply that upgrade. So, while we acknowledge three hour barriers are a real challenge, we do think it's premature to conclude that all three hour barriers are out of the question to qualify.

(Slide) Turning to page 16, I'd like to just briefly show you a chronology of the key activities. I hope to show you that we really have been working hard on this for a long time. While I won't go through the list, I will point out a few of the key factors.

In June of 1992, the test results from

some of the early testing at Texas Utilities came out, which I think was the first time it clearly demonstrated that we had more than a regulatory paperwork problem. It clearly demonstrated that there were structural problems with the barriers and therefore that the exact installation and configurations were very important.

In August of 1992, we held a workshop for the industry, specifically to impress upon everyone that this, in fact, was a real problem that needed real attention and was going to be a very difficult one to resolve and that we really needed the support of the industry to proceed forward with resolution.

By September of '92, we had submitted a white paper to begin a discussion with the staff on the testing and acceptance criteria under which we would proceed to look at the fire barriers. We had those interactions over the rest of 1992.

In February of 1993, we received our survey results from the industry with all of the design and installation details on the existing cable raceway applications which allowed us then to begin to formulate the details of a test matrix.

(Slide) Continuing onto page 17, we had an interesting happening in February of 1993 which, in

fact, did lead to a several month delay in our actually starting the test program. I want to explain that to you because it has nothing to do with the technical details. We had designed a test program which we thought to be most effective should take advantage of equipment and personnel from the utilities so that we would not have to hire contractors to build and install and actually conduct and monitor the test program.

So, we had several utilities lined up that were going to supply us materials such as cable trays and conduits for the phase 1 testing. They were going to supply the manpower to actually construct the material, apply the Thermo-Lag and they were going to supply the quality assurance people to, in fact, monitor the test.

Unfortunately in February of 1993, subpoenas appeared at all or most utilities with respect to a grand jury investigation underway in Baltimore and upon finding out that that was a criminal investigation, the legal advice to those utilities was to have no direct participation in the test program. So, at that time we had to step back and, in fact, take a different approach whereby NUMARC contracted separately and distinctly with contractors

to build the test articles, to install the Thermo-Lag and to do the quality assurance checks necessary for the testing. For us to regroup in that situation did, in fact, result in a delay in the test program. However, it was only the delay due to the contractual necessities, not any technical difficulties.

In March of '93, we made the decision, we think at some risk, to proceed forward even though we had not finalized test and acceptance criteria with the NRC because we realized that there would have to be public comment on those proposed criteria and that that would result in a significant delay. We felt at that time, however, that we could not wait until those criteria were completely finalized because it would result in too long of a delay in resolving these issues. So, we have pressed ahead with determination, realizing that there is some degree of risk that the NRC will not accept results that we think are satisfactory because they differ with the criteria. On the other hand, we think we have a technically sound program that will withstand the scrutiny and result in approval, even though we may have a few deviations.

(Slide) On page 18 we show the activities immediately ahead of us. We have another industry-

wide workshop scheduled for December 1st and 2nd where we intend to present to the industry in excruciating detail the results of the phase 1 testing and what we have learned and to go over with them our thoughts on phase 2. We will also at that time give the industry the first presentation on the intention for the application guideline and get them to begin to understand how they will go about using these test results on a plant-specific basis.

By the end of this year we expect to have the phase 1 test reports officially published and distributed to the industry. As I said before, the phase 2 testing will proceed in January and early in 1994, upon completion of the phase 2 testing and upon discussion of the staff with the industry application guideline, we hope to have all of this material in the hands of the industry within the first quarter of 1994.

COMMISSIONER ROGERS: That application guide, that doesn't depend upon phase 2 testing results, I take it?

MR. RASIN: Well, it does, Commissioner, in that there is certainly a synergism between the testing and the application guideline and the various combination of parameters that one is trying to

envelope. So, from the tests we learn the significance of different combinations of parameters. That in turn affects the application guideline as to what we think can be technically justified in terms of referencing plant-specific configuration to a test.

(Slide) Moving onto page 19, I'd like to talk very briefly to you about the test and acceptance criteria issues.

Generic Letter 86-10 specified measurement of temperature at the unexposed side of the barrier and the basis for that were existing industry standards at that time. In fact, we don't quarrel with that because what was used was all that existed at the time. But, in fact, the main determinant was a standard that was based on use of non-load bearing walls, as fire protection between two adjacent rooms with the intent being to protect combustible material on the cold side of the wall. There were no cable raceway standards in existence at that time. So, it's certainly understandable why such criteria were chosen. In fact, I hope to show you as we proceed forward that it's quite a different situation and that, in fact, certain portions of these criteria do make a considerable difference particularly in how one goes about testing.

Furthermore, the actual tests that we have seen for typical fire barrier materials in the industry have not rigorously applied this standard but, in fact, have been accepted upon further review of cable temperature and circuit integrity.

(Slide) Next slide, please.

The NRC staff has proposed a supplement to Generic Letter 86-10 with the express intent of clarifying test and acceptance criteria. As we discussed earlier, those criteria are still under final consideration of public comments and have yet to be issued. However, again, as I said, in the spring of '93 we determined we had to move forward even in the absence of those final criteria.

(Slide) Page 21, please.

We believe that the clarification of the 86-10 requirements in fact involves quite a number of increased conservatisms and we have those listed here. I will say that we had very thorough discussions with the staff on these issues and with just a couple exceptions we, in fact, agree that these new criteria and these conservatisms are appropriate for this situation.

(Slide) Page 22, please.

However, we do have technical differences

on the significance of two issues. One is the placement of thermocouples for cable trays and one is the use of representative cable fill in cable tray tests. I would point out that these are not completely unrelated issues. They're not separate and distinct independent variables and we'll try to explain that later.

Let me say with respect to conduits and the criteria put forth, we have absolutely no disagreement with what the staff has proposed and, in fact, our test program is entirely consistent with that.

(Slide) Page 23, please.

The basis for the temperature measurement approach that we have used in our testing program is given here. It is consistent with what we believe is an applicable industry standard, consensus standard, ASTM E5.11, which admitted is, in fact, in draft form. However, it is so much closer to appropriate for what we're actually testing here that we think there's a reason for giving it serious consideration as opposed to relying on an old standard which clearly is nowhere close to the actual situation we're testing.

We believe temperatures should be measured in the areas containing or in contact with cables

since, in fact, it is the cables themselves that we are trying to protect and the temperature of those cables is what directly relates to the performance of a safety function.

Barrier temperature location outside the cables we believe is unnecessarily conservative with respect to cable functionality. We have found only one valid mechanism for cable barrier contact that we think is a reasonable consideration and while we will talk about that, but briefly it is the sagging of the upper section in a very wide cable tray, bringing that section into direct contact with cables.

Finally, we believe that while the staff has maintained that they have always held to a cold side barrier temperature, in fact previous tests have not been approved to that criteria. Previous tests have been considered on a case by case basis and approved in spite of that criteria. We see no sense holding to a criteria that in fact is a screening value that's always broken.

COMMISSIONER ROGERS: Before you leave that, just could you explain that comment on the next to the bottom bullet, upper copper conductor in place to address this effect? I don't quite understand that.

MR. RASIN: I believe I can answer that a little better when we get to a picture of an actual cable tray installation.

COMMISSIONER ROGERS: Fine.

MR. RASIN: That will be just a few slides later.

COMMISSIONER ROGERS: Okay.

COMMISSIONER de PLANQUE: Before you go on, can you tell me where the ASTM standard is in the consensus process? I see they're up to draft 14. Where is it?

MR. RASIN: It is in the balloting process for that and whether that will result in final issuance or whether it will result in draft 15 or 16 or 17, we can't say. As you well know, one can never predict the consensus standard process. On the other hand, from the standpoint of the thermocouple locations, it is -- to our knowledge it has never been a technical issue throughout the many drafts of the standards as to the location. In recent drafts there have been questions raised about the location of the thermocouple with respect to whether you do or do not have cable in the cable tray. We think they're not completely unrelated issues and I will try to explain that to you. But the location itself has not been.

In fact, the recent controversy appears to have arisen after we designed our test program and proceeded as we have and we think the standard committee is responding to questions brought up by the NRC staff and that that is part of the concern as opposed to just a pure technical concern.

(Slide) Page 24.

With respect to the testing with the representative cable fill, our test program uses a single layer of cable fill for the cable trays. We'll point out that with respect to conduit there is no issue. There is no cable included in conduit for testing and we agree with that approach.

This single layer in our testing represents about a 15 percent cable fill. From our survey results we've concluded that this would envelope 90 percent of the existing cable tray installations in the industry, meaning that any cable tray with a greater than 15 percent loading could reference one of our reports successfully. Those with less than 15 percent, of which there are less than ten percent of the installed configurations, would not be able to directly reference these test reports with no other work or considerations.

CHAIRMAN SELIN: Is there a significant

variation from one lot of cable to another in its heat sink characteristics or from one manufacturer to another of cable ostensibly meeting the same specification? Or if you have a 15 percent fill, does that really take care of all the 15 percent fill or greater in the industry?

MR. RASIN: It does. However, in the application guideline the major point is the amount of thermal mass that that represents. That will be known and that is based on the type and size of the cable that is used. In fact, what we'll look for in matching up these tests is a thermal mass.

With respect to the cables themselves, there are different properties with respect to the insulation, but the heat absorption and heat transfer characteristics of the cable is pretty well fixed based on the fact that they're copper. So, it's only the diameter of the gauge used that has any variation.

With respect to the cable fill, we believe that this will provide a test condition that is much more representative of actual plant installations. Again, as we hope to show, the barrier performance itself, particularly because of the test and the way we're testing it, even more so than the existing in-plant installations, is significantly affected by the

fact of whether there is a thermal mass inside the barrier or not.

(Slide) Moving to the next page, what we have shown here is a plain view of a typical ladderback cable tray. Running up and down the page horizontally are what are called side rails, running across the -- I'm sorry, vertically. Running across the page horizontally are the rungs of the so-called ladder of the ladderback cable tray. You can see that they are actually rather thin structural membranes on which the cables are laid.

(Slide) Going on to the next page, one can see a cross sectional view of such a cable tray with the side pieces noted on the left and the right-hand side and across the bottom is one of those membranes on which the cables rest. It's important to keep in mind that that is not a solid floor of the cable tray. Also shown on here are the thermocouple locations that we have used in the test. You can see that there's one right in the center, in amongst the cables, resting on that membrane. There is a -- and these are bare copper conductors to which the thermocouples are attached, so that we do have a uniform measurement throughout.

On the left and right you will see

thermocouples attached to the outside of the rails and in the center on the very top, Commissioner Rogers, is another bare copper conductor with thermocouples attached.

What we were talking about before is the structural integrity of the top of this barrier. If you look at the barrier going across the top, especially for 36 inch trays, that's quite a wide span. If there is no internal banding providing structural support, as the Thermo-Lag reaches high temperatures, we'd see a tendency of that top piece to in fact sag downward. I might also add we see a tendency of the bottom piece to sag downward. That's really of no consequence with the cable itself. But the top piece, in fact, can sag far enough to come in contact with the cables and, in fact, it would touch that top conductor. So, with the test, we could see, in fact, that that had happened.

CHAIRMAN SELIN: Before you leave this chart, Mr. Rasin, would you be so gracious and open-minded to put where you think the staff would have you -- show us where you think the staff would have the thermocouples placed?

MR. RASIN: Well, according to the proposed criteria, the staff would like us to place

the thermocouple below the cable rung, actually in contact with the lower cold side of the barrier. So, it would be between the horizontal rung on the bottom and the fire barrier down below that.

COMMISSIONER ROGERS: Or right on it? Right on the fire barrier?

MR. RASIN: It says cold side of the fire barrier. So, ideally, you would like it in contact with --

CHAIRMAN SELIN: Would there be any difference on the sides?

MR. RASIN: No. Well, I don't think so. The location is in the side. The standard requires it to be in contact with what can contact the cable. I guess a rigorous application would be cold side. However, that's not been raised as an issue in our discussions.

CHAIRMAN SELIN: Okay. You've got four thermocouples on this sketch. You talked about the one in the middle towards the bottom. In other words, middle from left to right towards the bottom.

MR. RASIN: Yes.

CHAIRMAN SELIN: There's also one in the middle from left to right towards the top. I assume that would be in contact with the whatchamacallit or

with the thingamajig.

MR. RASIN: No. No.

CHAIRMAN SELIN: With the barrier.

COMMISSIONER de PLANQUE: The Thermo-Lag on the top?

MR. RASIN: The whatchamacallit with the thingamajig is supposed to stay up where it is. But as I was explaining to Commissioner Rogers, if in fact that sagged, it would come in contact --

CHAIRMAN SELIN: But wouldn't that thermocouple be actually attached to the cold side of the top barrier as opposed to the insulation?

MR. RASIN: No. No. It is not, nor am I aware that that's a particular issue.

CHAIRMAN SELIN: So --

MR. RASIN: The main issue we've had is with the lower one.

CHAIRMAN SELIN: So, the configuration we're talking about would be one thermocouple, right?

MR. RASIN: Yes.

CHAIRMAN SELIN: Can I ask you another --

MR. RASIN: Now, one set. That's actually a common --

COMMISSIONER ROGERS: Thirty-six inches.

CHAIRMAN SELIN: I understand.

MR. RASIN: A bare copper conductor with many thermocouples.

CHAIRMAN SELIN: But in this section it's one of them.

MR. COLVIN: Yes, sir.

CHAIRMAN SELIN: Okay. I have a loaded question for you, so please beware. What would it cost you, not in terms of the ability to argue your case, but in terms of dollars and sense or inconvenience, what have you, to add a thermocouple so that you had one where you show it and one where the staff would show it?

MR. RASIN: It's not a major cost issue with the test. There's some additional cost, but clearly that is not the issue. In fact, we have agreed in phase 2 that in a set of the test, meaning one of the baseline configurations and one of the related upgrade to that baseline, we would in fact include an additional bare copper conductor with thermocouples in that location requested by the staff and provide that information to them for their consideration. We will discuss the effects of that later and what I hope to do is to set, as you say, an open mindedness for what those results say.

I think in the previous briefing the

message was left that, well, we don't think it will make much difference. In fact, that's not quite true. I think the not makes much difference people have in mind, well, if it's only ten degrees or so it doesn't matter. In fact, it may be greater than that and the fact that it's greater than that leads to why it matters and I'll try to explain that to you a little more.

COMMISSIONER de PLANQUE: Do you have any sense of how much greater than that it might be? I know it's a guess.

MR. RASIN: Yes. Actually, the best guess I have at this point in time is some feedback from some of the staff contractors where I believe they think for our configuration that it may be in the range of 80 degrees. I think that might be a little bit high, but they may be right.

(Slide) To go on to the next page, we have created a little model to try to demonstrate conceptually the importance of this issue and why with respect to just these two points on measurement location and cable inclusion, why we think that we just go too conservative. As I stated, many of the other criteria had conservatisms, but we think they are justified to the situation.

I want to add great caution as we go through and talk about this that this model does not represent Thermo-Lag, it does not represent any fire barrier material on the market right now. It is, in fact, in analysis using a representative insulation material to demonstrate a point. However, we have crafted this so that we think the principles shown in fact are representative of a typical fire barrier material.

One of the problems is that a fire barrier material typically in use today is not a simple insulating material. It is a chemically and physically active material that seeks to take the heat away as opposed to simply insulate the enclosure. That makes it an extremely difficult analytical problem because both the specific heat and thermal conductivity are functions of temperature and, in many cases, time at temperature. However, one can represent these by an effective specific heat and thermal conductivity, and that is what we have tried to do here.

The first picture shows what I think a pure fire protection engineer would like to see and that's quite understandable. He would like to see a fire barrier represented with absolutely nothing

inside it so that if the temperature on the inside surface in fact met the criteria, there would be absolutely no question to where it was used or how it was used or what was inside it. A notable goal, but it's quite a price.

(Slide) If we go to the next page, we see a more representative situation where, in fact, inside this barrier is some thermal mass. What we have depicted here is simply a copper bar, a thin copper bar located in the center. What I hope to show you is that, in fact, particularly given the test configuration, the presence of thermal mass is very important.

(Slide) If we go to the next page, we have a chart of some analytical results running a simple one dimensional heat transfer model for this situation. The dashed line on this curve represents the temperature at the inside surface of the barrier with nothing but air inside the barrier. Now, it's important to understand the physical situation with a testing program because, in fact, a test model, whether small scale or large scale, is a completely sealed unit with no ability to transfer heat outside. Therefore, it is only a thermal mass which simply absorbs heat. In the case where there's nothing

inside the barrier, in fact the barrier itself absorbs heat and therefore the inner surface temperature is reflective of the amount of heat absorbed. There can be no heat transfer out of that inner surface and therefore one could expect the temperature to be higher. In this case it's shown it is very significantly higher. That's why we alluded before to the fact that the thermal mass within the barrier actually has a significant effect on the successful performance of that barrier. To have a barrier that would meet the successful criteria with nothing inside it will require substantially greater thickness than one in a more realistic situation.

CHAIRMAN SELIN: And, in fact, we really wouldn't care what would happen to a raceway that had no cable in it.

MR. RASIN: No, I really wouldn't care very much. I don't think we'll see a major safety issue.

MR. COLVIN: From a safety standpoint, yes, sir.

MR. RASIN: The next one line down the little dots and Xs in fact represents the inner surface temperature of this model with the existence of the copper --

CHAIRMAN SELIN: I'm sorry. Just a second. The dashed line is the temperature at the inside of the barrier?

MR. RASIN: The inner surface of the barrier, the first barrier with nothing but air inside.

CHAIRMAN SELIN: So, there are two differences between the first and the second line, both what's in the cavity and also where you're measuring temperature.

MR. RASIN: Yes. Where you measure temperature is the point of the second chart and the lower --

MR. COLVIN: In fact, I think you've misunderstood. The temperature measurement for the crossed line is at the same point in both test models. Is that correct?

MR. RASIN: That is correct. The temperature -- the dashed line and the line with the dots and Xs, in fact, represents the same temperature monitoring location.

CHAIRMAN SELIN: Oh, it does?

MR. RASIN: The difference being -- and that is the inner surface of the insulator. The difference being whether there is or is not an

additional thermal mass within the barrier itself. So, the dashed line is the picture with nothing inside.

CHAIRMAN SELIN: Where did you measure the first temperature?

MR. COLVIN: Okay. If you go to the first slide, Mr. Chairman, that has no top or mass.

MR. RASIN: See where it says "T surface?"

MR. COLVIN: You see T surface?

CHAIRMAN SELIN: Right.

MR. COLVIN: And then you go -- for that model that's the dashed line.

CHAIRMAN SELIN: Okay. And so that's where you're measuring the temperature?

MR. COLVIN: That's where you're measuring the temperature. When you go to the second model, which has the copper in it, the measurement T surface, which is the crossed line, is the same. The bottom line, which Bill hasn't gotten to yet with the rectangular lines is, in fact, measuring at the copper bar itself.

CHAIRMAN SELIN: Okay. Right. Thank you.

MR. RASIN: (Slide) Now, to move to the second diagram, we have the question of do you measure at the surface or do you measure at the cable? As we

just concluded, the center line with the Xs and dots is the inner surface, including the thermal mass of the copper within the barrier. The square dots and the lower curve represent the actual copper temperature in this situation, and I'll try to explain to you in this model kind of what happens.

We have explored the three different types of heat transfer, which is conduction, convection and radiation in this model. We find that because this is a completely enclosed structure that convection plays very little part, and so at the lower temperature and time limits we have a predominant conduction heat transfer. That heat has to conduct through a layer of air which if fact is itself a very good insulator, particularly in an enclosed stagnant state. As we proceed to higher temperatures, the radiative heat transfer in fact becomes the dominant mode that is proportional to the absolute temperature difference to the fourth power and so one can see a very rapidly escalating heat transfer as the temperatures increase, which is what one would expect in theory.

Now, the difference between the center curve and the lower curve is the question of the conservatism as to whether you measure the cold side of the barrier or whether in fact you measure the

temperature in closer proximity to the cables. Again I'll stress this is an analysis to demonstrate the point. We do not believe that the temperature difference will be as large as shown here in the natural situation.

CHAIRMAN SELIN: Because there's real convection in the--

MR. RASIN: No, I don't think the convection. I think the geometry is a little different. For one thing, we don't have a thin copper bar right through the center of this thing. We have a more distributed mass. The distance involved is less. And in fact, at the sides there's actually some contact between the sides of the barriers and the cable tray itself. So it's a more complicated geometry, however the same principles apply. And as I've stated, some thoughts we've had from some contractors actually involved in this testing think that the temperature difference we may experience may be as large as 80 degrees, certainly much less than shown here.

Now there is another factor, though, that speaks to the conservatism of this situation. When you are in the test mode, as I said, you have a sealed element which simply is a heat absorption machine. In

an actual in-plant configuration you have large runs of cable on either side of any particular fire zone and, as was brought up before, copper is a very conductor of heat and so in fact in an actual in-plant setting you would have a very rapid transfer of heat down the length of the cable as the temperature increased resulting in overall significantly lower cable temperatures than one would expect in a test situation.

CHAIRMAN SELIN: What this all shows me is what I thought coming in, namely that there seems to be an awful lot of argument over really very small points, and I'd like to explain.

First of all, I'd like to repeat what I said at the beginning, which is, even if there were no differences on the testing questions, there are still major concerns about what will come out. And I think in a different way your remarks support that, that the efficacy of particularly the three hour barrier, the different configurations, et cetera, says we're likely to have a serious problem in some of the locations in a lot of these plants regardless of the test results. I'd just like to restate that so that my comments are in a more limited context.

Where you measure the temperature, it just

seems to me you ought to measure the temperature in both places. You still will have an argument with the staff about what temperature at what location equates with a certain safe cable operation. In other words, we're looking for a surrogate, a screening factor, and the question comes, well, at what temperature rise do we not even have to take a look at the impact on the cable or what-have-you, we just know there's no problem.

And this argument is mixing up two points. One is, from a testing point of view, what should we know? And I think it's very clear that everybody, the industry, NUMARC, the staff, the ACRS, would like to know what the temperature gradients are so that for a better model and for use in a particular configuration we really do know for likely configurations how fast the temperature drops with distance from the insulation.

So what you're arguing is not where the temperature should be measured. To me it's clear that it should be measured in both places. What you're arguing is what use should be made of that temperature. For a given temperature, should the screening criterion be set for 275 degrees at the cable or at the wall? And if you have the data,

you're in a better position to argue that with the staff.

As far as the fill goes, I mean, in a sense that's the industry's call. If it's clear that the temperature criterion can't be met in most cases with an empty raceway, then I would think you'd be in a position to say "we'll take the measurement with 15 percent fill, maybe even with multiple fills," and come argue with the staff that says that "these aren't as general as we'd like them to be, but we think they cover 90 percent or 80 percent of the configurations." And, you know, it's almost irrelevant -- sorry, it's not irrelevant, but it's almost an industry call as to how much fill to put in. What the ACRS subcommittee feels, what the staff feel and what I feel is that obviously the less you're relying on the cable the more unchallengeable your results would be. But if they're unachievable, you could come in with temperatures to be determined at what point for different amounts of fill and say, "at least for these configurations, we think we've met the standard." And the standard is clearly written in terms of temperatures at specific points as a surrogate for damage done to cable and the staff is really trying to make your life easier, namely come up with a situation

that covers 100 percent of the situations, but there doesn't seem to -- that may be an empty case.

And so it seems to me the argument between NUMARC and the staff on the fill is sort of irrelevant, that you run the fill that you want and the more fill you have the more limited the case, and that our desire is not so much for a more conservative figure but for a figure that would just be more widely applicable. But it just seems sort of obvious you ought to run as little fill as you think you can get reasonable results in the range of temperatures and then argue about whether we're being too conservative as to where the temperature is measured.

MR. RASIN: Let me respond to that just briefly, because clearly from a reasonable technical point of view one could proceed that way.

What we have been concerned about is two things. One -- and I'll just give you a for-instance. If, in fact, the 80 degree temperature difference thought by different contractors is correct, then all of the tests that I previously pointed out to you as being successful in fact now are not successful, and so then--

CHAIRMAN SELIN: I was trying to avoid the question of what's successful and what's not

successful to the point --

MR. RASIN: But how could we do that when we are trying to show compliance with the regulation? That is the difficulty, and so you get into a very resource intensive interaction with the staff which takes a lot of time and I am convinced that in the end we would come up with a successful resolution that shaded on the over-conservative side leading to upgrading of a lot of barriers which in fact would perform their function very well and in fact it will only take longer to reach final resolution. And that's been our concern in this issue, looking for a practical resolution in a timely fashion that did not indiscriminately just require unnecessary upgrading of all the existing barriers. In all of the discussions we had quite good technical agreement in all areas except for these simply for that reason.

CHAIRMAN SELIN: Let me just follow-on.

Number one, the real question is how much damage would be done to the barriers. We need to know the temperature both at the -- I'm sorry, not to the barriers but to the cable. We need to know the temperature at the cable and we need to know the temperature at the barrier. We need to know something about the gradient as you move in, and we need to know

more than we seem to know about the characteristics of the cable.

My understanding of the history of this regulation was that the reason that the measurement was intended to be made at the insulation was not because we didn't know there was a gradient but because we felt that that temperature at the cable might in fact be too low. In other words, there's an argument about what temperature the cable is supposed to operate at.

But you'd be much better off having the data. Even taking the measurement as we're asking you to do doesn't mean that you agree with or surrender to the concept that that's where the measurement should be taken for regulatory compliance. You still can argue that that's too conservative as a standard, but knowing what the temperature is and what the gradients are would facilitate your arguments with the staff, would make it much easier for the industry to then look at specific configurations and figure if they have the problem.

I just want to add one more point to that. It's clear to me, even though you're not ready to agree to that, that there is inevitably going to be a fair amount of configuration-specific, site-specific

discussion. You'd be much better off if the data on temperature gradients were available so that those could be referenced when a specific utility came in to say, "We may not meet your regulatory standard, but we don't have a problem. Let us explain why."

What you're trying to do is subvert the science to solve a regulatory argument. If you won't measure it here, then we can insist that the standard be set at this point instead of that point, and I just think that's foolish, actually.

MR. COLVIN: I think the question that's been on the table for the industry and has been addressed from a policy standpoint is not whether we ought to do the tests, whether there's an expense or cost with respect to putting these thermocouples, but really questioning when you get that result what does that result mean.

CHAIRMAN SELIN: Right.

MR. COLVIN: You know, I think if you look at the ASTM standard and the technical issues, there is no technical agreement by any of the parties except for the NRC staff, to my knowledge, that there ought to be a measurement at the cold side of the barrier for raceways. I mean, the technical experts in this issue say that you ought to measure it where in fact

it is being measured.

The second point is that when you have 300 thermocouples instrumented down that line and any one of those thermocouples requires the cessation of the test -- I mean, the test is a go/no-go. The test is set up to be a pass/fail test and the whole criteria is such that then when you fail then the next step to do that is then to do the engineering analysis that's required to analyze each thermocouple and what the temperature rise over time and so forth.

So what we're talking about, although it may seem like a -- I mean, it's a simple point to put the thermocouples there. When you try to then take that to the application in the engineering effort, you really raise a number of questions as to whether we can effectively and in a timely manner get to resolution on those issues. That's the real meat of the issue from the industry standpoint.

COMMISSIONER de PLANQUE: You're saying that in the majority of cases then you would have to go through that exercise?

MR. COLVIN: For every test that you have these measurements, and again we have agreed to set up a test with a baseline and an upgrade to do that from a research standpoint. I mean, that's really what

that is, is a research standpoint, not an issue of whether the cable integrity is at risk, which is the safety issue. I don't think there's been any disagreement from the technical people on that point.

The question is, what is the real temperature there, and there is some concern about what do you do if a cable was sagging down on that and that happened to touch, which is a question that we need to look at. But when you really get down to it, what that would require is a considerable amount of effort, time and engineering and analytical work to try to answer those questions about what each one of those temperature differences mean without any real result affecting safety. I mean, that's the real issue.

CHAIRMAN SELIN: So what I would do if I were in your shoes would be argue a little bit about the protocol as opposed to the measurements and come back to the basic idea. The idea is not to get a regulatory agreement or disagreement. The idea is to get an answer to a real and immediate fire safety problem that, even if all these tests are entirely successful by your standards, we still have a lot of problems in a lot of locations that have to be solved.

And this testing question will not be so

generic that it's going to solve all your problems, so maybe you might consider recasting the argument a little bit about, if you take the two measurements and one passes and one doesn't, do you have to do as full analyses or where do you go.

MR. RASIN: Well, that's probably the reality of where we find ourselves, but it's still -- I understand your physical, technical and, in a very few cases, perhaps, safety concern, and I think that can be quickly dispensed with. But if we go back to the fact that the end result of this for final resolution of this issue to return to regulatory compliance, in fact I think we have a very real regulatory question and it just does not seem to me to be the expeditious way through it to set a criteria that's unnecessarily conservative to the point where every test result is unsatisfactory until thoroughly discussed and point by point and test by test and application by application approved by the staff through some internal process. Then why bother setting a screening criteria?

CHAIRMAN SELIN: I've given you a fair amount to think about. I'm not going to repeat the point, but put a little more emphasis on discussing what the protocol is and a little less on where you

take the measurements. You might have a more productive dialogue.

Commissioner Rogers?

COMMISSIONER ROGERS: Well, I have to say that what I've heard the Chairman say strikes a resonant chord with me. Maybe I'm not looking at this thing the way you folks are looking at it, but it does seem to me that it looks to me as if you're saying "don't take the measurement at the wall because the results might give you a regulatory problem."

You want to make the argument that it's the integrity of the cables and the cable temperature which is really the important thing in an actual situation. That's clearly true. On the other hand, if there is a regulatory issue about what the wall temperature is and whether you're satisfying that, not taking that temperature isn't going to make that issue go away.

I mean, you're trying to change the basis of your argument, it seems to me, from satisfying a regulatory requirement which is stated in terms of wall temperature to what is the actual temperature at the cables, because that's the important thing. Well, you know, I have to agree with you. That's the important thing.

But if there is a regulatory issue that revolves around what the wall temperature is, not taking the wall temperature isn't going to get you out of that pickle, so, I mean, I don't understand why you don't take the wall temperature measurement and then make your arguments however you want to make them. But not taking a piece of data and then saying, "well, because we don't have the data, that's really not the important point, the important point is what the temperature is at the cables," I think just tries to sidestep the regulatory issue that maybe you just have to head into, maybe we all have to head into.

But I'm very uncomfortable about what I'm hearing here on this, because it doesn't seem to me as if the issue which you seem to be very concerned about, whether there's a regulatory sticking point attached to what the wall temperature is versus what the cable temperature is, I don't think that problem is going to go away by not taking that data.

Now something you said about how you do the experiments, it's a go/no-go experiment, don't you just run the thing out? I mean, if any thermocouple exceeds this 275 degrees, do you suddenly cease the experiment? I mean, that would be crazy. You run it all the way out and then you take the data and look at

whatever you've got. So, I don't understand. There are several things here I don't understand.

CHAIRMAN SELIN: To put it simply, the 80 degree differential demonstrated would certainly buttress your argument about the regulatory piece.

MR. COLVIN: Mr. Chairman, we are going to do that. There's no question. We've already agreed that we will take those measurements.

I think I'd like to go back and address Commissioner Rogers' point, though. We need to go back to what is the basis. The regulatory requirement that existed in 1986 was a regulatory basis designed to test a wall, not designed to test a cable tray. That's where the barrier requirement came from.

COMMISSIONER ROGERS: I understand.

MR. COLVIN: Today that requirement is not within the ASTM standard. That requirement for raceway testing is in fact only a requirement from the staff to go back and relate the '86 requirement, which we all agree was not the right requirement. So, we are going to do that. We're not trying to skirt the issue.

The question is, what is an acceptable, technical, credible test for the application to protect the safety? That's what we're trying to come

to and I think the ASTM standard gives us that. That's at least the --

COMMISSIONER ROGERS: The draft standard?

MR. COLVIN: The draft standard gives us that.

COMMISSIONER ROGERS: It's a draft standard.

MR. COLVIN: So there's no question of trying to circumvent the test or any question that we're trying to not do that. I think we're coming back to the real basic issue of what is the right test to qualify this material and ensure the safety of the cables.

We would be willing -- and in the Texas Utilities test they did not measure the barrier on the inside. Okay? They measured and instrumented the cable. We'd be happy to instrument the cable, but that's not an acceptable solution. So I think what we're trying to do is get into the issues in a way that gives us the right technical solution that provides the confidence that we can solve the regulatory aspect.

I don't want to leave the impression with you and the impression that you gave in the comments that we are trying to get away with something by not

measuring. That clearly is not the case.

COMMISSIONER ROGERS: No, I think you're not trying to get away with something. You're trying to change the basis of a judgment, and from the earlier standard, which we all agree was accepted at the time because that's all there was, that was based on -- that related to wall temperature to a standard that doesn't relate to the wall temperature. That's, it seems to me, what you're arguing for and --

MR. COLVIN: If I could interrupt, Commissioner Rogers, not to argue the point, but, the point is that the standard in 1986 was not applied. The application was, in fact, for every application and every test we looked at, that standard and measurement technique was not utilized. I mean, that's really part of the issue that we're dealing with is whether or not that was an accurate application then and whether it is today.

COMMISSIONER de PLANQUE: We can all argue over what is the best test for what you're trying to achieve, but right now you may be stuck with a certain test.

MR. COLVIN: Absolutely.

COMMISSIONER de PLANQUE: Okay. I think you have to face that reality.

Now, down the road, if there's any chance of having a more reasonable approach to that, the more data you have to support your argument the better, in my estimation.

MR. COLVIN: Absolutely. And, you know, I want to make it clear. We asked -- we came to the Commission to give you our insights and our views and not to ask you to make a decision. In essentially every discussion we've had, whether it's with senior management of the staff or whether it's with industry, we all get immediately down into the technical details of which I am certainly not competent to discuss.

So I think that we have, Mr. Chairman and Commissioners, we have the understanding of the Commission, your views from that standpoint. We will clearly take those into account and we are trying to move ahead with this test program and do so in an expeditious manner.

CHAIRMAN SELIN: Well, you know, in the constructive tone that you've put in, Mr. Colvin, a lot of what you've said today has been very reassuring about the thoroughness, not only the tests but the limited conclusions that are drawn from them, the necessity of looking at specific configurations.

I'm sorry we even used the word

"exemption." They're not exemptions that we grant. What we're saying is, well, you didn't pass the screening test, but let's look at the actual safety analysis, that the safety standard that we're setting is no lower in those specific cases than in the general cases. It's just that the surrogate, the screening tests, are a way to save time and effort when it's possible.

So a lot of what you've said today is very positive. You didn't ask for and you really didn't get a Commission conclusion, but you did get the reaction of three of the Commissioners who are -- we have diplomas that say we used to be scientists and engineers, so I think they should be taken seriously and there will be further conversation.

Commissioner Rogers?

COMMISSIONER ROGERS: Just that I do appreciate hearing more of the details here of what you're presented today, because I think that it does indicate that there is progress and it puts the whole question or many questions in a perspective that, quite frankly, I didn't have until today.

So, I appreciate very much the presentation and the detail with which you've expressed it, and with that I guess I've said all I

can say.

CHAIRMAN SELIN: Commissioner de Planque?

COMMISSIONER de PLANQUE: I have nothing further.

CHAIRMAN SELIN: I believe the first turkey of the week will not in fact come until tomorrow, Mr. Colvin.

Thank you. Thank you very much.

(Whereupon, at 10:48 a.m., the above-entitled matter was adjourned.)

CERTIFICATE OF TRANSCRIBER

This is to certify that the attached events of a meeting of the United States Nuclear Regulatory Commission entitled:

TITLE OF MEETING: BRIEFING BY NUMARC ON THERMO-LAG

PLACE OF MEETING: ROCKVILLE, MARYLAND

DATE OF MEETING: NOVEMBER 24, 1993

were transcribed by me. I further certify that said transcription is accurate and complete, to the best of my ability, and that the transcript is a true and accurate record of the foregoing events.

Carol Lynch

Reporter's name: Peter Lynch

Industry Fire Protection Program

- Testing Thermo-Lag fire barriers
- Concerns relative to other fire barrier materials
- Proposed revision to fire protection regulations - 10 CFR 50.48 and Appendix R

Industry Thermo-Lag Program

OBJECTIVE:

To re-establish the technical and licensing basis to qualify Thermo-Lag materials for use in one and three hour fire ratings as required by Appendix R

Thermo-Lag Concerns

- Conclusion by NRC staff that fire endurance tests are "indeterminate"
- Differences in installation due to varied installation instructions
- Thermal performance and structural issues
- Inconsistencies in ampacity derating values
- Combustibility
- Generic applicability of test program to actual plant installations

Discussion Topics

- Test Program
- Applicability of Program Results
- Test Results
- Test/Acceptance Criteria Issues
- Conclusions

Fire Protection

- Defense in depth
  - prevent fires
  - detect and promptly suppress fires
  - protect equipment if fire cannot be extinguished (fire barriers)
- Requirement for 1 or 3 hour barriers unrelated to plant fire loadings
  - Low fuel loads are typical (less than 20 minutes)
  - No actual fire has challenged installed barriers
  - NRC has recognized the actual fire hazards in granting numerous plant specific exemptions

Thermo-Lag 330

- Predominant cable raceway fire barrier material used for Appendix R

- Large scope of installation:

  - 1 hour conduit: 69,000 linear feet
  - 1 hour cable trays: 16,000 linear feet
  - 3 hour conduit: 22,000 linear feet
  - 3 hour cable trays: 13,000 linear feet

- All previous tests declared indeterminate by NRC staff

- Successful test program must re-establish qualification basis

Generic Fire Barrier Test Program

- Purpose:
  - Assess Thermo-Lag performance for representative plant cable raceway installations
    - » Baseline
    - » Upgrades using Thermo-Lag
    - » Upgrades using other materials
- Scope:
  - 17 test configurations
  - Phase 1 - seven tests
  - Phase 2 - ten tests
  - Further tests may be undertaken

Program Applicability

- Many attributes of installed configurations are known to affect Thermo-Lag performance
  - material thickness
  - pre grouting of joints
  - direction of structural ribs
  - internal panel supports
  - band or tie wire spacing
  - type of joints
  - unsupported span distance
  - support protection
  - cable fill
  - raceway mass
  - raceway dimensions
  - raceway material
  - others

Program Applicability (Cont)

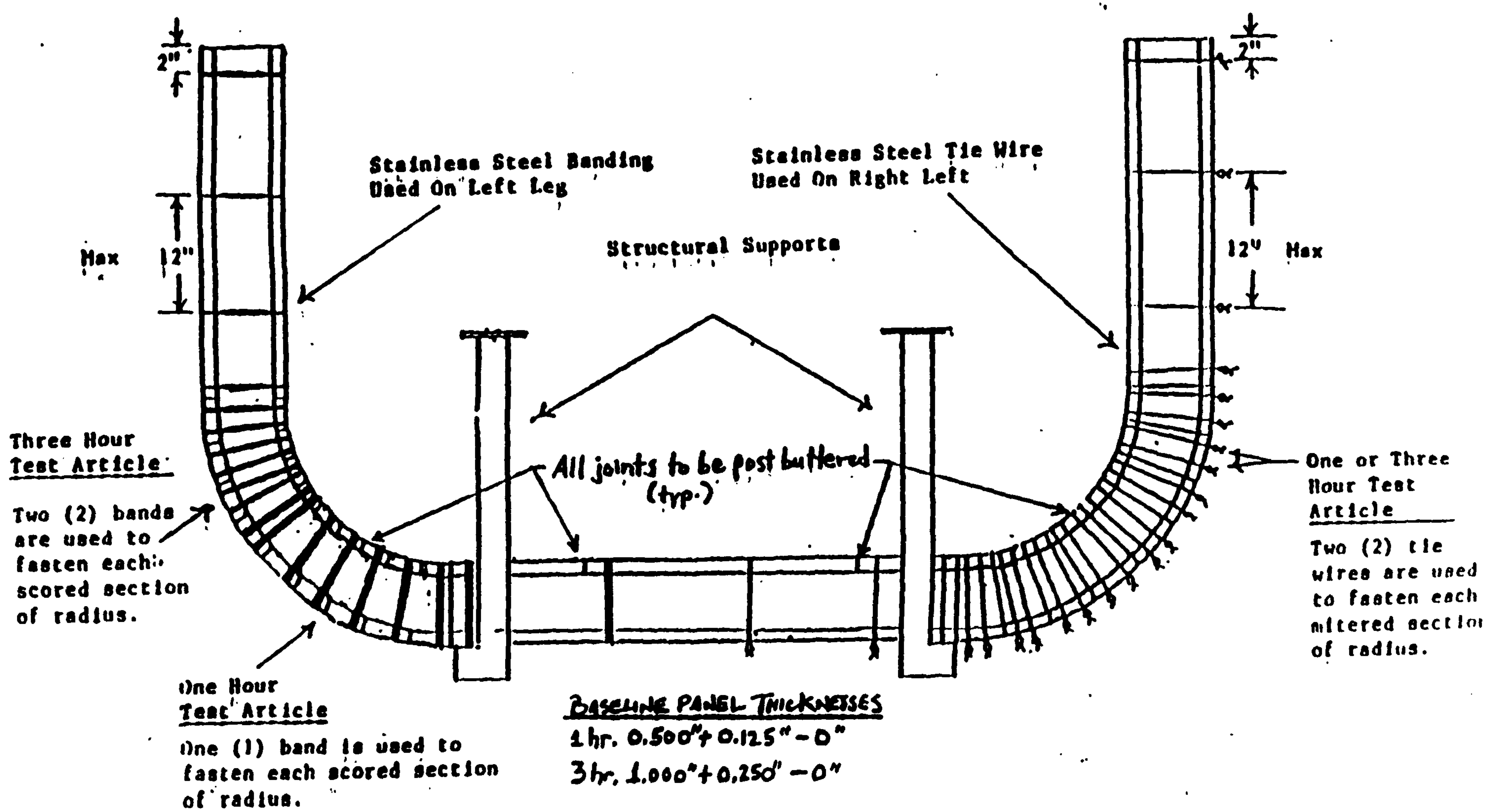
- NUMARC conducted surveys requesting extensive information on installed configurations

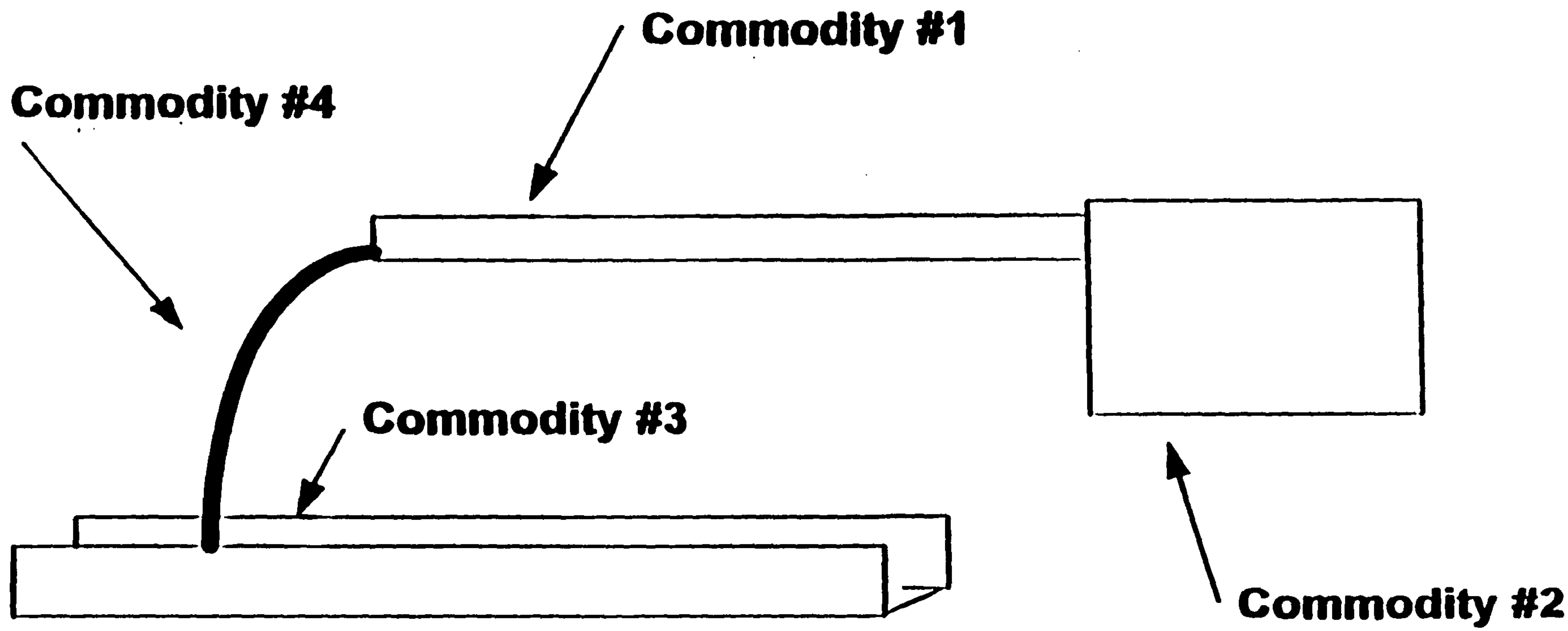
- Analysis of survey results revealed broad distribution of data relative to important performance parameters

- Challenge is to bound these factors without developing upgrades that are overly conservative for typical installations

1 and 3 Hour Baseline Thermo-Lag Installation

36" and 24" Cable Trays: Tests 1 - 5





Fire Resistive Barrier System

Program Applicability (Cont)

- Program will bound significant percentage of plant cable raceway installations

- Program will not address

  - Large, unusual shaped enclosures

  - Large wall type installations

  - Raceway installations having unique installation attributes

- NUMARC *Application Guide* will address comparison of tested to installed configurations

Program Applicability (Cont)

- Generic applicability cannot be precisely quantified until Phase 2 tests results are known

- Utility alternatives to achieve full compliance following program completion:

  - Upgrade barriers

  - Install other barrier types

  - Exemption request - demonstrate installed barrier adequate to address actual hazard

  - Reroute cables

  - Install suppression systems

Phase 1 Test Results

- Phase 1 upgraded configurations exhibiting satisfactory performance
  - 1-hour rated conduits (3 sizes, steel and aluminum) and junction box
  - 3-hour rated straight run steel cable tray
  - 3-hour rated junction box
  - 3-hour rated small conduit

Phase 1 Test Results (Continued)

- Phase 1 upgraded configurations with temperature exceedances in final 1 to 13 minutes of test, no cable damage observed
  - 3-hour rated aluminum cable tray with "T" section
  - 3-hour rated wide span (36") steel cable tray
  - 1-hour rated wide span (36") steel cable tray
- Phase 1 upgraded configurations not demonstrating satisfactory performance:
  - 3-hour rated medium and large conduits
  - 3-hour rated air drop assembly

Phase 1 Test Results (Cont)

- Conservative baseline installations contributed to test failures
  - Minimum material thickness
  - Minimum construction attributes
- Failure mechanisms well understood

Phase 1 Conclusions

- 1 hour upgrades can be demonstrated through tests
- 3 hour barrier upgrades are likely to involve more extensive retrofits of existing installations
- Premature to conclude that 3 hour upgrades cannot be successfully developed
  - Phase 2 may demonstrate more practical upgrades
  - Gaining experience with testing to new criteria
- Challenge is to develop upgrades that can be practically installed

Chronology of Key Industry Activities

3/92	NUMARC forms AHAC
6/92	TUEC test results - Bulletin 92-01
8/92	NUMARC holds initial industry workshop
9/92	NUMARC submitted test and acceptance criteria white paper to NRC
10/92	Test program funding approved
10/92	Industry installation survey developed, forwarded
11/92	NUMARC provides written comments on NRC proposed test/acceptance criteria
2/93	NUMARC received industry survey results

Chronology (Cont)

2/93	Receipt of subpoenas results in withdrawal of direct utility involvement in test program
3/93	Decision made to proceed with test program prior to NRC criteria finalization
4/93	Industry survey results compiled
5/93	Test program contractors and lab selected
6/93	Combustibility tests completed at UL
7/93	Second industry workshop held
8/93	Responded to FRN on draft NRC test/acceptance criteria
9/93	Phase 1 testing Combustibility evaluation guideline distributed to industry

Scheduled Activities

- Industry Meeting - December 1 - 2
- Phase 1 test reports to industry by end of year
- Phase 2 testing January 1994
- Industry *Application Guide* early 1994

Test/Acceptance Criteria Issues

- GL 86-10 specified "unexposed side of barrier" as temperature measurement location
  - Basis: NFPA 251, ASTM E-119 (wall standards)
  - Cable raceway standards did not exist at that time
- Actual tests for all barrier types were typically conducted and accepted on basis of cable temperature, circuit integrity (ANI)

Test/Acceptance Criteria Issues (Cont)

- NRC proposed Supplement to GL 86-10 would “clarify” test and acceptance criteria

- Revised criteria have not yet been finalized

- Spring 1993: NUMARC decision to test with criteria based on best technical judgment

Test/Acceptance Criteria Issues (Cont)

- Clarification of 86-10 requirements involves increased conservatism:
  - Retain original wall standard as basis
  - Specify instrumentation requirements for "unexposed side of barrier" temperature measurement
    - » thermocouple placement, spacing
    - » use of bare copper conductors
  - Provide more rigorous and explicit process for comparison of tested to installed configurations
  - Provide increased requirements for cable functionality determination

Test/Acceptance Criteria Issues (Cont)

- Agreement has been reached on most aspects of test criteria

- Technical differences exist on:

  - Placement of thermocouples (lower copper conductor) for cable trays

  - Use of representative cable fills in cable tray tests

Test/Acceptance Criteria Issues (Cont)

- Bases for temperature measurement approach:
  - Consistent with applicable industry consensus standard (ASTM E5.11 Draft 14)
  - Temperatures should be measured in areas containing, or in contact with cables, since cable temperatures relate directly to performance of safety function
  - Barrier temperature at location outside cable tray is unnecessarily conservative with respect to cable functionality protection
  - Only valid mechanism for cable/barrier contact is sagging top panel. Upper copper conductor in place to address this effect
  - NRC proposed temperature measurement method has not been applied to any previous cable tray test

Test/Acceptance Criteria Issues (Cont)

- Basis for position on testing with representative cable fill

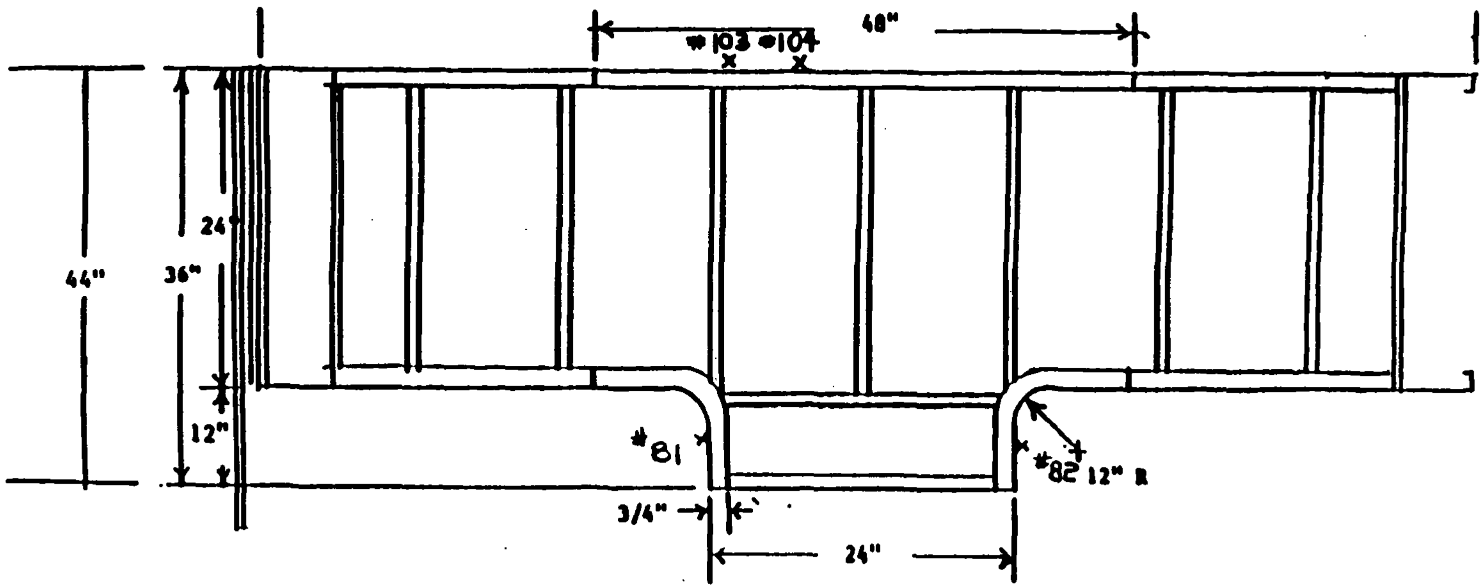
  - NUMARC program uses single layer (15%) cable fill for cable tray tests

    » NUMARC survey data show 90% of industry cable tray installations bounded by NUMARC cable fill percentage

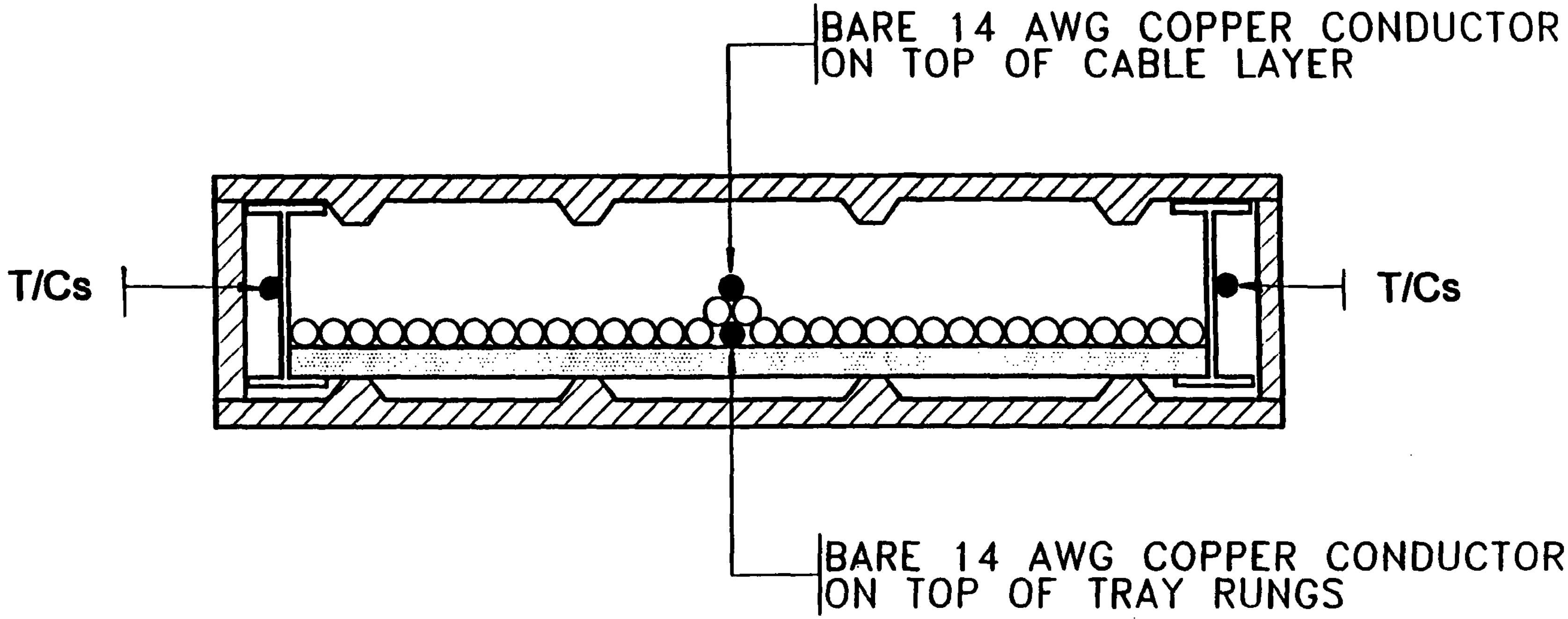
  - Basis: Provide test conditions representative of actual plant installations

  - Barrier performance affected (improved) by additional mass of cables

24 INCH OPEN TOP, LADDERBACK, CABLE TRAY TEST ARTICLE
WITH HORIZONTAL TEE - TOP VIEW

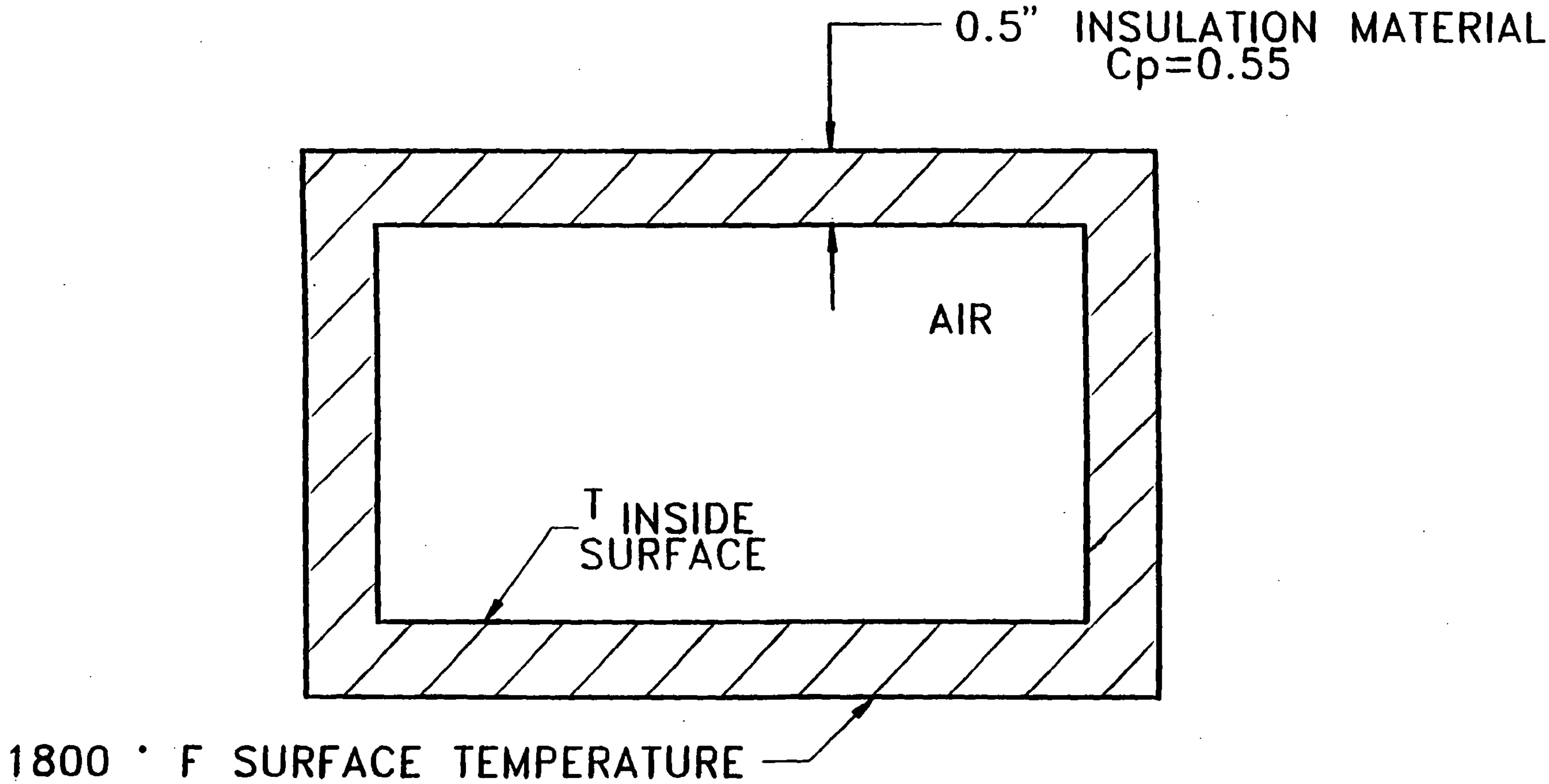


LOCATION OF BARE COPPER CONDUCTORS IN CABLE TRAY TEST ARTICLES

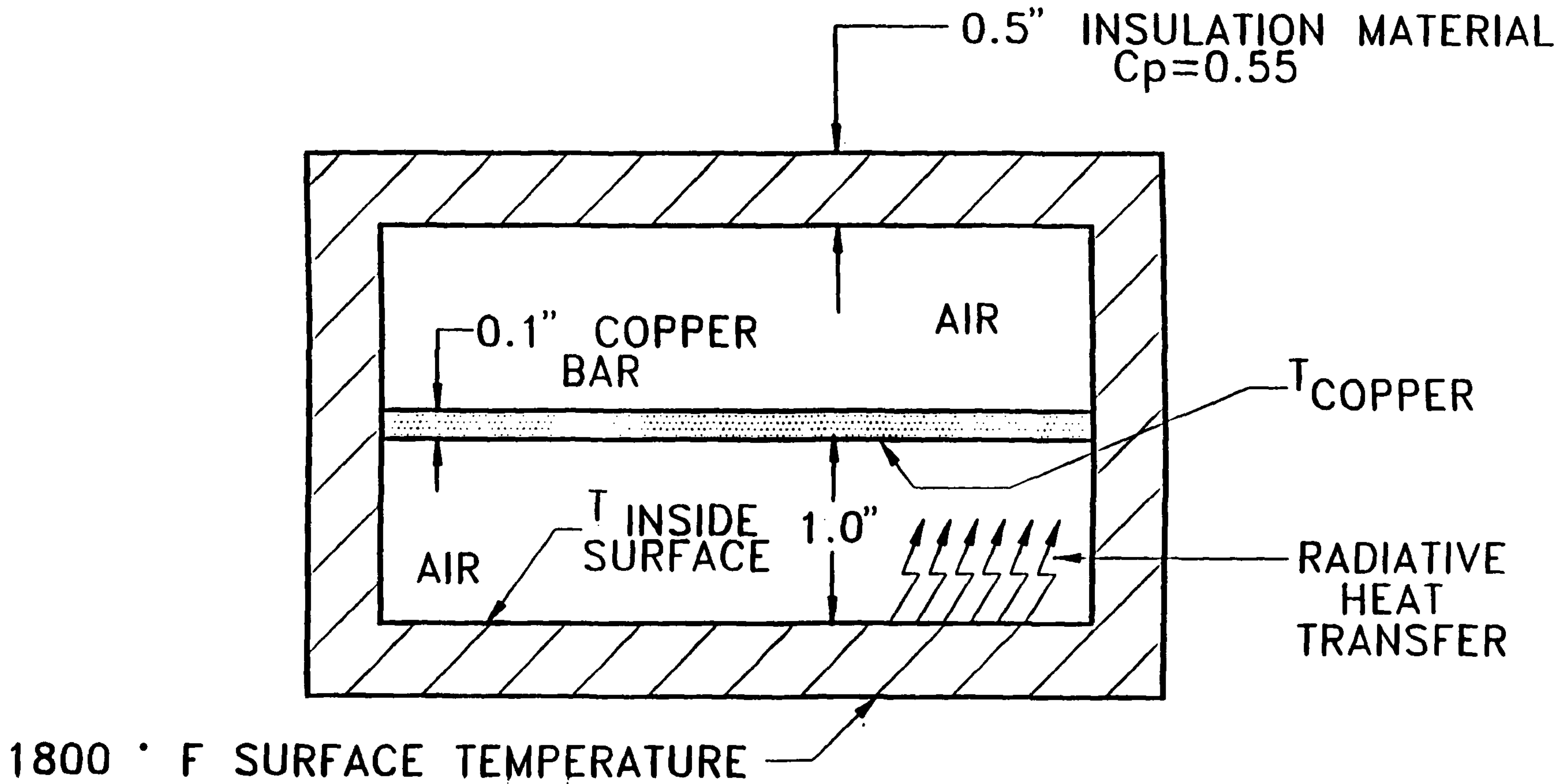


T/Cs LOCATED EVERY 6" ALONG CONDUCTOR AND SIDE RAILS

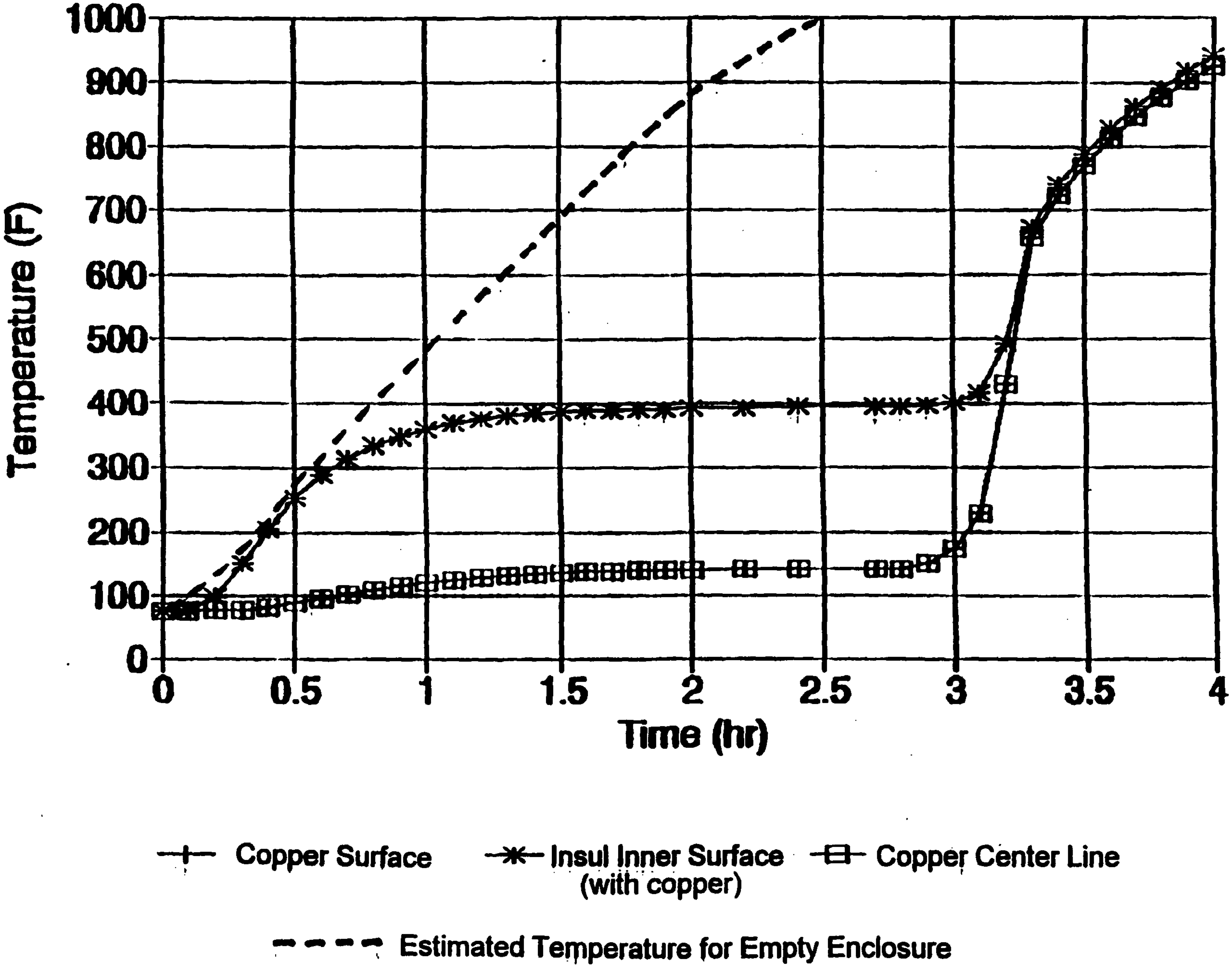
SIMPLIFIED 1-D THERMAL MODEL OF RACEWAY FIRE BARRIER ENCLOSURE



SIMPLIFIED 1-D THERMAL MODEL OF RACEWAY FIRE BARRIER ENCLOSURE



Simplified Model Time - Temperature Characteristics



Effects of Increased Conservatisms

- Barrier upgrades solely to address new conservatisms

- Increased difficulties in addressing conflicting safety requirements for ampacity derate and seismicity

- Contrary to program objective of re-establishing the technical and licensing basis to qualify Thermo-Lag materials for Appendix R compliance

Conclusion

- NUMARC program is:
  - Technically sound and consistent with draft consensus standards developed for cable raceway testing
  - Takes into account actual installation parameters
  - Provides practical generic resolution