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NUCLEAR MANAGEMENT AND RESOURCES COUNCIL

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William H. Rasin
Vice President & Director
Technical Division

January 26, 1994

Dr. Thomas E. Murley, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: NRC 50.54(f) Letter on Thermo-Lag Fire Barriers

Dear Dr. Murley:

I have enclosed for your information the guidance we distributed to the industry to assist utilities in developing their individual plant responses to the subject letter. I have also included the cover letter so that you are aware of how we characterized this guidance. This guidance was developed with the assistance of the NUMARC Fire Protection Working Group with one objective being to provide utilities information relative to the generic test program and its applicability. A second objective is to assist each utility in developing a comprehensive plan for dealing with Thermo-Lag material at their plants realizing that there presently remain significant unknowns with respect to this issue. We believe that some of the requested information cannot be conclusively provided under oath or affirmation at this time. However, utility licensees can indicate when such information will be available in their overall decision and planning process.

We believe the responses to the 50.54(f) letter will provide the NRC with the necessary information to facilitate movement toward an overall resolution of the Thermo-Lag issue. However, we must continue to answer the remaining questions with respect to the acceptable performance of fire barrier materials. We are continuing with Phase 2 of the industry test program and the development of the associated Applications Guide. We will provide the test results and guide to the NRC staff as soon as they are available.

We will be happy to answer any questions on the enclosure and the status of our other efforts in developing generic industry resolution of this important issue at our next senior management interaction scheduled for February 9, 1994.

Sincerely,

W. H. Rasin for

William H. Rasin

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NUCLEAR MANAGEMENT AND RESOURCES COUNCIL

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January 14, 1994

TO: NUMARC Administrative Points of Contact

SUBJECT: NRC 50.54(f) Letter On Thermo-Lag Fire Barriers

Our letters of December 17 and December 23, 1993, discussed NRC actions to issue letters to licensees, under the provisions of 10 CFR 50.54(f), requesting additional information on installed Thermo-Lag fire barriers. The NRC letters were issued in late December, with a 45-day response schedule. The purpose of this letter is to provide guidance for your consideration in responding to the specific items contained in the NRC information request. Please forward this information expeditiously to personnel within your organization responsible for developing your utility's response to the 50.54(f) letter.

The enclosed response guidance may be quoted, referenced, or used in your response to NRC to the degree that it is applicable to your plants, and as you deem appropriate. This guidance has been carefully reviewed by the NUMARC Fire Protection Working Group with the intent of providing the basis for a consistent industry response on this important issue, and assuring optimal benefit from addressing generic matters on a generic basis. We believe that substantial deviations from this guidance in individual responses have the potential to adversely impact the generic resolution process. As a result, if you believe that a fundamentally different approach is appropriate, we request that you contact us as soon as possible.

Both NRC and industry are under considerable pressure to show progress towards resolution of this issue. We recognize that responding to the NRC request represents a complicated effort with a short response time; however, it is important that a reasonable effort be made to provide as much information as possible to NRC in a timely manner; to provide a positive and constructive response; and to provide sound bases for those situations where deferred responses to portions of the request are appropriate (as detailed in the enclosed response guidance.)

NUMARC Administrative Points of Contact

January 14, 1994

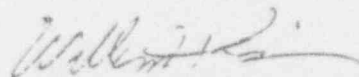
Page 2

We have scheduled a meeting with NRC senior management in early February to discuss these matters, and will continue frequent meetings at the Senior Management level to facilitate progress towards issue resolution. However, your response to NRC should not be delayed or in any way contingent on the result of these meetings.

So that we can continue to coordinate the generic resolution of these issues, please provide a copy of your NRC response, when submitted, to the attention of Alex Marion of the NUMARC staff.

We will continue to keep you informed of the progress in resolving this issue. Please contact me, Alex Marion, Biff Bradley, or Morris Schreim of the NUMARC staff if you desire further information.

Sincerely,



William H. Rasin

WHR/REB/cma

Enclosure

- c: NUMARC Board of Directors (w/o enclosure)
- NUMARC Executive Points of Contact (w/o enclosure)

**RESPONSE GUIDANCE FOR NRC
10 CFR 50.54(F) REQUEST FOR ADDITIONAL INFORMATION
REGARDING THERMO-LAG 330-1 FIRE BARRIERS**

Item I. Thermo-Lag Fire Barrier Configurations and Amounts

The requested information is similar to that provided by utilities in response to previous NUMARC surveys, with some additions. The NUMARC surveys were limited in scope to cable raceway applications for protection of safe shutdown functions in accordance with 10 CFR 50, Appendix R. The NRC information request addresses any use of Thermo-Lag to satisfy regulations, license conditions, or commitments. This includes the fire barrier applications covered by the NUMARC surveys, as well as Thermo-Lag installations used to achieve physical independence of electrical systems (Regulatory Guide 1.75 applications), radiant energy shields, wall and ceiling installations, structural steel protection, etc. Item I.B.2. requests information on *square feet* of barriers for cable tray applications, radiant energy shields, and any other barriers other than conduit applications. The NUMARC surveys requested linear feet of installed conduit and cable tray barriers only.

If walkdowns or documentation reviews are required to access information not previously provided in the NUMARC surveys, you should consider whether the requested 45 day response is appropriate with respect to your other priorities and, if so, advise the NRC when you will be able to provide the requested information. Because the information you will be providing to the NRC falls under the oath or affirmation provisions of 10 CFR 50.54(f), we recommend you use the terms "estimated" or "approximate" in describing installed quantities.

Item II. Important Performance Parameters

This section requests information on performance parameters. Through previous NUMARC workshops, correspondence, and surveys, considerable information has been communicated within the industry relative to fire barrier and raceway parameters known to affect performance. This information has included illustrations of various joint types, construction techniques, etc. The NUMARC Application Guideline, following NRC review, will provide final positions with respect to bounding parameters, and is expected to be issued in April. Based on testing performed to date, the draft application guideline would address the parameters listed in Attachment 1. This attachment provides a clarified parameter listing, inclusive of the 24 point listing provided in the NRC letter. We suggest referencing the NUMARC listing in responding to NRC Item II.B. Note that the parameters in Attachment 1 are separated into raceway parameters and barrier parameters, and the parameter numbers are different from the 24 item NRC listing.

It should be noted that parameters not listed in Attachment 1, including fire barrier panel rib location (inside/outside), raceway gage (mass), type of cable tray side rails ("C" shape facing in, "C" shape facing out, "I" shape), cable tray ladder rung spacing, and thermal shorts penetrating the barrier but not contacting the raceway, have been identified as potentially important. Planned Phase 2 testing could identify further parameters of importance, or demonstrate that some of the above parameters are not significant. NRC Item II.B.1 requests discussion of the parameters you have not obtained or verified. In responding, we suggest you discuss the preliminary nature of the parameter listing, and the need for caution in proceeding with major parameter identification efforts that may prove to be unnecessary, or could prove to be incomplete, based on the final content of (and NRC agreement with) the Application Guide.

Information on parameters internal to the barrier system may be unknown if it was not documented during installation. NRC Items II.B.2 and 3 request information on these "unknown parameters." We suggest you respond to NRC Item II.B.2 on a general basis, discussing how you intend to conduct an appropriate evaluation using one or more of the following options:

1. Assume limiting conditions, e.g., post-buttered versus pre-buttered joints, no internal bands versus internal bands, etc. (This would limit the scope of barrier review activities, but would likely lead to more significant upgrades.)
2. Reviews of contractor work practices and procedures through documentation or testimony.
3. Destructive examination of barriers on a sample basis to obtain information on construction techniques. (This would require development of a sampling plan providing sufficient confidence in the nature of unexamined barriers.)

The NRC 50.54(f) letter also provides an 8 item listing of parameters of importance concerning cable protected by fire barriers. It is not clear that consideration of these parameters would be necessary for most barriers; therefore, significant efforts to obtain the listed parameters, or describe how barriers will be evaluated in the absence of these parameters, may be unjustified. To the extent that fire test results are satisfactory on the basis of temperature, as provided for in the NRC draft test and acceptance criteria, we believe the NRC listing of cable performance parameters to be evaluated should be limited to the percentage cable fill in cable trays (subset of item 4 of the NRC 8 item listing), which relates to enclosed thermal mass and barrier performance.

In responding to NRC Item II.B.2, we believe consideration of the remaining listed cable parameters (items 1, 2, 3, 5, 6, 7, and 8) should be deferred until the scope of cable functionality verification becomes clear. As the basis for this deferral, we suggest you consider including the following wording in your response:

If fire tests demonstrate temperature criteria exceedances, one optional approach to resolution, as provided in the NRC draft test and acceptance criteria, would be to evaluate cable functionality at the elevated temperatures. In this case, determination of cable performance at elevated temperature (item 8) would be necessary, using cable performance test data or information for specific installed cable types (items 1, 2, 3, and 7 of the NRC listing). However, NRC has yet to finalize requirements for cable functionality evaluation, nor are test results yet available that would clearly indicate the scope of such evaluations. The degree and conservatism of cable functionality evaluation requirements implied by the NRC listing of cable parameters, and discussed in proposed Supplement 1 to Generic Letter 86-10, significantly exceeds the original requirements of Generic Letter 86-10.

Items 4, 5, and 6 of the NRC listing address issues relative to potential cable/barrier contact for cable trays. This is an unresolved issue at this time, and barrier inspection in this regard would be difficult or impossible. Barrier contact would be most likely to occur in situations of large cable fills. However, the large cable fills also provide significant thermal mass that could improve barrier system performance and mitigate the effect of cables in contact with the barrier. NUMARC has agreed to provide additional thermocouples below the cable tray rungs in the Phase 2 cable tray tests to provide information to address NRC concerns relative to potential contact of cables with the cold side of the fire barriers. Further, note that a small piece of Sealtemp cloth (NRC item 6) was used only in NUMARC test Number 1-4 (24" steel cable tray with air drop, three hour test), and did not impact performance or useability of the test.

The NRC 50.54(f) letter discusses chemical testing of Thermo-Lag. Chemical testing performed by NUMARC on a wide variety of aged samples has not revealed significant variations in chemical composition. These test results will be shared and discussed with NRC, and distributed to industry along with the Phase 1 test reports. Further, Phase 2 testing will include barrier materials of various ages, as well as additional chemical testing. Unless unexpected results are encountered, we do not believe plant unique chemical evaluation should be necessary.

III. Thermo-Lag Fire Barriers Outside the Scope of the NUMARC Program

This section requests information on barriers falling outside the scope of the generic test program, and corrective action planned for these barriers. The NRC has stated that responses from licensees are required to address the current scope of the program, and the potential for expansion to address additional configurations. The NRC letter uses the phrase "bounded by the NUMARC test program." Note that while the "scope" of the test program is known, what will ultimately be "bounded" is a function of the outcome of the tests, and the final content of the Application Guide.

Our letter of December 17, 1993, requested information on your determination of installed configurations outside the scope of the current industry program. We will evaluate this information, and, through the Fire Protection Working Group, provide recommendations to the NUMARC Executive Committee for potential test program expansion. We will provide you with information on any planned test program scope expansion by April 1, 1994. However, the generic testing program, including potential expansions, will be limited to *cable raceway* protection applications. [Note: While Regulatory Guide 1.75 applications may involve Thermo-Lag in cable raceways, this is not considered a cable raceway protection application for the purposes of the generic test program.] Preliminary feedback from the industry meeting indicated potential additional generic benefit might be realized from testing the following types of configurations:

1. Air drops
2. Cable trays with small (less than 15%) cable fills
3. Cable trays with large (greater than 15%) cable fills
4. Cable trays with T-sections
5. Box installations with panel ribs facing outward
6. Further testing of alternate upgrade materials/techniques for cable raceways
7. Further testing of box enclosures mounted to concrete

NRC Item III.B.1 requires licensees to describe those barriers falling outside the scope of the generic program. You should be able to assess which plant installations would be covered under the scope of the current NUMARC test program, and which would not be covered, using the following information:

1. Performance parameters as discussed in Attachment 1;
2. Detailed information on the Phase 1 and 2 test programs provided at the December 1, 1993, industry meeting;
3. Attachment 2, which summarizes the performance parameters and test configurations to be addressed by the NUMARC Phase 2 tests, and provides additional information to that discussed at the industry meeting. [This information is preliminary and should be referenced accordingly when responding under oath and affirmation provisions of 50.54(f).]

In responding to NRC Item III.B.1, we suggest you describe those barriers you have determined to be clearly outside the scope of the current test program. However, for those barriers that would appear to be covered in the generic program, but for which only incomplete information is currently available, we suggest you consider that these barriers would be within the scope of the generic program and that you so advise the NRC. For *cable raceway* barriers outside the current program scope, we suggest you state that a supplemental response will be provided to the NRC, after taking into consideration the results of the expanded generic test program, if undertaken.

We have concluded that *non-cable raceway* installations (walls, structural steel protection, radiant energy shields, Regulatory Guide 1.75 applications) and very large or unusually shaped raceway applications cannot practically be included in an expanded generic program. Further, it should be noted that explicit thermal performance requirements, test protocols and acceptance criteria have not previously been established for Regulatory Guide 1.75 or radiant energy shield applications. As noted in our December 17, 1993, letter, certain installations may require plant unique tests, or shared testing by a small number of utilities. NUMARC is initiating actions to facilitate shared testing of installations that cannot be practically considered under the generic program scope but may be common to several facilities. It is expected that a matrix of shared tests could be developed and provided to the industry. The NUMARC Fire Protection Working Group will evaluate how best to proceed in this regard. Additional information, will be provided to utilities in this regard by April 1, 1994. For *non cable raceway* barriers, we therefore suggest you state that a supplemental response will be provided to the NRC, taking into consideration the potential for future plant specific or shared testing.

NRC Items III.B.2 and III.B.3 request information on plant specific corrective action programs for barriers falling outside the generic test scope. We suggest that you advise the NRC that your response to Items III.B.2 and III.B.3 will be deferred until May. By that time, you should be able to assess the final generic program scope, and the potential for plant specific or shared testing, both of which could reduce or eliminate the need for plant specific corrective actions, particularly fire testing. Further, a response deferred

until May would allow you to consider the outcome of the NUMARC Phase 2 test results in addressing the need for plant specific corrective actions. See Item V, "Alternatives," for further discussion of uncertainties potentially impacting corrective actions.

With regard to NRC Item III.B.3.a., generic test and acceptance criteria for cable raceway fire barriers are under development by NRC (draft proposed supplement to Generic Letter 86-10), and have been subject to considerable public review, technical scrutiny, CRGR and ACRS review, and NRC management involvement. This criteria, when final, would be required for establishing ratings for cable raceway fire barriers used for protection of safe shutdown functions in accordance with Appendix R. As noted in our December 17, 1993, letter, we recommend caution relative to licensee's conducting independent fire testing for cable raceway fire barriers until test and acceptance criteria issues are resolved.

Because of the advantages afforded through the generic review and approval process, we recommend that you propose specific test and acceptance criteria to NRC staff only in unique situations where the generic criteria could not be applied (e.g. applications other than cable raceway fire barriers). In these situations, it is expected that test and acceptance criteria would be developed and discussed with NRC as plant unique or shared test programs are designed.

IV. Ampacity Derating

This section requests information on actions to address ampacity derating concerns. We suggest that you consider the following wording in responding to NRC Item IV.B.:

Ampacity derating is an issue that applies only to cable raceways containing power cables. Ampacity derating factors determined for upgraded configurations can be conservatively applied to baseline configurations. The NUMARC program for ampacity derating evaluation contains the following elements.

For upgraded one hour cable trays and conduits, NUMARC will be discussing with NRC the generic applicability of ampacity derating factors derived by TUEC using the methodology of IEEE P848 Draft 11, with some modifications. The IEEE P848 test methodology has been extensively discussed with NRC by NUMARC and TUEC. However, NRC acceptance of the methodology is still pending. NRC has informed NUMARC that they will issue a request for further information to TUEC regarding the submitted ampacity test report. The TUEC testing provided preliminary ampacity derating factors of 32% for cable trays and 11% for conduits, which are within the range of previously reported values.

NUMARC will conduct ampacity testing of upgraded three hour barriers to the requirements of IEEE P848, following determination of appropriate barrier upgrades for three hour installations and agreement with NRC on ampacity test methodology. It is expected that this testing would be conducted in the second quarter of 1994, at the earliest. To the extent that successful upgrades using alternative materials are identified, ampacity testing of these upgrades would be considered as well.

The IEEE P848 approach provides for testing of a single cable tray, and small and large conduits. The limiting conduit derating factor (of the two sizes tested) is applied to the range of conduit sizes, cable fills, etc. For cable trays, the single cable tray derating factor is applied to all sizes of cable trays, cable fills, etc. Thus, ampacity testing can be performed generically with broad applicability, unlike fire testing where many performance parameters must be considered. The NUMARC program is expected to provide ampacity derating factors for one and three hour barriers, for cable trays and conduits. Assuming NRC agreement with the IEEE P848 approach, few if any installations are expected to fall outside the generic scope.

A schedule to address ampacity is dependent on completion of 3 hour fire duration tests and NRC acceptance of the initial TUEC tests (and the IEEE P848 methodology). An update will be provided to utilities by NUMARC in April. As noted in the NRC 50.54(f) letter, you may update your NRC response at that time.

V. Alternatives

NRC Item V.B requests information on resolution alternatives if practical upgrades are not feasible. As discussed in our December 17, 1993, letter, uncertainties must be considered in developing resolution plans. We suggest that you consider including the following in your response to NRC Item V:

Three currently undefined factors must be considered in determining whether upgrades using additional Thermo-Lag materials are practical, and what alternatives would be most appropriate in case Thermo-Lag upgrades cannot be developed:

- 1. Test and acceptance criteria have not been finalized and issued by NRC. Proposed draft criteria contain new conservatisms in fire test methods and acceptance criteria that could affect the scope and complexity of upgrades to installed barriers. The content of the final criteria, and the resulting impact on utility-specific action plans, is uncertain.*

2. *Complete Phase 2 test results will not be known until the mid-March time frame. Results of baseline (as installed) and upgraded test configurations from Phase 2 must be considered to determine appropriate utility action plans to address specific configurations. Moreover, further generic testing may be undertaken following Phase 2, as noted previously.*
3. *The NUMARC Application Guideline, to be final by mid-April, will include a matrix of important performance parameters and bounding conditions. Discussion with NRC will be necessary to reach agreement on the selection of comparison parameters and bounding conditions. The results of these NRC interactions will define the final content and would directly impact the generic applicability of a given test to an installed configuration.*

Given the above uncertainties, we strongly recommend that you maintain the option to use a range of alternatives based on the outcome of the above factors in your response to NRC Item V.B. Given the complexity of many plant installations, a combination of resolution approaches may be necessary. Further, the NRC 50.54(f) letter provides only a partial listing of resolution alternatives. Three additional resolution alternatives are provided below. Other resolution alternatives may be possible. Further, it should be noted that implementation of alternative solutions may be considered even if upgrades have been successfully tested. Potential alternatives include:

1. Re-evaluation of engineering analyses used for determination of Appendix R safe shutdown pathways, equipment, and actions, could provide a basis for reduction in the scope of protected circuits and their associated fire barriers.
2. Exemption requests could be submitted based upon the use of fire modeling in conjunction with baseline (non-upgraded) test results to demonstrate adequate protection for the installed hazard. Alternatively or in conjunction, probabilistic safety analysis (PSA) could be used as an exemption basis, by demonstrating insignificant core damage frequency impacts, assuming barrier inoperability.
3. Re-evaluation of licensing commitments that may exceed the requirements of the pertinent regulations may be undertaken.

VI. Schedules

Because of the uncertainties noted in the above discussion of NRC Item V, submittal of an integrated schedule will require careful consideration, including provisions for flexibility and future revision. The NRC's current expectation is that the issue can be resolved in approximately 2 years. Accordingly, there are a number of actions that should be undertaken based on information NUMARC has already provided to you, and further actions that will need to be considered based on the milestones noted below. In your response to NRC, we suggest you provide only a very general schedule, discuss the above uncertainties, and clearly identify the potential need for you to adjust your schedule based on the outcome of these events.

Schedules are provided for the following NUMARC activities to allow you to determine plant specific actions and schedules in response to NRC Item VI.B. The following schedule addresses currently funded and approved activities. Additional schedules for potential test program expansion will be provided as noted earlier. Should additional generic testing be pursued, it is *estimated* that it could be conducted in the July/August 1994 period.

<u>Activity</u>	<u>Schedule</u>
Issue Phase 1 test reports	January 31
Perform Phase 2 testing	January 26 - March 24
Generic test program scope information	April 1
Shared testing information	April 1
Issue Phase 2 test reports	April 15
Issue Application Guide	April 15
Ampacity program information	April 29
Perform ampacity testing	July (estimated)
Issue Ampacity test report	August (estimated)

Attachment 1

Clarified Parameter Listing

Raceway Parameters

<u>Tested Configuration</u>	<u>Bounded Installed Configurations</u>
1) Orientation (horizontal, vertical, radial bends)	All orientations
2) Dimensions (small and large limits)	Range bounded by test specimen dimensions
3) Conduit (No cable)	Conduits, bounded by test specimen dimensions, with any cable fill
4) Junction Boxes and Lateral Bends	Junction Boxes and Lateral Bends bounded by test specimen dimensions
5) Ladder Back Cable Tray with single layer cable fill	Solid back and ladder back cable trays of equal or less dimensions and equal or greater cable fill (in terms of thermal mass) - and - Boxed Conduits, Boxed Enclosures (of equal or greater thermal mass and equal or less dimensions)
6) Cable Tray with T-Section	Cable Tray of equal or less dimension with T-section, and equal or greater cable fill
7) Aluminum	Steel (side by side testing of conduits and trays will be conducted to validate bounding condition)
8) Support protection, thermal shorts (9" protection for one hour), (18" protection for three hour)	Thermal Shorts with equivalent or greater protection
9) Air Drops	Air drops of equivalent construction and dimensions

Attachment 1 (Cont)

Raceway Parameters (Cont)

- | | |
|--|---|
| 10) Box barrier systems attached to concrete walls, ceilings, etc. | Barrier systems of similar construction |
|--|---|

Fire Barrier Parameters

Tested Configuration

Bounded Installed Configurations

- | | |
|---|--|
| 1) Baseline Panel Thickness
(One Hour 0.50", +0.125", -0")
(Three Hour 1.00", +0.250", -0") | Equal or greater panel thickness |
| 2) Preformed conduit panels | Sprayed on or troweled on installations of equivalent or greater thickness and stress skin configuration |
| 3) Panel Ribs (parallel to raceway) | Parallel or perpendicular to raceway |
| 4) Unsupported span (typically 48") | Equal or less dimensions |
| 5) Stress Skin
(One hour, inside)
(Three hour, inside and outside) | As tested, plus panels using additional stress skin |
| 6) No stress skin over joints | Stress skin over joints |
| 7) No stress skin ties | Stress skin ties |
| 8) Dry fit, post buttered joints | Pre-buttered joints |
| 9) Joint gap width | Equivalent or smaller gap width |
| 10) Butt joints | Grooved and scored joints |
| 11) Cable tray radial bends with separate mitered pieces | Grooved and scored radial bends |

Attachment 1 (Cont)

Fire Barrier Parameters (Cont)

- | | |
|---|---|
| 12) Steel bands | Tie wires (will be validated through testing) |
| 13) Band/wire spacing | Equivalent or closer spacing |
| 14) Band/wire distance to joints | Equivalent or closer distance |
| 15) No internal bands in trays | Internal bands in trays |
| 16) No additional trowel material over sections, joints | Additional trowel material applied |
| 17) No edge guards | Edge guards |

Attachment 2

Phase 2 Test Descriptions and Parameter Information

Use of the Table:

- Column 1 (TEST) is the Phase 2 test number as presented at the industry meeting, and references notes following the table
- Column 2 (1 or 3 HR) notes the duration of the test
- Column 3 notes baseline (B) or upgrade (U)
- Column 4 (DESCRIPTION) is a description of the test configuration. Note that this is changed from the December 1 industry meeting for test 2-4
- Column 5 (JUSTIFICATION) is a description of the basis for the test
- Column 6 (RACEWAY PARAMETERS): The upper series of numbers represent the raceway parameters, from Attachment 1, that would be addressed by the given test
- Column 6 (BARRIER PARAMETERS): The lower series of numbers represent the fire barrier parameters, from Attachment 1, that would be addressed by the baseline barrier configuration for a given test

PRELIMINARY

NUMARC PHASE 2 TEST ASSEMBLIES				JUSTIFICATION	RACEWAY PARAMETERS BARRIER PARAMETERS
TEST	1 OR 3 HR.	B/U	DESCRIPTION		
2-1 (Note 1)	1	B	3/4", 2", 4", and 6" ϕ AL conduits protected with preshaped sections.	Provide Baseline data for 1 Hr. pre-shaped sections to bound prevalent industry size range.	1, 2, 3, 4, 7, 8 1, 2, 5, 6, 7, 9, 10, 12, 13, 14, 16
2-2 (Note 2)	1	B	3/4", 2", and 3" ϕ AL conduits in Baseline "box" design enclosure, using "score and fold" technique with Hilti bolts to concrete deck.	Provide Baseline data for representative 1 Hr. "box" design conduit enclosure.	1, 3, 7, 10
		B	3/4", and 2" ϕ steel conduits protected with pre-shaped sections using 3M Fire Dam 150 caulk to pre-butter joints (Outdoor Application)	Provide Baseline data for representative 1 hr. conduit barriers for Outdoor Applications.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 16
		U	3/4", 2", and 3" ϕ AL conduits in Upgraded "box" design enclosure (same as above with reinforced joints)	Provide viable Upgrade for representative 1 Hr. "box" design conduit enclosure.	
2-3 (Note 1)	3	B	3/4", 3", and 6" ϕ AL conduits protected with preshaped sections.	Provide Baseline data for 3 Hr. pre-shaped sections to bound prevalent industry size range.	1, 2, 3, 4, 7, 8 1, 2, 5, 6, 7, 9, 10, 12, 13, 14, 16
2-4 (Note 3)	3	U	3/4", 3", and 6" ϕ AL conduits protected with preshaped sections with design upgrades.	Provide viable Upgrade methods for 3 Hr. preshaped conduit sections to bound prevalent industry size range.	1, 2, 3, 4, 7, 8 1, 2, 5, 6, 7, 8, 9, 10, 12, 13, 14, 16
2-5 (Note 3)	3	U	Four (4) individual 3/4" ϕ AL conduits with preshaped sections and four (4) different upgrade methods and materials.	Provide various Upgrade methods for 3 Hr. preshaped conduit sections for worst case thermal challenge	1, 2, 3, 4, 7, 8 1, 2, 5, 6, 7, 8, 9, 10, 12, 13, 14, 16
2-6 (Note 4)	3	B	3/4", 2", and 3" ϕ AL conduits in Baseline "box" design enclosure, using "score and fold" technique with Hilti bolts to concrete deck.	Provide Baseline data for representative 3 Hr. "box" design conduit enclosure.	1, 3, 7, 10
			3/4", 2", and 3" ϕ AL conduits in Upgraded "box" design enclosure (same as above with reinforced joints)	Provide viable Upgrade for representative 3 Hr. "box" design conduit enclosure.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 16

PRELIMINARY

2-7 (Note 5)	1	B	(2) 6" x 4" AL cable trays (1 "score and fold" design, 1 "4 piece" design) (2) 24" x 4" AL cable trays (1 "score and fold" design, 1 "4 piece" design)	Provide Baseline data for 1 Hr. cable trays using 2 most prevalent construction techniques to bound prevalent industry sizes.	1, 2, 5, 7, 8 1, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17
2-8 (Note 6)	1	U	(2) 6" x 4" AL cable trays (1 "score and fold" design, 1 "4 piece" design), with design upgrades (2) 24" x 4" AL cable trays (1 "score and fold" design, 1 "4 piece" design), with design upgrades	Provide viable Upgrade methods for 1 Hr. cable trays using 2 most prevalent construction techniques to bound prevalent industry sizes.	1, 2, 5, 7, 8 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17
2-9 (1-2) (Note 7)	1	U	(1) 36" x 4" AL cable tray (from Phase 1) using "4 piece" design. Upgrade utilizes Thermo-Lag materials.	Provide viable Upgrade method to bound upper size range of industry 1 Hr. tray configurations.	1, 2, 5, 7, 8 1, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 16, 17
2-10 (Note 5)	3	B	(2) 6" x 4" AL cable trays (1 "score and fold" design, 1 "4 piece" design) (2) 24" x 4" AL cable trays (1 "score and fold" design, 1 "4 piece" design).	Provide Baseline data for 3 Hr. cable trays using 2 most prevalent construction techniques to bound prevalent industry sizes.	1, 2, 5, 7, 8 1, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17
2-11 (Note 6)	3	U	(2) 6" x 4" AL cable trays (1 "score and fold" design, 1 "4 piece" design), with design upgrades (2) 24" x 4" AL cable trays (1 "score and fold" design, 1 "4 piece" design), with design upgrades.	Provide viable Upgrade methods for 3 Hr. cable trays using 2 most prevalent construction techniques to bound prevalent industry sizes.	1, 2, 5, 7, 8 1, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17

NUMARC PHASE 2 TEST ASSEMBLIES
TEST CONFIGURATION NOTES

<u>Note # (from Column 1)</u>	<u>Explanation</u>
1.	Joints between preshaped conduit sections will be pre-buttered. Lateral and radial bands will be tested but no junction boxes.
2.	<p>For the Baseline conduit "box" enclosure, the "score and fold" design will be used with 330-1 trowel grade material added to fill in scored panel seams. Butt joints between panels will be pre-buttered.</p> <p>For the two (2) "outdoor application" conduits, joints between preshaped sections will be pre-buttered using 3M Dam 150 caulk. Lateral bends will be tested but no junction boxes.</p> <p>For the Upgrade conduit "box" enclosure, the "score and fold" design will be used with 330-1 trowel grade material added to fill in scored panel seams. Butt joints between panels will be post-buttered. All seams and joints will then be reinforced using stress skin and trowel grade material.</p>
3.	Joints between preshaped conduit sections will be post-buttered. Then design upgrades will be applied. lateral and radial bends will be tested but no junction boxes.
4.	<p>For the Baseline conduit "box" enclosure, the "score and fold" design will be used with 330-1 trowel grade material added to fill in scored panel seams. Butt joints between panels will be pre-buttered.</p> <p>For the Upgrade conduit "box" enclosure, the "score and fold" design will be used with 330-1 trowel grade material added to fill in scored panel seams. Butt joints between panels will be post-buttered. All seams and joints will then be reinforced.</p>
5.	Joints between panels will be pre-buttered, separate "mitered" pieces will be utilized at cable tray radial bends.
6.	Joints between panels will be post-buttered, separate "mitered" pieces will be utilized at cable tray radial bends. Then design upgrades will be applied.
7.	Joints between panels will be pre-buttered, both separate "mitered" pieces and scored panels will be utilized at cable tray radial bends. Then design upgrades will be applied. In addition, the cable tray will be "pre-banded" (in horizontal sections only) prior to Thermo-Lag installation.