

August 19, 1997

Mr. James W. Langenbach
Vice President and Director, TMI
GPU Nuclear Corporation
P.O. Box 480
Middletown, PA 17057

SUBJECT: THREE MILE ISLAND NUCLEAR STATION, UNIT 1 - FIRE BARRIER CABLE
FUNCTIONALITY (TAC NO. M97747)

Dear Mr. Langenbach:

By letter dated December 31, 1996, GPU Nuclear Corporation submitted a request for an exemption from the fire endurance performance criteria in Generic Letter 86-10, Supplement 1, for a specific set of installed fire barriers at Three Mile Island, Unit 1. The NRC staff, in conjunction with our contractor, Sandia National Laboratories, have reviewed the above-cited submittal, and find that additional information, as delineated in the Enclosure, is required in order to continue our evaluation.

It is requested that you provide your response within 60 days of receipt of this letter.

Sincerely,

Original signed by

Bart C. Buckley, Senior Project Manager
Project Directorate I-3
Division of Reactor Projects
Office of Nuclear Reactor Regulation

Docket No. 50-289

Enclosure: Request for Additional
Information

cc w/encl: See next page

DISTRIBUTION

Docket File B. Buckley
PUBLIC E. Dunnington
PDI-3 RF OGC
B. Boger ACRS
R. Eaton C. Hehl

DOCUMENT NAME: G:\BUCKLEY\M97747.RAI

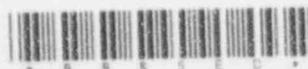
To receive a copy of this document, indicate in the box: "C" = Copy without attachment/enclosure "E" = Copy with attachment/enclosure "N" = No copy

OFFICE	PDI-3/PM	<input checked="" type="checkbox"/>	PDI-1/LA	<input checked="" type="checkbox"/>	(A):PDI-3	<input checked="" type="checkbox"/>		
NAME	BBuckley		EDunnington		REaton			
DATE	08/19/97		08/14/97		08/19/97			

OFFICIAL RECORD COPY

DF01 1/1

9708210282 970819
PDR ADOCK 05000289
F PDR



NRC FILE CENTER COPY

Three Mile Island Nuclear Station, Unit No. 1

cc:

Michael Ross
Director, O&M, TMI
GPU Nuclear Corporation
P.O. Box 480
Middletown, PA 17057

Robert B. Borsum
B&W Nuclear Technologies
Suite 525
1700 Rockville Pike
Rockville, MD 20852

John C. Fornicola
Director, Planning and
Regulatory Affairs
GPU Nuclear Corporation
100 Interpace Parkway
Parsippany, NJ 07054

William Dornsife, Acting Director
Bureau of Radiation Protection
Pennsylvania Department of
Environmental Resources
P.O. Box 2063
Harrisburg, PA 17120

Jack S. Wetmore
Manager, TMI Regulatory Affairs
GPU Nuclear Corporation
P.O. Box 480
Middletown, PA 17057

Dr. Judith Johnsrud
National Energy Committee
Sierra Club
433 Orlando Avenue
State College, PA 16803

Ernest L. Blakely, Esquire
Shaw, Pittman, Matthews & Trowbridge
2300 N Street, NW.
Washington, DC 20037

Chairman
Board of County Commissioners
of Dauphin County
Dauphin County Courthouse
Harrisburg, PA 17120

Chairman
Board of Supervisors
of Londonderry Township
R.D. #1, Geyers Church Road
Middletown, PA 17057

Michele G. Evans
Senior Resident Inspector (TMI-1)
U.S. Nuclear Regulatory Commission
P.O. Box 311
Middletown, PA 17057

Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

REQUEST FOR ADDITIONAL INFORMATION
THREE MILE ISLAND, UNIT 1
FIRE BARRIER CABLE FUNCTIONALITY ISSUES
(TAC NO. M97747)

BACKGROUND

By letter dated December 31, 1996, GPU Nuclear Corporation (the licensee) submitted a request for an exemption from the fire endurance performance criteria in Generic Letter 86-10, Supplement 1 for a specific set of installed fire barriers at Three Mile Island (TMI), Unit 1. The licensee has performed a review of all of its installed fire barriers systems.

For a limited subset of the fire barriers, the licensee has invoked a cable functionality analysis in an attempt to demonstrate the equivalent of a one-hour "cable qualification rating (CQR)". The CQR is based on an assessment of cable functionality during an exposure time period beyond the time interval at which the nominal test acceptance criteria were exceeded during the test. These cases involve installations for which a 1-hour American Society of Testing Materials/National Fire Protection Association (ASTM/NFPA) fire endurance rating of at least one hour cannot be demonstrated. For these applications the licensee is requesting an exemption from the nominal ASTM/NFPA fire performance evaluation criteria in favor of acceptance of barrier ratings derived from the functionality assessments.

Specifically, the licensee has followed the "functionality path" for fire barriers in ten specific fire zones. Some of these zones contain numerous individual barrier systems. All of the cable functionality evaluations are associated either with cables in conduits (including straight sections of conduits, radial bends, and condulets) or with armored cables. All of the functionality assessments have been based on the extrapolation of test results from a single fire endurance test; namely Nuclear Energy Institute (NEI) test 2-1.

The overall licensee functionality assessment process can be summarized as follows:

- The licensee has estimated the "Cable Functionality Temperature" (CFT) for its cables to be 698°F (370°C). The licensee assumes that this value represents a reasonable bounding estimate of the thermal failure threshold of its installed cables. This value is based on the results of Sandia National Laboratories (SNL) testing of cables as referenced in its submittal of December 31, 1996.
- The licensee has compared its installed, non-upgraded fire barrier systems to those described in the NEI Application Guide. The licensee has concluded that the installations used in NEI test 2-1 are representative of all of the conduit and armored cable base installations. This single NEI test is then used as the basis for all of the subsequent cable functionality evaluations.

ENCLOSURE

- The licensee utilizes the NEI test 2-1 data to make a direct assessment of the "actual rating" for the subject barriers. The "actual rating" is based only on the nominal single point temperature rise criteria established in the ASTM E-119 and NFPA 251 fire test standards (i.e., 325 °F rise above ambient). In all cases relevant to the functionality based exemption requests, these "actual" endurance times are less than the nominal 1-hour rating of the TMI Unit 1, installations. In particular, in NEI test 2-1 the conduits exceeded the nominal temperature criteria in 27-50 minutes depending on the individual conduit.
- In order to assess the cable functionality at 60 minutes, the licensee extrapolated the measured temperature response from NEI test 2-1 beyond the range of actual test data. That is, NEI test 2-1 was terminated after a 50 minute exposure, and no temperature data beyond this time is available. Therefore, the licensee has extrapolated the test data out beyond the actual test duration to estimate what the temperature response might have been had the test been continued for a full hour.
- The resulting temperature response is then compared directly to the CFT with some modification for margin factors (for plant ambient and cable temperature). Based on this comparison, the licensee determines a duration time that it defines as the "Cable Qualification Rating" (CQR). That is, the time at which the actual or estimated thermal response, plus some margin factors, exceeds the CFT is cited as the CQR. This represents the licensee's assessment of the estimated time threshold when installed cables would have actually reached a potential failure threshold in the context of cable functionality beyond the nominal temperature rise limits of a barrier test.
- For those cases where a CQR of 57 minutes or greater is determined, the licensee requests an exemption where the CQR calculation represents the technical basis for compliance with Appendix R requirements. In each case the assessments are also supported by a discussion of the local fire hazard conditions.

QUESTIONS

1. Sandia National Laboratories (SNL) made the following finding after a review of the licensee's cable functionality assessment method:

The licensee basis for its determination of the temperature response measured during the fire endurance tests has not been adequately established. Of particular concern to SNL in this regard is that the licensee has taken fire test data from a test that lasted for less than one hour (i.e., 50 minutes) and has extrapolated that data to a one-hour exposure period using a thermal model that was not included in the submittal. The extrapolation of fire endurance data beyond the actual test duration is, at best, an uncertain practice. Many factors can influence the thermal response of a fire endurance test, and certain of these factors may not be amenable to analysis or extrapolation.

Further, although Supplement 1 of GL 86-10 states that cable functionality assessments can be made if they are "based on a comparison of the fire barrier internal temperature profile measured during the fire endurance test to existing cable specific performance data", alternative methodologies can be used provided that the technical basis can be established for the assessment of the thermal exposure conditions.

Given the above finding, the licensee is requested to provide the supporting document, Calculation C-9000-814-5310-002 and a detailed explanation of both the uncertainties and conservatisms in these extrapolations. Specifically, the licensee should address the following points:

- How has the analysis treated the potential for material burn-through in extrapolating the NEI test data assessment?
 - On what basis has the licensee thermal extrapolation model been validated? Documentation of the extrapolation model should be in detail so as to allow independent implementation and verification. The licensee is requested to provide the corresponding validation results and studies for staff review.
2. Many of the fire barrier tests performed by the industry have failed due to burn-through. SNL would consider burn-through to be a case where the virgin Thermo-lag barrier material is fully consumed at any given location during the test leaving only a fragile char layer visible. It appears that the NEI tests were evaluated using a different interpretation of burn-through.

Specifically, SNL makes the following observations:

SNL has reviewed the documentation for NEI test 2-1 as presented in the NEI Application Guide. Particularly troubling to SNL are certain passages included in the post-test inspections of the test articles. The licensee applications involve 2" or larger conduits; hence, only the corresponding 2" and larger test results are of direct interest. Consider for example the description for the 2" conduit. The NEI/Omega Point Laboratories (OPL) test report cites the following:¹

For the vertical section: "Several areas having 0 in. uncharred material remaining."

For the horizontal section: "Several areas in section having 0 in. uncharred material remaining."

Similar descriptions are given for the 4" and 6" conduits as well, particularly in the case of each horizontal section. This condition is not described as a "burn-through" in the report, but it is unclear how NEI/OPL defined a "burn-through". SNL's finds that this physical description is a clear indication that burn-through was, at the very least, imminent at the time of test termination. Once the virgin Thermo-Lag has been consumed and there is no remaining uncharred material, burn-through is all but inevitable unless the test is stopped. The statements of no remaining virgin material in "several areas" raises troubling questions for the TMI Unit 1 analysis and in particular the validity of any data extrapolations.

The material Thermo-Lag 330-1 is purported to derive its primary fire protective ability through sublimation (direct solid-to-gaseous phase transition) and intumescence (the swelling and formation of a char layer as a result of the combustion process) behavior. Once the virgin material has been consumed, the only protective

¹See page 14 of the OPL/NUMARC Report No. 13890-96141 as presented in Appendix I of the NEI Application Guide.

mechanism left active is the modest insulating power of the char layer. The charred material is relatively fragile, and may be dislodged from the cables during fire exposure. Unlike the virgin material, the char layer is porous and significant heat transfer through the char layer would be expected and the temperature will experience a sudden increase in the rate of temperature rise. Therefore, an understanding of burn-through behavior is critical for predicting the ultimate thermal response of the protected commodity to the exposure fire.

The licensee is requested to discuss the post-test physical inspection results for the relevant test items from the NEI test report and specifically to address the implications of the statements such as "several areas having 0 inch of uncharred material remaining" with regards to the application of the NEI test results for extrapolation purposes such that the subject cables will be able to continue to function during the full one hour period.

3. SNL noted that the licensee cable functionality assessments as contained in the December 31, 1996 submittal requires additional clarification or justification in the following areas:
 - a. SNL finds that the licensee's submittal has not established an adequate basis for the assumed cable damage or failure threshold. SNL does not question the acceptability of the cited NUREG/CR test results in general, but rather, the applicability of the cited result to the licensee's cables. The licensee is requested to provide the cited GPUN memo 5350-95-063 for review along with any supporting documentation.
 - b. SNL finds that the licensee's has not established an adequate basis for the assessment of individual circuit performance requirements. While the cited cable performance results are appropriate for low-to-medium voltage power cables and control applications, they may not be appropriate for higher voltage power nor instrument circuits. The licensee is requested to: (1) identify each of the analyzed circuits as either power, control, or instrumentation along with the corresponding voltage and ampacity loads for all power cables; and (2) provide an assessment of circuit performance requirements for both a limiting voltage power cable application and for a limiting instrumentation case. This assessment should include a direct link between circuit functionality requirements and the cited damage threshold.
 - c. SNL finds that the licensee's analyses have not adequately addressed the issue of power cable self-heating effects, and in particular, that the cited cable performance tests upon which the cited functionality limits are based have not bounded this effect. Hence, the submittal is deficient in this regard.

Specifically, SNL makes the following observations:

SNL finds that the licensee's inclusion of an additional 7°F increment to allow for cable self-heating effects is not adequate to address the concern. It would appear that the licensee is attempting to address self-heating effects by simply incrementing the ambient exposure to reflect the ambient temperature within the fire barrier. The specific question is what is the additional temperature increment between the cable itself and the ambient temperature at the onset of the fire, not what is the temperature of air immediately around the cable. A second factor to be considered is the fact that the cited licensee documents (Reference: Letter from J. Brendlen to J. W. Langenbach, "TSI Derating

Check", G/C/TMI-1CS/16503 dated September 15, 1988) supporting this value were reviewed separately as a part of the licensee ampacity assessments. As a result of this separate review, the licensee has agreed that the cited tests were not of adequate quality to be used in the context of the regulatory process and hence, has withdrawn their reliance on those results for ampacity derating process. The exact same objections would apply in this application. In particular, the licensee has not demonstrated an adequate level of quality assurance for these tests, nor has the licensee demonstrated that the cited tests actually measured a limiting case for the electrical raceways installed in TMI-1.

As noted by the licensee on page 11 of the Topical Report #094 attached to the subject submittal, the SNL test cited as the basis for the licensee assumed cable damage limits did involve an imposed voltage potential, but did not involve imposed current flows during the tests. It is not correct to infer that cable self-heating are bounded by tests such as those performed by SNL. Therefore, the licensee assessments should independently allow for the ohmic effect for energized power cables.

The licensee is requested to: (1) identify each of the barrier envelopes that includes power cables within the protected envelope; (2) for each power cable circuit determine whether or not it is reasonable to postulate that the circuit might be energized at the outset of a fire; (3) for all energized power cables assess the temperature increment that characterizes the rise in temperature of the cable above the surrounding ambient due to ohmic heating effects consistent with the licensee's own ampacity assessments; and (4) for each impacted envelope explicitly include the power cable self-heating effect in the functionality assessment including consideration of the mutual heating effect for collocated but non-energized cables.

- d. As a final point of note, the licensee has apparently assumed that an equivalent cable qualification rating of "at least 57 minutes" is sufficient to meet the intent of the Appendix R requirement for a one-hour barrier system. The licensee is requested to provide justification for the above assumption.