A Technical Evaluation of the Florida Power Crystal River Ampacity Derating Test Report 95NK17030NC1973

A Letter Report to the USNRC

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Revision 0

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ATTACHMENT 1

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FORWARD

The United States Nuclear Regulatory Commission (USNRC) has solicited the support of Sandia National Laboratories (SNL) in the review of licensee submittals associated with fire protection and electrical engineering. This letter report represents the second and likely the last report in a series of review reports associated with ampacity derating submittals from the Florida Power Corporation (FPC) for the Crystal River Energy Complex (CREC). The original submittal reviewed by SNL documents the results of a series of test sponsored by the licensees to assess the derating impact of Thermo-Lag 330-1[1] and Mecatiss fire barriers when installed on cable trays and conduits. An initial SNL review of this submittal was documented in an SNL letter report of March 7, 1997. As a result of that review one minor and one significant point of technical concern was identified. The current report document SNL findings and final recommendations based on a review of the licensee response to these concerns. The documents were submitted by the licensee in response to USNRC Generic Letter 92-08 and two subsequent USNRC Requests for Additional Information (RAIs). This work was performed as Task Order 1 of USNRC JCN J2503.

[1]Thermo-Lag 330-1 is a registered trademark of Thermal Sciences Inc.

1.0 INTRODUCTION

1.1 Objective

In response to USNRC Generic Letter 92-08 and a subsequent USNRC Request for Additional Information of June 22, 1995, the Florida Power Corporation (FPC) Crystal River Energy Complex (CREC) provided documentation of the licensee position regarding ampacity derating factors associated with its installed fire barrier systems. SNL was asked to review the licensee's submittals under the terms of a general technical support task ordering agreement JCN J2503, Task Order 1. An initial review report was forwarded to the USNRC by letter report on March 7, 1997[2]. That report was based on a review of the following documents:

- Letter, P. M. Beard, Jr., FPC, to the USNRC Document Control Desk, Item 3F0795-05, July 27, 1995.

- Letter, G. L. Boldt, FPC, to the USNRC Document Control Desk, Item 3F0696-14, June 26, 1996, including an attached test report from Underwriters Laboratory, "Ampacity Test Investigation of Raceway Fire Barriers For Conduit and Cable Tray Systems," Report Number 95NK17030NC1973, May 7, 1996.

Two points of technical concern, one minor and one significant, were identified by SNL. As a result, on May 22, 1997 the USNRC forwarded an additional RAI to the licensee requesting resolution of the identified concerns. The licensee response was documented in:

- Letter, J. J. Holden, FPC, to the USNRC document control desk, licensee item 3F0797-06, July 3, 1997 with one attachment (4 pages total).

The objective of the current report is to document SNL's findings and recommendations regarding this licensee response.

1.2 Overview of the Licensee Ampacity Derating Approach

The licensee approach is based on an experimental determination of ampacity derating factors for certain fire barrier installations, presumably typical of those used in the plant. The tests were performed consistent with the guidance provided in Draft 16 of the IEEE P848 test standard for ampacity derating. The tests performed included three different types of test items; namely, 1" conduits, 4" conduits, and a 4"x24" cable tray, all consistent with the IEEE standard. Six basic fire barrier systems were evaluated for each test item including a 1-hr TSI system Thermo-Lag 330-1 at nominal 5/8" thickness, a 3-hr TSI system Thermo-Lag 330-1 at nominal 1¼" thickness, a 1-hr Mecatiss upgrade system MPF-60 over the 1-hr TSI system, a 3-hr Mecatiss upgrade

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[2]See SNL letter report "An Initial Review of the Florida Power Crystal River Ampacity Derating Test Report 95NK17030NC1973," forwarded under cover from S. Nowlen, SNL, to R. Jenkins, USNRC/NRR/EELB, dated March 7, 1997. Work performed under USNRC JCN J2503 Task Order 1.

system MPF-180 over the 3-hr TSI system, a 1-hour Mecatiss stand-alone system MTS-1, and a 3-hr Mecatiss stand-alone system MTS-3.

The licensee has only provided the test reports which document the results of the ampacity testing program. Hence, SNL's review is limited to an assessment of the technical acceptability of the licensee test results. No documentation of how the test results have been applied to the assessment of individual cable ampacity loads has been provided to SNL, hence, this aspect of the licensee's assessments have not been reviewed.

1.3 Organization of Report

Section 2 provides a more detailed review of the licensee test program, and identifies the points of technical concern raised by SNL in the March 1997 letter report including the licensee resolution of those concerns. Section 3 summarizes the SNL findings and recommendations. Appendix A provides the detailed information regarding SNL's calculations for the various test articles which were put forth by SNL in March 1997 as the basis for the most significant point of technical concern raised by SNL. This is related to one test item in particular, the MTS-1 system installed on a 4" conduit.

2.0 THE LICENSEE TEST PROGRAM

2.1 Overview of the Test Program

The tests submitted by FPC/CREC were actually performed by Underwriters Laboratory as a "Special Services Investigation." This simply implies that the tests do not result in a UL listing for the product. It is important to note that the tests were performed under the direct supervision and control of UL personnel establishing a strong basis for independence of the tests from any potential perceptions of conflict of interest. UL is a well known and highly qualified fire research laboratory and is quite capable of performing tests of this type.

The test protocol was based on Draft 16 of the IEEE P-848 standard. All of the provisions of the standard were followed. All of the test acceptance criteria were achieved with one notable exception which was discussed at length by the licensee (see discussion in Section 2.2.2 below). Based on the initial review of 3/97 SNL found that the test protocol was acceptable and was adequately implemented in the licensee tests.

The licensee test program involved four Test Articles. Each of these test articles was, in turn, comprised of three items; namely, a 1" conduit, a 4" conduit, and a 4"x24" ladder back cable tray. Each of the items in each test article was evaluated in a base line condition, and separately in the clad condition. Hence, there were a total of four 1" conduits, four 4" conduits, and four 4"x24" cable trays evaluated. Each of the 1" conduits had a single, 4/C, 10AWG, 600V light power or control cable installed. For each of the 4" conduits, a tightly wrapped bundle of 12, 3/C, 6AWG, 600V cables (a total of 36 individual conductors) was installed. The 4"x24" cable trays each had three layers of the 3/C 6AWG cable installed. All of these provisions are fully consistent with the test standard specifications.

All of the instrumentation specifically required in the IEEE standard was installed in the FPC tests. In addition, the licensee included a number of supplemental thermocouples to measure conduit and cable tray surface temperatures, and fire barrier material surface temperatures (outside for all layers and inside for some). All test data was monitored using calibrated devices and UL is known to have an excellent calibration process that is followed as routine practice. No anomalies in this regard were noted.

The licensee has investigated six basic fire barrier systems, each installed on the 1" conduit, the 4" conduit and the 4"x24" cable tray. These are:

- A 1-hour Thermo-Lag 330-1, single layer, fire barrier system alone
- A 3-hour Thermo-Lag 330-1, single layer, fire barrier system alone
- A 1-hour Thermo-Lag 330-1 fire barrier system with a Mecatiss MPF-60 upgrade system
- A 3-hour Thermo-Lag 330-1 fire barrier system with a Mecatiss MPF-180 upgrade system
- A 1-hour Mecatiss MTS-1 system
- A 3-hour Mecatiss MTS-3 system

One important factor to note is that the fire barrier system for each of the cable tray items included a solid tray cover place over the ladder back cable tray prior to installation of the fire barrier system itself. (The base line tests did not include the cover plate as discussed in 2.2.1 ...w.)

2.2 Current RAI Items

The USNRC RAI of 5/22/97 raised two points of technical concern related to the FPC/CREC test reports. The concerns and the licensee responses are summarized in the following two subsections.

2.2.1 RAI 1: Tray Covers

One minor point of concern was raised regarding the installation of a solid cover onto the cable tray test items as a part of the fire barrier system. The report had implied that the covers were not in place during the base line test for the items. The licensee was asked to confirm this interpretation of the test report.

The licensee response definitively states that the tray covers were not present during the base line test of each cable tray test item. This fully resolves this item. The practice applied by the licensee is conservative and appropriate. This response also indicates that the cited test results can be appropriately applied as conservative bounding estimates of the ADF impact for similar fire barrier systems which lack a tray cover. No further actions on this RAI item are recommended.

2.2.2 RAI Item 2: Potential Undetected Data Anomaly

The licensee report includes a discussion of an apparent discrepancy involving the base line tests for the 1" conduit specimens. In particular, the base line ampacity limits for the 1" conduits in Test Articles 1 and 2 differed significantly from those for the nominally identical 1" conduits in Test Articles 3 and 4. This anomaly was investigated at some length. Although no firm conclusion was reached as to the cause of the discrepancy, it was ultimately concluded that the original Test Article 1 and 2 results were in error and had recorded a false-high ampacity limit (the tests had overstated the actual base line current limits). These base line tests were repeated after removal of the barrier system and the modified results were in agreement with the Test Article 3 and 4 results. The original base line results were discarded, and the newer values were used to calculated ACF/ADF values.

In general, SNL found that this was an adequate and appropriate resolution of the observed anomaly. However, in examining the balance of the licensee test data, it became apparent that a second test item, the 4" conduit with MTS-1 system, had likely been compromised by a similar test anomaly that was not detected by either the licensee or by the UL test personnel. The details of this evaluation were presented in detail in the SNL letter report of 3/97, and are summarized in Appendix A of this report. In the USNRC RAI of 5/22/97, the licensee was requested to provide for some resolution of this concern.

The licensee response did not provide any new information to either refute of confirm SNL's concerns in this regard. Rather, the licensee simply stated that they would accept the use of the

SNL estimated ADF of 33% in lieu of the nominal test value of 23%. It had not been our original intent that the SNL calculation be used in this manner; however, SNL has once again reviewed the calculation in some detail and found no apparent errors or shortcomings. The calculation is based on firm and well established principals of heat transfer backed by solid experimental data. SNL has confidence in the reliability of the calculation result, hence, SNL recommends that the calculation results be accepted as a reasonable estimate of the actual ampacity derating impact of the fire barrier product in this configuration.

While it is somewhat disappointing from a purely intellectual standpoint to have no concise resolution of the identified concern, in this context acceptance of the more conservative calculated ADF will resolve the identified uncertainty. No further actions to resolve the identified concern are recommended. This is a point which should also be observed in any potential applications of this data set by other licensee's as well. That is, in any application of this particular test by any licensee, the SNL estimated 33% ADF should be applied instead of the test report cited nominal value of 23%.

3.0 FINDINGS AND RECOMMENDATIONS

3.1 Adequacy of RAI Responses

SNL finds that the licensee has adequately responded to each of the two items raised by the USNRC in its RAI of 5/22/97. No further actions on either item are recommended.

With regard to the licensee response to RAI item 1, SNL notes that the licensee did not provide additional information to either confirm or refute SNL's findings. However, the licensee has cited that the more conservative SNL estimate of the anticipated test result will be applied in practice. While SNL's concern remains unanswered in one regard, the licensee application of the more conservative SNL ADF estimate is adequate to resolves the concern.

3.2 Summary of Test Results

The test results obtained by FPC are summarized in Table 4.1. This summary has included the "corrected" ACF for the MTS-1 4" conduit test item as discussed in 2.2.2 and Appendix A of this report. For each of the test items in each barrier configuration both the ampacity correction factor (ACF) and the ampacity derating factor (ADF) is given. Recall that the relationship between these two values is as follows:

$$ADF = (1 - ACF) * 100\%$$

SNL recommends that the values cited in this table be accepted for use in the determination of ampacity limits for cables clad by the subject fire barrier systems. This recommendation includes the application of these values both by FPC/CREC and potentially by other licensee's as well.

Table 4.1: Summary of FPC/CREC test results.			
Test Item	Barrier System	ACF	ADF (%)
1" Conduit Tests	1-hr Thermo-Lag	No Result*	No Result*
	3-hr Thermo-Lag	1.04	-4.26
	MPF-60 Upgrade	0.838	16.2
	MPF-180 Upgrade	0.843	15.7
	MTS-1	0.818	18.2
	MTS-3	0.775	22.5
4" Conduit Tests	1-hr Thermo-Lag	1.03	-3.31
	3-hr Thermo-Lag	0.973	2.69
	MPF-60 Upgrade	0.801	19.9
	MPF-180 Upgrade	0.765	23.5
	MTS-1**	0.667	33.3
	MTS-3	0.665	33.5
Cable Tray Tests	1-hr Thermo-Lag	0.590	41.0
	3-hr Thermo-Lag	0.586	41.4
	MPF-60 Upgrade	0.444	55.6
	MPF-180 Upgrade	0.421	57.9
	MTS-1	0.397	60.3
	MTS-3	0.361	63.9

* No results reports due to problem with original base line test and inability to repeat clad test.
** This value is based on the SNL re-analysis as discussed in 2.2.2 and Appendix A.

Appendix A: Apparent Discrepancy in Clad Case for a 4" Conduit with the MTS-1 Barrier System

The FPC/UL tests did experience some anomalous current readings. In particular, the test report discusses in some detail false-high current values measured in the initial testing for two of its base line test items. No clear and definitive source for this error was identified, although it was speculated that a loose shunt connection had caused the problems. The failure to concisely identify a cause for this problem leaves open the possibility that other tests may have been affected by a similar problem.

As will be demonstrated in the following discussion, SNL does consider that one test in particular did, in all likelihood, experience a similar problem that impacted the test results. The particular concern is associated with the clad test for the MTS-1 system installed on the 4" conduit (the 4" conduit of Test Article 3). Based on SNL calculations, it is suspected that this test also suffered from a false-high current reading. Given that this is a clad test, a false-high current reading would yield an overly optimistic ampacity derating impact.

In order to illustrate why SNL has reached this conclusion, one must look at the available data in a somewhat unique way. One way to view the cable/conduit/barrier thermal system is using the electrical network analogy. That is, one can think of heat flow as analogous to electrical current, temperature as analogous to voltage, and thermal resistance as analogous to electrical resistance. Using these analogies, the system can be viewed as a thermal resistance network characterized by certain temperatures, heat flows, and thermal resistance elements. Under this approach, heat flow between two elements or nodes of the thermal system (Q) can be expressed as follows:

$$Q = \frac{\Delta T}{R_{thermal}}$$

where (ΔT) is the temperature difference between the thermal elements or nodes, and ($R_{thermal}$) is the thermal resistance between the elements or nodes. Given this expression, if the heat load and temperature difference are known, then one can easily calculate the effective thermal resistance between the two elements. In the case of the ampacity derating tests, the heat load is easily determined based on the cable ampacity setting as follows:

$$Q = I^2 \, R_{elec} \, n_{conductor}$$

where (I) is the ampacity load on each conductor, (R_{elec}) is the electrical resistance of the conductors, and ($n_{conductor}$) is the total number of conductors within the conduit.

Of most critical importance to the current discussion will be the thermal resistance that exists between the cables and the conduit. This thermal resistance has been the focus of considerable investigation. The most concise treatment was that of Buller/Neher[1] and Neher/McGrath[2]. In these works this value was found to be a function of the conduit size and cable fill characteristics only. It is especially important to recognize that this value will not be influenced in any way by external factors such as the ambient temperature, or the presence of a fire barrier system.

In fact, one of the fundamental precepts of a conduit ampacity derating test set is that the thermal behavior between the cables and the conduit should remain constant in the clad and the base line tests. That is one of the primary reasons why the IEEE standard requires that the same physical test specimen (conduit and cables) be used to perform both the clad and base line tests. Otherwise, unintended changes in the internal thermal behavior might easily bias the test results which are intended to reflect only changes in the external thermal behavior.

Given this concept, one simple check that can be performed to assess the consistency between a base line and a clad conduit ampacity test is to check the value of the internal cable to conduit thermal resistance in each test. This value should remain essentially constant, and significant deviations would be indicative of potential problems. The only supplemental data, beyond that required by the IEEE P848 standard, needed to perform this calculation is the temperature of the conduit itself. Fortunately, the FPC/UL tests report these conduit temperature values for most of the tests performed.

Using the FPC/UL data, and the two equations above, SNL has calculated the effective thermal resistance between the cables and the conduits for all those tests which report conduit temperatures. A variety of temperature bases were tried (i.e., cable hot spot to individual conduit temperatures, cable hot spot to average conduit temperature, and cable average temperature to conduit average temperature). The results for each of these calculations were quite consistent. For illustrative purposes, the discussions which follow will utilize the thermal resistance values based on the difference between the average temperature of the cable bundle at the center location as reported by UL and the average temperature of the conduit surface[3]. Table A.1 illustrates the results obtained by SNL for the 1" conduit test items.

As can be seen, the values derived are quite consistent with one notable exception. Within any given test article, the derived values are extremely consistent, varying in all cases by less than ±4%, and for most cases by less than by less than ±2.5%. Even comparing one test article to another, the variation is no more than ±10%. The one clear exception is the original base line test for Test Article 1. In this one case, a value is derived that is far lower than any of the other cited values. In fact, the estimated base line thermal resistance is nearly 30% lower than the values obtained for the two corresponding clad cases.

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[1]F. H. Buller and J. H. Neher, "The Thermal Resistance Between Cables and a Surrounding Pipe or Duct Wall," AIEE Transactions V69, 1950 pgs 342-349.

[2]J. H. Neher, and M. H. McGrath, "The Calculation of the Temperature Rise and Load Capacity of Cable Systems," AIEE Transactions, Oct. 1957, pgs 752-772.

[3]The average conduit temperature was calculated by SNL using the simple average of the temperatures for all conduit thermocouples installed on a given test item as reported by UL.

Table A.1: Summary of thermal resistance calculation results generated by SNL for the FPC/UL 1" conduit ampacity tests. All values are calculated based on the difference between the average temperature of the cable bundle and the average conduit temperature.		
Test Article	Barrier Configuration*	Cable to Conduit Thermal Resistance (°C*ft/W)
Test Article 1	Base Line	4.15
	Clad: 1hr TSI	5.91
	Clad: MPF-60	5.84
Test Article 2**	Clad: 3-hr TSI barrier	6.16
	Clad: MPF-180	6.43
Test Article 3	Base Line	6.85
	Clad: MTS-1	6.80
Test Article 4	Base Line	6.96
	Clad: MTS-3	6.48
Range of derived values:***		5.84-6.96

*Note that values can only be calculated for the initial licensee runs. The repeated tests do not report conduit temperature data. Hence, all references here are to the first test of each identified configuration only.
**The initial run of the base line case for Test Article 2 is unavailable due to an apparent oversight in preparation of the UL report. See Section 3.3.2 for further discussion.
***Range excludes Test Article 1 base line test.

This calculation is fully consistent with the UL observation that the initial base line test for Test Article 1 suffered a false-high current reading. This false-high current would overstate the heating rate, and hence understate the thermal resistance factor given that the temperatures were measured correctly. As can be seen the thermal resistance calculation can provide a clear and accurate indication of potential problems in the test data. (It is fully expected that a similar treatment for the Test article 2 initial base line run would reveal a similar effect, and that the same treatment for the repeated base line tests would reveal thermal resistance values far more consistent with the other cited values. Unfortunately, the report does not provide the necessary conduit temperature data for these cases.)

Now consider the same process as applied to the 4" conduit tests. The results for these test items are summarized in Table A.2. The values are again calculated on the same basis; namely, average cable temperature at the center location as reported by UL and the average conduit temperature.

In this case the overall values are much lower indicating a better overall thermal contact between the cables and the conduit. More importantly, as with the 1" case the results are, again, very self-consistent with one notable exception. Within any given test article, the variations are all within a ±4% band. Even comparing between test articles, the variations are all within a ±8% band. The one notable exception is the clad test for Test Article 3. In this one case, the thermal resistance value is approximately 23% lower than the corresponding base line test value. This deviation is much larger than one should anticipate and rivals that of the Test Article 1 and 2, 1" conduit, base line test known to have been a problem. This is a clear indication that a similar problem may have occurred in this test, that is, a false-high ampacity reading may have been obtained.

Table A.2: Summary of Thermal Resistance calculation results generated by SNL for the FPC/UL 4" conduit ampacity results. All values are calculated based on the difference between the average temperature of the cable bundle and the average conduit temperature.		
Test Article	Barrier Configuration	Cable to Conduit Thermal Resistance (°C*ft/W)
Test Article 1	Base Line	1.84
	Clad: 1hr TSI	1.73
	Clad: MPF-60	1.74
Test Article 2	Base Line	1.86
	Clad: 3-hr TSI barrier	1.87
	Clad: MPF-180	1.93
Test Article 3	Base Line	1.86
	Clad: MTS-1*	1.43
Test Article 4	Base Line	1.79
	Clad: MTS-3	1.77
Range of Results:*		1.73-1.93
*The range of results excludes the Test Article 3 clad test.		

The next logical question to ask is how significant the impact might have been. This question can be answered by "working backwards" through this same process. First, we can assume that the measured temperatures are correct. Second, given the relative consistency of the various values we also assume that the measured base line current is correct. Together these two assumptions imply that the calculated thermal resistance between the cables and the conduit during the test article 3 base line test is accurate. Finally, we assume that this thermal resistance value from the base line test can be applied directly to a re-analysis of the corresponding clad test. The question then is to estimate the actual current that should have yielded these test conditions (cable temperature, conduit temperature, thermal resistance, and ampacity). The first step in this process is to calculate the heat flow rate based on the temperature difference and the base line case thermal resistance as follows:

$$Q = \frac{\Delta T}{R_{thermal}} = \frac{86.7 - 75.7}{1.86} = 5.914\ W/ft$$

Based on this heat flow rate we can now estimate the corresponding ampacity based on the number of conductors and the electrical resistance values as follows:

$$I = \sqrt{\frac{Q}{R_{elec} * n_{conductor}}} = \sqrt{\frac{(5.914)}{(5.15E-4)(36)}} = 17.9\ A$$

This then is the "raw" current value we should have anticipated for this test. In order to perform the ampacity derating calculation we must normalize this value to the standard temperature conditions:

$$I' = I\sqrt{\frac{(90-40)(\alpha+T_c)}{(T_c-T_a)(\alpha+90)}} = 17.9\sqrt{\frac{(90-40)(234.5+90.5)}{(90.5-39.0)(234.5+90)}} = 17.6A$$

Finally, the ACF and ADF factors can be estimated using this modified estimate of the clad ampacity in comparison to the measured value of the base line ampacity as follows:

$$ACF = \frac{I_{clad}}{I_{baseline}} = \frac{17.6}{26.4} = 0.667$$

$$ADF = (1.0 - ACF)*100\% = 33.3\%$$

Hence, this exercise has illustrated that the anticipated derating impact should have been on the order of 33.3% versus the value of 23.1% cited in the test report.

One might question the accuracy of this approach. This can be demonstrated by once again returning to the test article 1 and 2, 1" conduit, base line case known to have been compromised by a false-high ampacity measurement. If the same procedure is repeated for the first run of the base line test, the predicted normalized cable ampacity is found as follows[4]:

$$Q = \frac{\Delta T}{R_{thermal}} = \frac{88.2 - 57.1}{5.87} = 5.298\ W/ft$$

$$I = \sqrt{\frac{Q}{R_{elec}*n_{conductor}}} = \sqrt{\frac{(5.298)}{(1.31E-3)(4)}} = 31.8\ A$$

$$I' = I\sqrt{\frac{(90-40)(\alpha+T_c)}{(T_c-T_a)(\alpha+90)}} = 31.8\sqrt{\frac{(90-40)(234.5+90)}{(90.0-39.9)(234.5+90)}} = 31.8A$$

Hence, a "corrected" normalized base line ampacity of 31.8A is predicted as compared to the original value measured for this test of 37.8A. More importantly, the normalized base line current for the repeat test was found to be 32.1A, a value very close to the predicted value 31.8A (less

[4]Thermal resistance was taken as the average of the other two "first run" cases for the Test Article 1, 1" conduit as shown in Table 3.2; namely, the clad test for the 1-hr TSI barrier and the MFP-60 systems.

than 1% error). The minor difference can easily be attributed to (1) the fact that the cables were replaced between tests which would cause a minor change in the thermal conditions and (2) inherent uncertainty.

Given these observations, SNL finds that the clad test ampacity for the 4" conduit protected by the MTS-1 fire barrier system (test article 3) is suspect. The test was likely compromised by a false-high ampacity limit similar to the false-high values obtained in the Test Article 1 and 2, 1" conduit, original base line tests. No other tests appear to have been impacted by a similar problem. This would have resulted in the calculation of a overly optimistic ADF value for this one barrier configuration, the MTS-1 system on a 4" conduit. SNL recommends that this particular test result should not be accepted by the USNRC as representative of the ampacity derating impact of this fire barrier system.

Given the relative consistency of the SNL calculation results, and the very simple nature of the thermal problem being analyzed, SNL has confidence that the cited calculation results represent an accurate estimate of the actual derating impact that should have been measured. Based on the results SNL recommends that under no circumstances should the original cited 23.1% value be applied unless and until an alternate resolution of the SNL concern is provided. However, again based on the self-consistency of the calculations, SNL does recommends that the calculated ADF impact of 33.3% be accepted as an estimate of the fire barrier ADF for this particular barrier system.