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United States Nuclear Regulatory Commission
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Washington, D. C. 20555-0001

Subject: Response to the Request for Additional Information on Cable Ampacity (TAC No. M85542)

Ladies and Gentlemen:

Toledo Edison (TE) received the Nuclear Regulatory Commission's (NRC) October 9, 1996 request for additional information on cable ampacity on October 15, 1996 (TE Log Number 4927). The October 9, 1996 NRC letter requests further clarification and discussion of information provided by a June 26, 1996 Toledo Edison letter (TE Serial Number 2381), which provided an evaluation for the Davis-Besse Nuclear Power Station (DBNPS) of ampacity issues related to Thermo-Lag 330-1 fire barriers. Enclosed is the response to the NRC request for additional information.

As stated in its June 26, 1996 letter, Toledo Edison is proceeding with replacing Thermo-Lag material utilized in existing one-hour and three-hour rated fire barriers and radiant energy shields with an alternate material. These activities are expected to be completed in the fourth quarter of 1998. The evaluation provided in the June 26, 1996 letter concluded that there is adequate margin to accommodate the ampacity derating due to application of Thermo-Lag 330-1, from the time it was installed to the time it is eventually removed, such that the insulation properties of the protected cables are not adversely impacted. This conclusion remains unchanged.

Based on the providing of this additional information, Toledo Edison requests that the NRC issue a safety evaluation to provide concurrence that the Thermo-Lag 330-1 fire barrier ampacity issue has been satisfactorily addressed for the DBNPS by December 30, 1996, so as not to impact Toledo Edison's replacement schedule.

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If you have any questions, please contact Mr. J. L. Freels, Manager - Regulatory Affairs, at (419) 321-8466.

Very truly yours,

John K. Wood
Vice President - Nuclear
Davis-Besse Nuclear Power Station

MKL/laj

Enclosure

cc: A. B. Beach, Regional Administrator, NRC Region III
A. G. Hansen, NRC/NRR DB-1 Project Manager
S. Stasek, NRC Region III, DB-1 Senior Resident Inspector
Utility Radiological Safety Board

RESPONSE TO THE

REQUEST FOR ADDITIONAL INFORMATION

AMPACITY DERATING ISSUES

FOR

DAVIS-BESSE NUCLEAR POWER STATION

UNIT NUMBER 1

This letter is submitted pursuant to 10 CFR 50.54(f). The attachment responds to the October 9, 1996 NRC request for additional information on cable ampacity.

By: [signature]
J. K. Wood, Vice President - Nuclear

Sworn to and subscribed before me this 5th day of November, 1996.

[signature]
Notary Public, State of Ohio
Nora Lynn Flood
My commission expires September 3, 1997.

RESPONSE TO THE

REQUEST FOR ADDITIONAL INFORMATION

AMPACITY DERATING ISSUES

FOR

DAVIS-BESSE NUCLEAR POWER STATION

UNIT NUMBER 1

NRC Request for Information:

1. You properly identified an additional der.·ing factor to account for multiple conductors within the raceway, if applicable, utilizing the appropriate factor provided in the industry standard. However, this derating factor is not applied in actual calculation. If a conduit has three 1/C #2/0 cable with one #4 ground, the total number of conductors in the conduit is four. According to National Electric Code (NEC) or Insulated Cable Engineers Association (ICEA) Standard, a derating factor of 0.8 shall be used in the ampacity determination. This is not the case as shown in Table 1, "Ampacity Derating due to Thermo-Lag," of the subject calculation. The licensee needs to include total number of conductors in each conduit and appropriate derating factors in its calculations. The staff believes that the ampacity of cable will be impacted by the number of conductors inside a conduit. Provide justification for this deviation or provide a revised calculation.

Toledo Edison Response:

1. For cabling in conduit, such as the three 1/C #2/0 power cable with one #4 ground cited above, "base" ampacity values were obtained from IPCEA P-46-426, "Power Cable Ampacities, Volume 1 - Copper Conductors," Table on Page 264, "Triplexed Concentric Stranded Rubber Insulated Cables in Conduit." Since this table provides ampacity values for triplex cable, which contains the same number of current-carrying conductors as the application, use of this table is considered appropriate, and no multiple conductor derating factor is applicable. It is noted that all the cables listed in Table 1 of the June 26, 1996 Toledo Edison letter as being in conduit are triplexed cable.

NRC Request for Information:

2. For cables installed in exposed or enclosed groups of conduits in air, the grouping factors given in Table IX of ICEA Standard P-46-426, "Power Cable Ampacities, Volume I, Copper Conductors," shall be used when the spacing between conduit surfaces is not greater than the conduit diameter or less than 1/4 of the conduit diameter. The calculation did not use conduit grouping factor. Provide a discussion about the use of the conduit grouping factor for applicable DBNPS installations.

Toledo Edison Response:

2. A "conduit grouping factor" is applied for configurations in two locations, both consisting of two conduits in close proximity, enclosed together in a Thermo-Lag fire barrier with an elliptical-shaped cross-section:

Room 114

Cable 1PAC111A in 4" conduit 36007B and cables 1CAC111E and ACAC111D in 2" conduit 36006B are enclosed together for a short distance. The dimensions of the elliptical cross-section are approximately 7" x 12". This is a three-hour-rated configuration.

Cable 1PAC111A supplies power to High Pressure Injection (HPI) Pump 1-1 which is not normally running during normal plant operation. This is a 3-1/C #2/0 (triplexed) power cable with one #4 ground. The baseline ampacity is 204.0 amps. The load current for the pump is 77 amps.

Cables 1CAC111E and ACAC111D are control cables for HPI Pump 1-1. As stated in the June 26, 1996 letter, instrumentation and control circuits typically carry low current in relation to cable size, such that ampacity is not a concern.

As summarized in the June 26, 1996 letter, a 37% barrier derating factor was applied to cable 1PAC111A for this application. This derating factor includes an 18% factor for the three-hour-rated application, an additional 10% factor for added conservatism, plus an additional 9% factor to account for a stacked conduit configuration. The resulting derated cable ampacity is 128.5 amps.

The 9% factor applied for the stacked conduit configuration is analogous to the "conduit grouping factor" cited in the ICEA Standard P-46-426 Table IX, and is conservative when compared to the 6 to 8% derating factor listed in Table IX for a 1 x 2 array of conduits.

Since cable 1PAC111A would only be powered infrequently, and since there is a 51.5 amp margin between the derated cable ampacity and the load current, which represents 25.2% of the baseline ampacity, there is little likelihood of any excessive cable aging phenomenon due to the installation of the Thermo-Lag fire barrier.

It is noted that the June 26, 1996 letter also applied a 37% barrier derating factor for cable 1PAC112A in Room 114. Although this derating factor is conservative, th :able is not in a stacked conduit configuration. The 37% barr...r derating factor was applied to both cables since the cables shared the same ampacity calculation and since the cable 1PAC111A configurat ı was known to be bounding. Even with the added conservatism, cable 1PAC112A has a 78.5 amp margin between the derated cable ampacity and the load current, which represents 38.5% of the baseline amp·ity.

Room 217

Cable 1PBE1401C in 3" conduit 39029C and cable 1PBE1401D in 3" conduit 39028C are enclosed together. The dimensions of the el'.ptical cross-section are approximately 6" x 10". This is a one-half-hour-rated configuration.

Cable 1PBE1401C supplies power for low speed operation of the Containment Air Cooler (CAC) 1-1 fan. This is a 3-1/C #4/0 (triplexed) power cable with one #2 ground. The baseline ampacity is 278.0 amps. The load current for the fan in low speed operation is 76 amps.

Cable 1PBE1401D supplies power for high speed operation of the CAC 1-1 fan. This is a 3-1/C 250 kcmil (triplexed) power cable with one #2 ground. The baseline ampacity is 317.0 amps. The load current for the fan in high speed operation is 181 amps.

There are three installed CAC fans, however, during normal operation, only two CAC fans are operated in high speed to cool the containment atmosphere. The CAC fans selected to be running are chosen so as to even out the running time of each. During accident conditions, the fans are automatically switched to low speed operation. Thus the CAC 1-1 fan motor circuit is not continuously energized.

As summarized in the June 26, 1996 letter, a 30% barrier derating factor was applied to each of these cables for this application. This derating factor included an 11% factor for the one-half-hour -rated application, an additional 10% factor for added conservatism, plus an additional 9% factor to account for a stacked conduit configuration. The resulting derated cable ampacity is 194.6 amps for the low speed cable, and 221.9 amps for the high speed cable.

As noted above, the 9% factor applied for the stacked conduit configuration is analogous to the "conduit grouping factor" cited in the ICEA Standard P-46-426 Table IX, and is conservative when compared to the 6 to 8% derating factor listed in Table IX for a 1 x 2 array of conduits.

It is also important to note that the high speed running current for the fan motor would be somewhat less than the nameplate value of 181 amps assumed in the calculation. The high speed running current for the CAC 1-1 fan motor was recently measured to be approximately 154 amps.

Since low speed cable 1PBE1401C would only be powered infrequently, and since there is a 118.6 amp margin between the derated cable ampacity and the load current, which represents 42.7% of the baseline ampacity, there is little likelihood of any excessive cable aging phenomenon due to the installation of the Thermo-Lag fire barrier.

Since high speed cable 1PBE1401D is not powered full-time, and since there is a 40.9 amp margin between the derated cable ampacity and the load current, which represents 12.9% of the baseline ampacity, there is little likelihood of any excessive cable aging phenomenon due to the installation of the Thermo-Lag fire barrier.

A "conduit grouping factor" would be applicable for a third configuration located in Room 427, consisting of two conduits in close proximity, enclosed together in a Thermo-Lag fire barrier with a rectangular-shaped cross-section. However a portion of these circuits in Room 410, which has an upper range ambient temperature of 61.7°C (143°F), is more limiting due to the required temperature derate which must be applied. The fire barrier derate values reported in Table 1 of the June 26, 1996 letter for cables 3PBEF15A and 3PBEF15B reflect the bounding values for the circuits. Cable 3PBEF15A supplies power for low speed operation of the CAC 1-3 fan. Cable 3PBEF15B supplies power for high speed operation of the CAC 1-3 fan.

<u>NRC Request for Information:</u>

3. Conduit fills in percent should be included in the subject calculation. Justification of cable ampacity needs to be provided if the conduit fill exceeds the value given in NEC tables.

<u>Toledo Edison Response:</u>

3. For cabling installed in conduit, as listed in Table 1 of the June 26, 1996 Toledo Edison letter, the maximum conduit fill is less than 30%. The National Electric Code, 1996, Article 346-6, recommends a conduit fill of less than 40% for more than two conductors, which represents a practical limit for pulling cable in conduit.

NRC Request for Information:

4. It appears that the licensee used the name plate ampere rating as the load current. The nameplate ampere is at rated voltage and rated load. This is acceptable provided the loads are not operating at an overload condition or at a service factor and the rated voltage are maintained at the load terminals. Provide a discussion about the impact of overload conditions or the service factor of the load and voltage availability at the load terminals on the ampacity derating margins.

Toledo Edison Response:

4. Loads are typically not operated at overload conditions. Operating voltages are maintained within a tolerance of +/- 10%. Any overload condition would be a short-term event. Voltage differences would be expected to "even out" in the long-term. The ampacity calculations utilize expected long-term conditions, as is appropriate for addressing what is primarily a cable insulation aging issue.

NRC Request for Information:

5. Explain the technical basis for the margins added as described in Section III.C of this calculation. It should be noted that similar ampacity derating tests for a single enclosure containing multiple conduits were submitted by Tennessee Valley Authority for staff review of Watts Bar fire barriers.

Toledo Edison Response:

5. The technical basis for the calculational margins is discussed separately for one-half-hour and one-hour-rated applications and for three-hour-rated applications. A discussion of other supporting test data is also provided.

   One-Half-Hour and One-Hour-Rated Applications

   For one-half-hour and one-hour-rated applications, the technical basis for the ampacity derating factors is the ampacity derating test program performed for the Texas Utilities Electric Company (TUE) Comanche Peak Steam Electric Station (CPSES) Unit 2 by Omega Point Laboratories. The test results are described in Section III.A of the June 26, 1996 letter.

   The NRC Safety Evaluation Report (SER) for the CPSES Unit 2 required application of an additional 10% factor to the bounding 11% ampacity derating factor, resulting in a total 21% ampacity derating factor, to bound test protocol uncertainties. The SER did not explicitly state a technical justification for the 10% penalty, however this penalty seems reasonable given the considerable expense which would have been involved in re-testing configurations for which test protocol issues could not be resolved to the NRC's satisfaction.

The NRC SER for CPSES Unit 2 also required application of an additional 9% factor, resulting in a total 30% ampacity derating factor for non-standard configurations which were not tested, including a conduit/cable tray configuration. As stated on page 8 of the SER, the 9% penalty was based on analysis performed by Sandia National Laboratories (SNL).

Three-Hour-Rated Applications

For three-hour-rated applications, the technical basis for the ampacity derating factors is the ampacity derating test program performed for the Tennessee Valley Authority (TVA) by Omega Point Laboratories. The test results are described in Section III.B of the June 26, 1996 letter.

Based on discussions with the TVA Staff, in order to support licensing of their Watts Bar Station, TVA applied an additional 5% factor to the bounding 13% ampacity derating factor, resulting in a total 18% ampacity derating factor, to bound various test uncertainties. As stated in Section III.C of the June 26, 1996 letter, Toledo Edison applied an additional 10% factor for additional conservatism, for a total ampacity factor of 28%. In addition, Toledo Edison applied an additional 9% factor, resulting in a total 37% ampacity derating factor, for non-standard configurations which were not tested. The basis for the 10% penalty for standard configurations and the 9% penalty for non-standard configurations is the same as the basis for the one-half-hour and one-hour-rated applications.

Other Supporting Data

The June 26, 1996 letter described specific tests performed for TUE and TVA by Omega Point Laboratories (References 9 and 11 of the June 26, 1996 letter). A review of other available test data provides corroborating evidence as to the conservatism of the ampacity derating factors utilized in the DBNPS ampacity calculations.

An October 18, 1994 NRC letter from Ronaldo Jenkins, Electrical Engineering Branch, Division of Engineering, Office of Nuclear Reactor Regulation, to Alex Marion, Manager, Technical Division, Nuclear Energy Institute, enclosed a copy of an NRC letter to the Chairman of IEEE Task Force 12-45, which details staff concerns with draft IEEE Standard P848, "Procedure for the Determination of the Ampacity Derating of Fire Protected Cables." This letter provides a table summarizing the results of 29 ampacity tests for conduit ranging in size from 3/4" to 5", with Thermo-Lag thicknesses ranging from 1/2" to 1". With respect to this table, the letter notes that the range of test results is relatively small: ampacity correction factors (ACF) range from 0.9 to 1.05. These ampacity correction factors correspond to ampacity derating factors from 10% to -5%. The letter notes that the ACF for many of these tests seems to indicate that adding Thermo-Lag material actually improves heat dissipation. The letter attaches calculations which show that it is plausible that the clad conduit may have a higher ampacity than a bare conduit.

On this basis, the use of a 21% ampacity derating factor for DBNPS one-half hour and one-hour-rated applications, which have a maximum Thermo-Lag thickness of 3/4", appears to be very conservative.

Although the data provided by the October 18, 1994 NRC letter does not seem to indicate a strong correlation between Thermo-Lag thickness and the magnitude of the ampacity derating factor, the maximum thickness of Thermo-Lag included in the test summary was 1", which is less than the 1.5" maximum Thermo-Lag thickness used for DBNPS three-hour-rated applications. The DBNPS does not have access to test data for three-hour-rated thicknesses of Thermo-Lag, other than the TVA test data referred to in the June 26, 1996 letter. However, based on the TVA test data, it is believed that the use of a 28% ampacity derating factor for DBNPS three-hour-rated applications is also very conservative.

Relative to stacked conduit configurations, NUREG-0847 Supplement No. 18, "Safety Evaluation Report related to the operation of Watts Bar Nuclear Plant, Units 1 and 2," dated October 1995, includes a summary of ampacity derating factors for Thermo-Lag-enclosed electrical raceways which were selected by TVA for use at Watts Bar. The ampacity derating values listed in the summary appear to include margin. the summary includes ampacity derating factors of 8% for a 3 x 1 array of 1" conduits in a common 5/8" enclosure, and 26% for a 3 x 2 array of 1" conduits in a common 5/8" enclosure.

Although the above-mentioned Watts Bar stacked conduit configurations have a lower thickness of Thermo-Lag than the DBNPS configurations, the use of a 30% ampacity derating factor for DBNPS one-half-hour and one-hour-rated applications, and the use of a 37% ampacity derating factor for DBNPS three-hour-rated applications, again appears to be conservative.