[x] Safety-Related [ ] Non-Safety-Related

Client: Commonwealth Edison Company	Prepared by	Date
Project: Byron/Braidwood	Reviewed by	Date
Proj.No. 4391/2 & 4683/4	Approved by	Date 8/3/85

Purpose

The purpose of this calculation is to demonstrate that it is acceptable for a safety-related cable(s) routed in free-air to come in contact with a raceway containing a non-safety-related cable (s) and for a non-safety-related cable in free-air to come in contact with a raceway containing a safety-related cable(s). The calculation will demonstrate that safety-related circuits will not be degraded below an acceptable level by the presence of the non-safety-related circuit.

Reference

Ref. #

1. Wyle Laboratories Test Procedure No. 17769-1, "Electrical Separation Verification Testing for Sargent & Lundy (S&L) Engineers and Commonwealth Edison Company for use in Illinois Power Company's Clinton Nuclear Generating Station and Commonwealth Edison Company's Byron and Braidwood Nuclear Generating Stations" Revision 1

2. Wyle Laboratories letter G. F. Hauer to J. D. Regan (S&L) dated July 29, 1985

Sargent & Lundy Specifications

3. - F/L-2823, 600V Power and Control Cable

4. - F/L-2851, 5kV and 8kV Power Cable

5. - F/L-2852, Instrumentation Cable

Sargent & Lundy Component Qualification Division (CQD) Binders

6. - CQD Binder EQ-BB031, Okonite 600V Power and Control Cable

7. - CQD Binder EQ-BB033, Samual Moore Intrumentation Cable

8. - CQD Binder EQ-BB03007, Okonite 5 & 8kV Power Cable

Methodology

This calculation will demonstrate that fire or failure resulting from (a) an electrical fault induced in a non-safety-related cable routed within a raceway will not cause electrical failure of safety-related cable(s) which are routed in free-air and come in contact with the non-safety-related raceway and (b) an electrical fault induced in a non-safety-related cable in free-air will not cause electrical failure of safety-related cable(s) which are routed in a raceway which comes in contact with the non-safety-related cable. The calculation will be based on the actual results of a test performed to justify the electrical separation.

The cable failures which will be addressed in the establishment of separation distances in this calculation are those which will be induced by an electrical fault within the non-safety-related cable only. Cable failures which may result from design basis events external to the cable, such as those resulting from externally generated fires, high energy line break, moderate energy line break, flooding, etc., are addressed in separate analyses. The presence of the non-safety-related raceway (or cable) does not increase the vulnerability of the safety-related raceway (or cable) during any hazardous event external to the non-safety-related raceway (or cable) because if the event would affect the safety-related raceway (or cable) it would affect it to the same degree if the non-safety-related raceway (or cable) was not nearby.

Voltage Transients

All instrumentation cable furnished under the instrumentation cable specification for use in both safety-related and non-safety-related applications is rated for 600 volts with insulation tested to a minimum of 1500 volts with a tough overall protective jacket (Ref. 5 and 7). Instrumentation cable furnished under other specifications must be manufactured in accordance with Commonwealth Edison (CECo) Standard EM-2912D which requires that the insulation shall be rated at 600V. Instrumentation cables are applied in circuits with a system voltage of less than 30 volts. Therefore, there is a conservative design margin to assure adequate isolation from voltage transients in the non-safety-related circuit from adversely affecting a safety-related circuit.

All power and control cable used in both safety-related and non-safety-related circuits has been furnished under S&L specifications and must be manufactured in accordance with Commonwealth Edison Standards EM-29105, EM-29115, EM-29116 or EM-29150 for 600V power, 600V control, 5kV power, and 8kV control respectively. Control cables are applied in circuits with a system voltage of either 120Vac or 125Vdc. Low voltage power cables are applied in circuits with a system voltage of 480Vac. Control and low voltage power cables are required by S&L Specification F/L-2823 and CECo standards to have insulation rated at 600V. The cable is also tested to show that it can withstand voltage transients up to 1500V. Medium voltage power cables are applied in circuits with system voltages of 4160V or 6900V. These are required by S&L Specification F/L-2851 and CECo standards to have insulation rated at 5kV and 8kV respectively. The cable is also tested to show that it can withstand voltage transients of up to 16kV and 22kV respectively. Therefore, there is a conservative design margin in the cable to assure adequate isolation from voltage transients in the non-safety-related circuit from adversely affecting a safety-related circuit.

Current Transients

An actual cable separation verification test will be used to justify that an electrical fault induced by a current transient in a non-safety-related cable will not degrade a safety-related cable below an acceptable level. The procedure for the verification is described in Wyle Laboratories Test Procedure No. 17769-1, "Electrical Cable Separation Verification Testing for Sargent & Lundy and Commonwealth Edison Comapny For Use In Illinolis Power Company's Clinton Nuclear Generating Station and Commonwealth Edison Company's Byron and Braidwood Nuclear Generating Stations".

Two configurations were run during this verification test (1) safety-related cables in free-air in contact with a raceway containing a non-safety-related cable and (2) a non-safety-related cable in free-air in contact with a raceway containing safety-related cables. The type of cable which was used in this test was furnished under S&L Byron/Braidwood Specifications F/L-2823 and F/L-2851 and was shipped from Braidwood Station's inventory. The cable is representative of cable installed at both Byron and Braidwood Stations.

In order to address the most conservative interface between safety-related and non-safety-related cables, a 3/C-500MCM cable was chosen as the cable to be faulted (to represent the non-safety-related cable) and a single pair #16 AWG cable was chosen as the target cable (to represent the safety-related cable). A 500 MCM cable was chosen because it would generate more heat than smaller cables and due to its size, it would also require more time before it open-circuits. Therefore, it would be subjecting neighboring cables to more heat for a greater length of time than smaller cables would.

For the purpose of the verification test it was assumed that the circuit breaker feeding the overloaded cable fails to trip and the overload will persist on the cable.

The fault current which was considered the most credible severe overload condition which the cable may see during plant operation is that resulting from a motor failing to start but continuing to draw locked rotor current. The actual current values were selected from the largest motor which is fed with a 500MCM 600V cable at Byron or Braidwood Station. This motor is a 250Hp motor with a locked rotor current of approximately 1700A. If one considers the voltage drop, of approximately 80%, which would occur as a result of the stalled motor, the actual current which would be seen by the cable is approximately 1300A. The overcurrent test therefore consisted of energizing the 500MCM cable to 1300A for one hour and then 1700A until the cable open circuited. The two step overcurrent test was selected in order to simulate a worst case condition by energizing the cables with a fault current which would cause the cable to generate considerable heat but would not cause an open circuit, and then jump the fault current to a value which would eventually open circuit the cable. The one hour time limit on the 1300A portion of the test was considered conservative since a stalled motor would be alarmed and deenergized prior to one hour or the motor windings would short together and result in a full short circuit which would be of such a magnitude that it would be interrupted by upstream breakers.

The target cables (representing safety-related cables) were energized continually during the test. The current and voltage on these cables were monitored and recorded throughout the test. The target cables were also subjected to pre and post functional tests which consisted of insulation resistance and high potential withstand tests.

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Reviewed by Date
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Analysis of Test Results:

The results of the test run according to Wyle Laboratories Test Procedure No. 17769-1 indicate that all of the target cables maintained integrity to conduct specified current and voltage before, during and after the fault specimen was subjected to the overload current. Wyle Laboratories letter G. E. Hauer to J. D. Regan (S&L) dated July 29, 1985 certifies that the verification test was run in accordance with the test procedure and that the test requirements were successfully met. The verification test was witnessed by J. D. Regan and T. M. McCauley of Sargent & Lundy.

The currents which were chosen as test values were proven to be conservative in the test. The temperatures which were measured on the faulted cable indicate that the cable temperature was beginning to stabilize on the 1300A portion of the test at the end of one hour. The 1700A portion of the test subjected the target cables to an extremely harsh condition since the faulted cable remained intact and continued to generate large amounts of heat for at least 1 ½ hr prior to open circuiting. Although the faulted cable did ignite during the overcurrent test for each configuration, the flames were small and self-extinguished without impacting the target cables.

The test setup for the configuration of a cable in free-air in contact with a faulted cable in a conduit also provided a conservative condition since the conductors within the 500MCM were connected in series when energized with the fault current thus creating an unbalanced condition within the cable. This current imbalance resulted in an eddy current developing around the cable. This current heated the conduit such that the conduit was actually at a higher temperature than the faulted cable for a portion of the tests. This condition exposed the target cables to a harsher condition than they would normally see in the plant.

The length of time for which each of the faulted cables were energized with the overload current is also very conservative. As stated previously, the overload current value was selected because it was representative of the current which a stalled motor may draw. This was considered the most credible cause of a sustained overload current. However, the windings on the motor would eventually short together and result in a full short circuit which would be of a high enough magnitude to trip upstream circuit breakers even if one assumes the primary breaker fails. The test

also indicated that the faulted cable would generate large amounts of smoke when it is subjected to an overload current. This smoke would be sensed by the ionization smoke detectors which are mounted in each of the areas of the plant which contain safety-related equipment or cables. A fire/smoke alarm would result in station personnel being dispatched to the area and actions taken to interrupt the faulted condition. Therefore, it is very unlikely that a cable would be subjected to an overload for any sustained length of time.

This cable separation verification test has demonstrated that current transients within the non-safety related cable will not prevent the safety-related cable from performing its safety-related function.

Environmental Qualification and Fire Retardant Characteristics

Power, control and instrumentation cable used in both safety related and non-safety related circuits, has been environmentlly qualified to the requirements of IEEE 383-1974, including tests to assure that it is fire retardant and will not propagate a fire. (Ref. 6, 7, and 8).

Conclusion

Based on the above calculation/analysis, it can be seen that it is acceptable for (a) safety-related cable(s) in free-air to come in contact with a raceway containing non-safety related cable(s) and (b) non-safety related cable in free-air to come in contact with a raceway containing safety-related cables. This analysis has demonstrated that safety-related cables will not be degraded below an acceptable level due to the reduced separation. This calculation/analysis is in accordance with Byron/Braidwood commitment to Regulatory Guide 1.75 as documented in Byron/Braidwood FSAR Appendix A.

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

July 29, 1985

Reference No. 17769H-004

SARGENT & LUNDY
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JUL 30 1985

RECEIVED

Sargent & Lundy Engineers
55 East Monroe Street
Chicago, IL 60603

Attention: Mr. John Regan

Subject: Electrical Cable Separation Verification Testing for Sargent & Lundy Engineers and Commonwealth Edison Company for use in Illinois Power Company's Clinton Nuclear Generating Station and Commonwealth Edison Company's Byron and Braidwood Nuclear Generating Stations

Reference: Wyle Laboratories' Test Procedure No. 17769-1 as modified by Interim Procedure Revision 1 of July 24, 1985

Gentlemen:

Wyle Laboratories certifies that the subject testing has been completed in accordance with the referenced test procedure and that all test requirements were successfully met. A final test report will be issued within three weeks describing the requirements, procedures, results, and conclusions of the test program.

Enclosed are two videotapes for the subject tests.

Should you have any questions or require additional information, please contact the undersigned.

Sincerely,

WYLE LABORATORIES
Eastern Operations

George E. Hauer,
Senior Contracts Administrator

GEH/dem

Enclosures

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