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ACCESSION NBR:8505060381 DOC.DATE: 85/04/30 NOTARIZED: NO DOCKET #
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SUBJECT: Forwards summaries of test repts & analyses from GE design record files.Tests & analyses furnished as addl response to NRC Question 421.47 & Confirmatory Item 21.

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NIAGARA MOHAWK

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April 30, 1985
(NMP2L 0395)

Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Schwencer:

Re: Nine Mile Point Unit 2
Docket No. 50-410

Attached are summaries of test reports and analyses from General Electric design record files. These tests and analyses have been used to justify lesser separation than that recommended in Regulatory Guide 1.75 and IEEE 384. This is furnished as additional information to Nuclear Regulatory Commission Question 421.47 and confirmatory item 21.

Very truly yours,

CVMangan
C. V. Mangan
Vice President
Nuclear Engineering & Licensing

DS:mf
Attachment
xc: R. A. Gramm, NRC Resident Inspector
Project File (2)

B001
1/1

PGCC SEPARATION:

1.0 Common Devices: Relays and Contactors

1.1 Device Type

a. Relay - Agastat - PPD #164C5258P001

b. Contactor - GE Type CR205 - PPD #164C5651P001

1.2 Summary of Test Report

The test was conducted to demonstrate the separation characteristics of the devices under a fire environment. The coil and normally open contacts of the devices tested were monitored with the chatter detector to detect time discontinuity values in excess of 10 milliseconds throughout the test.

The test fire of approximately 10,000 BTU was created. The temperature was monitored/observed at the bottom and top of each device under test with thermocouples. Temperatures of the device and the fire were recorded. The test was continued until the devices were rendered non-functional by charring and dripping of the relay material or until the fire was exhausted at approximately 11 minutes into the test.

Assumption

A test failure consists of open, short or ground. Deformation was not considered a failure unless coil-to-contact, or contact to contact shorting occurs. Discoloration was not considered a failure.

1.3 Conclusion

A shorting/open did not occur for either coil to contact or contact to contact circuits.

1.3.1 Contactor operated normally before, during and after the fire test.

1.3.2 The Agastat relay was rendered completely non-functional by the fire environment because at approximately 4 minutes into the test the relay core was ignited and contributed to the environment by dripping. However, none of the contacts of the relay shorted to each other or to the coil circuit. Therefore, divisional circuit integrity was maintained within the relay.

1.4 Reference Document

GE Fire Test Report DRF #A42-14(6)

2.0 Sil-Temp tape as a separation barrier.

2.1 Material of the Tape

Sil-Temp tape or sleeving (Haveg Industries).

2.2 Summary of Test Report

A short circuit test was conducted on electrical wires using Sil-Temp tape as a separation barrier to demonstrate the adequacy of separation

characteristics. One pair (short circuit pair) of wires was wrapped with the Sil-Temp tape. A second (rated conductor) pair of wires was laid in contact with the tape. Thermocouples were installed to monitor the temperature of both pair of wires and ambient temperature. The power supply providing short circuit current was monitored. The rated current was applied to the rated current conductor pair. The short circuit current in the short circuit conductor pair was steadily increased until the cable pair failed. Failure was achieved in less than one minute. Flames were observed only on exposed insulation of the short circuit pair for 20 seconds only. However, some smoke was observed at the barrier, but no flame. At the point of failure the current was immediately removed from both pairs and the wires removed from the test fixture and visually examined for signs of deterioration or deformation. An insulation resistance test was then performed on the rated current conductor pair.

The rated current was allowed to flow without interruption in the rated current conductor pair during the test duration. There was no visible damage noted to the isolation barrier (Sil-Temp tape) material other than discoloration. There was no visible damage noted to tie-raps, and glass electrical tape other than discoloration in the area of high temperature.

2.3 Conclusion

The tests demonstrated that the tape has an ability to prevent propagation of damage between circuits under maximum short circuit and neighboring rated current circuits. Thus the Sil-Temp tape provides adequate thermal and electrical insulation to preclude propagation of damage between two redundant circuits or 1E and non-1E circuits.

2.4 Reference Document

Wyle Lab, Report No. 56719, GE DRF A00-01511-2

3.0 Flexible or rigid steel conduit as a separation barrier (test and analysis)

3.1a. Summary of Test Report

A test was conducted with the parameters enveloping the worst case fault condition and resulting thermal gain. Two flexible steel conduits, one filled with single pair #10 AWG stranded wire and the second conduit filled with 5 pair of #10 AWG wire were used. The second conduit was located immediately adjacent to the first conduit using Tefzel and Nylon cable ties. Both conduits were terminated at the module steel enclosure with the wires looped into the enclosure and resting upon the side of the enclosure. Some wires were fastened to the outside of the conduit touching the metal surface. One pair of the 5 pairs was connected to a power supply. The single pair was connected to a power source and monitored for continuity. Six thermocouples were installed inside and outside of the one pair and five pair conduits at different places to monitor the temperature. The thermocouples and single pair wiring were connected to data recorders for monitoring temperature, continuity and short circuits. DC current in the single pair was applied starting at zero amperes and manually increased in discrete steps up to 140 amperes. Temperature, circuit continuity and shorts were monitored during the entire test. The entire test sequence was terminated at 360 seconds due to melting of the #10 AWG wire in the single pair conduit which severed the DC input current source. During the test at 180 seconds smoke was emitted from the module enclosure which houses the single pair leads and at 280 seconds the insulation on the single pair circuit wires external from the conduit and between the input DC current connection and the conduit began to smoke and melt. All the tie-wraps remained intact and were not affected by the heat rise of the conduit. There were no discontinuities or shorts of the monitored circuits observed during the test sequence, except opening of the input DC current lead wire. The entire test sequence was terminated at 360 seconds.

b. Summary of Analysis

The heating effect due to a fault from an internal conductor to the inside of the flexible conduit is analyzed below:

1. By providing redundant circuit protection to non-1E circuits and by grounding the conduit at every thirty feet, the damaging fault will be cleared without degrading the adjacent essential circuits.

2. A normal low impedance short circuit in the conduit will cause a fuse or a breaker to operate quickly to clear the fault, and it will not cause significant heating. The chances of having a medium impedance fault are remote at 125 volts and below, since the shorted conductor will either weld itself to ground or clear itself. Nevertheless, the worst case medium impedance has been investigated and found to present no threat to divisional circuits.

   Measurements of temperature rise of conductors within a conduit caused by the overheating of external conductors in a flex conduit show that the heating effects are minimal.

3. Ampacity calculations were performed for PGCC floor section cable ducts to determine the maximum long term current required to raise the conduit temperature to the maximum fault temperature rating of the insulation. The calculated current is 57 amps. At 57 amps, a 30 amp breaker will clear a fault in approximately 120 seconds and a 30 amp fuse will melt in approximately 3 seconds.

   As confirmation of the long term heat flow calculations, the temperature rise was also calculated assuming that all heat is

retained, i.e., no heat transfer. This method of calculation using the definition of specific heat is widely used for short term (3 or 4 seconds) fault heating calculations. The method is very conservative for the 120 second opening time of the breaker because it is not possible to actually retain all the heat generated by the conductors in question. Calculating the temperature rise with no heat transfer from the conduit gives a final temperature of 125°C, which is far below the maximum overload temperature rating of Tefzel or Vulkene insulation. Thus it is demonstrated that the test condition represented the worst postulated case with regard to thermal damage potential to the wiring in contact with the conduit.

3.2 Conclusion

The test evidence demonstrates that the electrical short circuit in a #10 AWG, tefzel insulated wire circuit, supported by a continuous source of DC current of at least 140 amperes, within a flexible steel conduit, cannot cause an electrical fire of sufficient magnitude to cause thermal energy migration through a flexible steel conduit barrier, since the wiring which is generating the thermal energy supply to the separation barrier melts apart and becomes an open circuit before damage can occur to the separation barrier.

An internal fault will be cleared without overheating adjacent wires/cables.

3.3 Reference Document

a. Test report

GE DRF #A00-00794-(6)

b. Analysis

GE DRF A42-53 (12)

4.0 Smoke Detectors

Justification of less than 6" separation between smoke detector, its wiring and Class 1E wiring.

4.1 Summary of Evaluation

As far as possible, a 6" air space has been maintained between smoke detectors and Class-1E wiring. However, in certain unavoidable cases, less than 6" separation is provided. This exception is justifiable since smoke detectors uses low power (24 Vdc, 100 microamperes maximum standby condition), which is a very low energy circuit and does not have enough power to generate sufficient heat for a potential fire. Thus, the detector does not have a damage potential that may degrade the nearby divisional circuit. Therefore, separation of less than 6" from the smoke detectors to the Class 1E circuits are acceptable.

4.2 Conclusion

A less than 6" separation between smoke detectors and class 1E circuits is acceptable since smoke detector circuits are low energy circuits and do not have enough power to generate sufficient thermal energy to cause any damage.

4.3 Reference Document

General Electric Design Record File A00-01511-1

5.0 Exemption to R.G. 1.75 for NMS Panels P606, P608 and P633.

5.1 Summary of Analysis

Some of the neutron monitoring system (NMS) and process radiation monitoring system (PRMS) wiring is not designed to conform to the literal separation guidelines of R.G. 1.75. These portions of the NMS and PRMS (panels P606, P608 and P633) are acceptable since they meet the single failure criteria of IEEE Standard 279 as follows.

Single Failure in the NMS and PRMS Panels

The layout of the panels and the assignments of specific RPS trip logic channels provide the designs with the required tolerance to postulated single failures. The analysis demonstrates that the consequences of any single design-basis failure event in a safety-related portion of the systems can be tolerated without the loss of any safety function.

Following summarizes the bay assignments:

Panel #	Bay	APRM Ch.	IRM Ch.	Log Rad Mon.
H13-P606	1	-	A,E	A
	2	-	C,G	C
H13-P608	1	F	-	-
	2	D	-	-
	3	B,A*	-	-
	4	C	-	-
	5	E	-	-
H13-P633	1	-	B,F	B
	2	-	D,H	D

*APRM Channels A&B are arranged in subdivided bay with a barrier.

Adequate separation in the NMS and PRMS panels is achieved by using the bay design, using relay coil-to-contact separation, and by separation between divisions/channels/wiring.

Circuits that provide inputs to different channels of RPS are physically separated by air gaps or by the walls between the bays.

The worst-case single failure would be the loss of any combination of trip signals within one bay of any panel. However, the loss of any bay and its associated wiring would neither cause nor prevent a scram. A valid scram signal would be transmitted via the other bays because of the redundancy in the panel design and the interconnections to the RPS.

Common Associated Circuit Interfaces

Nonessential (associated) circuits to common information equipment are current limited and protected such that their failure cannot jeopardize an adjacent circuit.

5.3 Conclusion

The exception to R.G. 1.75 for NMS Panels P606, P608 and P633 is acceptable since these systems are designed to meet the IEEE Standard 279, single failure criteria, on a system level basis.

5.4 Reference Documents

1. Single Failure Analysis for the NMS and PRMS for NMP2 by J. Leahy, October 1974; GE DRF A00-01511-2.

2. Analysis Summary to Justify Separation Design of NMP2 Panels P606, P608 and P633. EDT SLO 00013. GE DRF A00-01511-2.

6.0 Justification of Running Bare Cable Wire Along with a Conduit

The PGCC separation configuration of wiring touching (e.g., fastened and in contact with) a conduit is encompassed by the test configuration described in Item 3 above (flexible or rigid steel conduit as a separation barrier). The adjacent wire fastened to the outside of the conduit was monitored during the test. The test demonstrated that the adjacent wiring was protected by the conduit barrier from the damaging effects of faults within the conduit.

6.1 Reference Document

GE DRF #A00-00794-(6).

7.0 Justification of Separation of Less than 1" between enclosed raceway and barriers (e.g., flexible or rigid steel conduits)

For detail discussion on demonstration of acceptability see Item 3.0 above (Flexible or Rigid Steel Conduit as a Separation Barrier).

8.0 Vendor Supplied equipment that does not meet Color Code Requirements

8.1 Analysis

Divisionality of the wiring is adequately identified by incoming wires/cables, thus certain prewired subassemblies supplied by the vendor do not have to meet color coding for separation purposes. Since the cable interfacing these devices are identified no need exists for additional identification.

8.2 Conclusion

This is not a separation exception. However, since interfacing cables/wires are adequately identified to establish the point of change of classification, no additional color coding is required.

8.3 Reference Document

FDDR KG-2303

9.0 Cable Connector Housing as an Acceptable Separation Barrier

9.1 Summary of Justification

The use of a metallic connector body as a barrier between divisional/nondivisional and sub-divisional separation inside panels to supplement an air space of one-inch minimum, is functionally adequate. The function of the barrier in these cases is to provide the equivalent of six-inch minimum total air space including the air space that actually exists. It is not required to act as a barrier for external exposure fires but simply to preclude propagation of damage to, or from, wires contained within the connector in the event of a short circuit. The heavy aluminum connector body could not be heated sufficiently by internal or by adjacent circuit overheating to cause loss of structural integrity of the connector because of circuit fuse protection.

The polychloroprene sleeve (part of the connector body clamp) will not pose any threat because the polychloroprene sleeve is self extinguishing.

9.2 Conclusion

Based on the above discussion, a metallic cable connector is an adequate separation barrier.

10.0 Utility Wiring

Justification of less than 6" separation between utility devices, its wiring and Class 1E circuits.

10.1 Summary of Evaluation

As far as possible, 6" separation has been maintained between utility circuit and Class 1E wiring. However, in certain unavoidable cases a minimum 2" separation has been provided. This condition is evaluated as follows:

- Utility wiring is run in conduit up to the light fixture.
- Utility circuit is protected by double overcurrent protection devices (fuse or/and circuit breaker combination) which will open to isolate the circuit under a fault condition.
- The light fixture does not contain combustible materials which can generate a fire by itself.
- The utility light is normally off and turned on only while the panel is open for test and/or maintenance purposes.
- Only a single divisional device/wiring is allowed in proximity with the utility fixture. This further reduces the risk of any damage potential to the plant safety function.
- The potential heat generation by a typical utility light is not sufficient enough to raise the ambient temperature to cause any damage to the nearby wiring/devices.

10.2 Conclusion

Based on the above evaluation it is concluded that the utility fixture within 6" of the divisional device/wiring will not jeopardize the divisional circuit.

10.3 Reference Documents

General Electric Design Record File A00-01511-1.

11.0 Non Class 1E devices connected to Class 1E Power Supply

11.1 Summary of Evaluation

The non-Class 1E devices connected to a Class 1E power supply or connected to Class 1E equipment and not isolated per R.G. 1.75 were analyzed in accordance with IEEE Standard 352-1975.

The non-Class 1E devices to be analyzed were identified by a study of Elementary Diagrams and Elementary Drawing Device Lists for all safety systems in the GE scope of supply. Those non-Class 1E devices connected to Class 1E power supplies, without acceptable isolating devices, were listed together with their Purchased Part Drawings (PPD). Each PPD was then checked to see if the device is Nuclear Safety Related (meets all requirements for Class 1E applications). Devices qualified for Class 1E applications were then removed from the list of non-1E devices to be analyzed. Devices connected to a Class 1E power supply during testing or maintenance only (not during normal plant operations) were also removed from the list.

Each non-Class 1E device was then analyzed to determine whether a component or mechanical connection could credibly fail and provide a ground path for the Class 1E power supply. A consequence analysis was performed if it could not be credibly demonstrated that the non-Class 1E device would not degrade the 1E power supply. The consequence analysis assessed the effects of a non-Class 1E device failure upon its Class 1E power supply, other Class 1E devices connected to the same power supply, and Class 1E or safety related functions. A worst case single failure was also assumed.

The analyses were based on IEEE Standard 352 "Guide for Reliability Analysis of Nuclear Power Generating Station Protection Systems." In accordance with the standard, Failure Mode and Effects Analyses (FMEA) were performed to define and provide a detailed evaluation of failures of each non-Class 1E device which has the potential to

adversely affect the Class 1E power source or the function of Class 1E devices that are also powered by the same source.

The acceptance criteria was defined to determine failure modes which affect the Class 1E power supply. The FMEA evaluated all device failure modes and addressed only those that have the potential for adversely affecting the Class 1E bus. The FMEA excluded detailed evaluation of open-circuit or instrument-drift failure modes because these modes would not adversely affect a Class 1E bus. The FMEA also excluded failure mechanisms that are not intrinsic to the device (e.g., operator error, environmental stress loads that exceed those specified for the location, fire, flooding, and sabotage). The function of the non-Class 1E device was not a concern of the analyses.

A failure rate was then assigned to the identified failures. Mil Handbook 217D, IEEE Standard 500 and manufacturer and industry data provided the basis to establish these electrical component failure rates.

The non-1E devices were evaluated on the basis of the FMEA to see that:

1. The failure of the non-Class 1E device will not degrade the Class 1E power supply such that Class 1E devices connected to that bus are degraded.

2. A safety related function is not degraded.

3. The consequences of the non-Class 1E device failure combined with the worst postulated single failure are acceptable.

11.2 Conclusion

All devices thus analyzed were confirmed to have no credible failure mode that would adversely affect the Class 1E power supplies, connected Class 1E devices, or any safety function.

11.3 Reference Document

GE DAL-17