Georgia Power Company
Post Office Box 282
Waynesboro, Georgia 30830
Telephone 404 554-9961
404 724-8114

Southern Company Services, Inc.
Post Office Box 2625
Birmingham, Alabama 35202
Telephone 205 870-6011

Vogtle Project

June 16, 1988

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

File: X7BC35
Log: GN-1459

PLANT VOGTLE - UNITS 1 & 2
NRC DOCKETS 50-424, 50-425
OPERATING LICENSE NPF-68, CONSTRUCTION PERMIT CPPR-109
ELECTRICAL SEPARATION CRITERIA

Reference: Letter GN-1434 from J. A. Bailey to NRC, dated March 14, 1988

Gentlemen:

In the referenced letter, Georgia Power Company informed the NRC of proposed changes to the FSAR establishing reduced separation distances for cable and raceway configurations not previously tested or analyzed. These reduced separation distances are based on testing conducted by the same laboratory and in accordance with the same criteria as the previous tests conducted in May 1986, and approved in SSER 4.

Attachment A to this letter provides our written response to your questions which were discussed in the May 25, 1988, telephone conference call on this subject. These questions concerned worst case orientation, peak temperatures, and insulation resistance.

Also mentioned were certain minor corrections and clarifications to be made to the proposed FSAR page changes submitted in the referenced letter. Attachment B to this letter provides these changes, as well as brief explanations or justifications for the changes.

Should you have any further questions, please advise.

Sincerely,

J. A. Bailey

J. A. Bailey
Project Licensing Manager

JAB/wkl
Attachments

B021
1/1

xc: NRC Regional Administrator
NRC Resident Inspector
P. D. Rice
L. T. Gucwa
R. A. Thomas
J. E. Joiner, Esquire
J. B. Hopkins (2)
G. Bockhold, Jr.
R. Goddard, Esquire
B. W. Churchill, Esquire
R. W. McManus
Vogtle Project File

ATTACHMENT A

RESPONSE TO NRC QUESTIONS

ATTACHMENT A

Responses to NRC Questions

Note: References to "Attachments" refer to attachments to letter GN-1434 dated March 14, 1988

1. **In many cases, the tested configuration involved a fault cable located only vertically below the target cables, yet the separation distance criteria allows the cables to be located horizontally at the same distance. Please clarify.**

   During the selection of the test configurations, the project attempted to select arrangements that are the most conservative and that would best envelope the conditions that could exist in the field. Typically, this resulted in placing the fault cable directly below the selected target cables such that the convective heat from the faulted cable would directly impinge on the target cables. This is considered the worst case condition and would envelope any other target location relative to the fault cable at the given separation distance. This consideration is documented in FSAR Table 8.3.1-4, sheet 1, note b.

2. **With regard to Attachment B, page 1, the tested separation distance is shown as 3/4" vertical and horizontal for configuration 1, test 1 (test 1/2). The associated test report (Attachment C) shows that the tested configuration was only in a vertical direction. Please clarify.**

   We believe your concern arises due to the fact that Attachment B inadvertently included the word "Tested" in the fourth column title on page 1. The intent of this column in Attachment B is to describe the required separation distance as a result of the test, not to describe the tested condition itself. The columns are correctly titled on Attachment B, page 2.

3. **With regard to Attachment C, test 4/2 has a conduit crossing free air cables at a 27° angle. How is this test configuration implemented in the field?**

   Field conditions typically have raceways installed in essentially perpendicular or parallel configurations. The test configuration was selected to envelope expected variations in the relative position of cables and raceways. A minimum angle limit of 30° has been imposed as indicated in FSAR Table 8.3.1-4, paragraph 15. Testing was conducted at 27° to provide margin beyond specified requirements. Presently, the Construction Specification does not allow the use of this relaxed criteria (free air cables touching conduits) however, it is available as a basis for Engineering to accept as built conditions that do not otherwise satisfy the present Construction Specification requirements in X3AR01-E8, Attachment B.

If raceways/cables were found to exist in the plant at relative angles less than 30°, the project would revert back to the separation criteria for cables/raceways that are parallel with each other (e.g. FSAR Table 8.3.1-4, paragraph 5).

4. **In Attachment C, test 4/3 has temperature measurements indicating that the peak temperature of the fault conduit (316 °F) is lower than the peak temperature of the free air target cable (332 °F) that is in contact with the fault conduit. This does not seem possible. Please clarify.**

   As documented in Attachment C, Section VI, various quantities of thermocouples (T/Cs) are installed on the fault cables, target cables, fault conduits, target conduits and on other locations as appropriate (within the limits of the test facility). These T/Cs are allocated to locations in proportion to their criticality. The T/Cs are then approximately evenly spaced along the length of the test specimen. This results in some locations being more closely monitored than others.

   This condition can lead to the condition identified in the question. The following table portrays the T/C arrangement for test 4/3:

Fault Cable		Fault Conduit		Free Air Target Cable	
# T/Cs	Spacing	# T/Cs	Spacing	# T/Cs	Spacing
8	16"	3	36"	8	12"

   As can be seen by this table, the target cable temperature is monitored on 12" centers whereas the fault conduit is monitored on 36" centers. This allows the possibility that the target cable temperature is monitored closer to the hottest point on the fault cable (such as the point of short circuit in the fault cable). The result would be that the measured temperature of the hottest spot on the target cable is higher than the measured temperature of the hottest spot on the fault conduit, such as is the case in this instance.

   It should be noted that the target cable is exposed to the fault cable over the entire length of the test specimen (to the extent possible or as appropriate for the physical configuration) and is therefore subjected to whatever degradation may result from the worst case temperature location. The post overcurrent electrical tests are imposed on the entire length of the target cable thus detecting any unacceptable degradation of the target cable. Therefore, the possibility that the T/C location on the fault cable may not be precisely located to measure the hottest spot on the fault cable or its associated raceway does not affect the results of the test.

5. **During a review of the insulation resistance test data, it was noticed that there seems to be a rather wide variation (as much as three orders of magnitude) in the values obtained, even for the same cable types. Please clarify why this occurs.**

The cables used in the separation test program were the same types of fully qualified class 1E cables used at the plant. Therefore the cause of the IR variation is not considered to be attributable to any defects or variation in the cable insulation itself.

There are several possible reasons for variations in the readings.

Although no records of lab humidity were kept, the potential effects of humidity, temperature, and other environmental factors on the test results is an industry-recognized consideration in the interpretation of insulation resistance test results.[1] The effects of temperature on IR readings is a well defined parameter.[2] However, the effects of humidity are highly variable and difficult to quantify. If the measurements are taken with the equipment below the dew point, the possibility of moisture condensation on the cable insulation or megohmmeter test leads can have an effect on the readings.[3]

1/ "Electrical Equipment Testing and Maintenance" by A. S. Gill, Copyright 1982. Pages 16 and 17. (The author is currently a member of the Nuclear Regulatory Commission staff.)

2/ Ibid, page 150.

3/ "A Stitch in Time...", A Manual on Electrical Insulation Testing by Biddle Instruments, Manufacturer of Electrical Testing and Precision Measuring Instruments, Copyright 1982. Page 30.

A third potential factor for the IR variation is partial contamination of the test leads or exposed portions of the cable insulation.[4] This surface contamination, possibly in conjunction with the presence of moisture condensation from the atmosphere, provides a leakage path resulting in lower IR readings. At the high levels of resistance being measured in the test (>1000 megohms at 1000 volts dc), slight leakage paths can have significant effects on the measurements.

Further corroboration of these factors effects on IR measurements is provided by IEEE Standard 43-1974, page 8. Although this standard is specifically for the testing of rotating machinery, the concepts regarding IR measurements are considered valid for other equipment also.

Although the IR readings taken during the test did exhibit some variation, the fact that all of them exceeded the pass/-fail criteria of the test program by nearly two orders of magnitude satisfies the purpose for which the measurements were intended.

4/ Ibid.

ATTACHMENT B

FSAR PAGE CHANGES AND JUSTIFICATIONS

TO ATTACHMENT A OF

LETTER GN-1434 DATED MARCH 14, 1988

Configuration/Service Level	Minimum Spatial Separation Distance
2. Cables in ~~solid bottom tray (or~~ tray with cover on the bottom~~)~~ from non-Class 1E cables in tray or free air (the non-Class 1E cables are limited to 480V or lower voltage and size #2/0 AWG or smaller~~)~~ and located below or along side class 1E tray).	3/4 in.
3. Cables in tray or free air running either vertically, or horizontally (side-by-side) from horizontal non-Class 1E cable in tray ~~or free air~~ (the non-Class 1E cables are limited to 480V or lower voltage and size #2/0 AWG or smaller).	1 in.
3a Cables in tray or free air ~~Free air cables~~ running either vertically, or horizontally (side-by-side) from horizontal non-Class 1E cable in ~~tray or~~ free air (the non-Class 1E cables are limited to 480V or lower voltage and size #2/0 AWG or smaller).	1-3/4 in.
4. Tray(c) or free air cables to a non-Class 1E rigid steel conduit carrying cables of 480V or lower voltage and sizes #2/0 AWG or smaller.	Contact
4a. Tray or free air cables to a non-Class 1E rigid steel conduit carrying cables of 480V or lower voltage and sizes #3/0 AWG through 500MCM.	3/4 in.
5. Tray or free air cables to a rigid steel conduit (the free air cables, cables in the tray, and in the conduit are limited to 480V or lower voltage and size #2/0 AWG or smaller).	1/2 in.
5a. Cables in tray to a rigid steel conduit routed below or beside the tray (the cables in the tray, and in the conduit are limited to 480V or lower voltage and size #2/0 AWG or smaller).	Contact
6. Tray or free air cables to a non-Class 1E flexible conduit (the non-Class 1E cables are limited to 480V or lower voltage and size #2/0 AWG or smaller).	1 in.
6a. Tray or free air cables to a non-Class 1E stripped flexible conduit (the non-Class 1E cables are limited to 480V or lower voltage and size #2/0 AWG or smaller).	Contact
7. Tray or free air cables to a flexible conduit (the free air cables, cables in the tray and in the conduit are limited to 480V or lower voltage and size #2/0 AWG or smaller).	1 in.
8. Tray or free air cables to a non-Class 1E aluminum sheathed cable of size #8 AWG or smaller	1 in.

C. FOR THE PURPOSE OF TESTING, THE CABLES IN THE PUNCHED BOTTOM TRAY ARE CONSIDERED THE SAME AS CABLES IN FREE-AIR SINCE THE CABLES IN THE TRAY ARE DIRECTLY EXPOSED TO THE HEAT GENERATED BY THE FAULTED CABLE IN THE AREAS OF THE TRAY THAT HAVE BEEN PUNCHED.

INSERT B
SA 20f

Configuration/Service Level	Minimum Spatial Separation Distance
or non-Class 1E electrical metallic tubing (EMT) carrying cables of sizes #8 AWG or smaller. (Limited to lighting, communications, and fire detection cables)	Info Only No Changes
9. Tray or free air cables to a non-Class 1E metal-clad cable (type MC) of size #8 AWG or smaller.	3/4 in.
10. Tray or free air cables to a non-Class 1E steel-armored 480V cable (500 MCM or smaller).	3/4 in.
10a. Tray or free air cables (480V or lower voltage and size #2/0 AWG or smaller) to steel-armored 480V cable (500 MCM or smaller).	3/4 in.
11. Cables in flexible conduit to cables in flexible conduit (the cables are limited to 480V or lower voltage and size 500MCM or smaller).	1 in.
11a. Cables in stripped flexible conduit to non-Class 1E cables in stripped flexible conduit (the non-Class 1E cables are limited to 480V or lower voltage and size #2/0 AWG or smaller).	Contact
11b. Cables in stripped flexible conduit to cables in stripped flexible conduit (the cables are limited to 480V or lower voltage and size #2/0 AWG or smaller).	Contact
12. Cables in flexible conduit to non-Class 1E cables in rigid steel conduit (the non-Class 1E cables are limited to 480V or lower voltage and size #2/0 AWG or smaller).	Contact
13. Between two rigid steel conduits (the cables in the conduits are limited to 480V or lower voltage and size #2/0 AWG or smaller).	Contact
13a. Cables in rigid steel conduit to non-Class 1E cables in rigid steel conduit (the non-Class 1E cables are limited to 480V or lower voltage and size #2/0 AWG or smaller).	Contact
14. Between perpendicular rigid steel conduits carrying cables of 480V or lower voltage and sizes #3/0 AWG through 500MCM.	1/8 in.
15. Cables in rigid steel conduit crossing non-Class 1E cables in tray or free air (the non-Class 1E cables are limited to 480V or lower voltage and size #2/0 AWG or smaller). The angle of crossing shall be 30° or greater.	Contact
16. Free air cables to free air cables, where one	6 in.

Configuration/Service Level	Minimum Spatial Separation Distance
of the groups is wrapped in three layers (200% overlap) of silicon dioxide cloth (Siltemp 188 CH). Service voltage is limited to 480V or lower voltage and sizes of 500MCM or smaller.	
16a. From non-Class IE free air cables, 480V or lower voltage and size of 500MCM or smaller, wrapped with three layers (200% overlap) of silicon dioxide cloth (Siltemp 188 CH) to class IE free air cables.	6 in
17. Free air cables 480V or lower voltage and size of 500 MCM or smaller, to free air control or instrumentation cables (#8 AWG or smaller). The control or instrumentation cables are wrapped in two layers (100% overlap) of silicon dioxide cloth (Siltemp 188 CH).	1 in.

TABLE 8.3.1-4 (SHEET 4 OF 6)

Configuration/Service Level	Minimum Spatial Separation Distance
18 ~~15.~~ Between free air instrumentation or control cables of 125-V dc or 120-V ac or lower, sizes number 8 AWG or smaller.	1 in.
19 ~~16.~~ Between free air instrumentation or control cables (125-V dc or 120-V ac or lower sizes number 8 AWG or smaller) with either group of cables wrapped in two layers (100% overlap) of silicon dioxide cloth (siltemp 188 CH).	In contact
20 ~~17.~~ Where raceways of different separation groups are brought to a single enclosure and:	
a. The lower separation group (i.e., separation group installed below the other separation group), wrapped in three layers (200% overlap) of silicon dioxide cloth (siltemp 188 CH). The cables are limited to 480 V or lower voltage of sizes 500 MCM or smaller.	6 in.
b. One separation group is control or instrumentation cables (#8 AWG or smaller) and is wrapped in two layers (100% overlap of silicon dioxide cloth. Cables of the other separation group are limited to 480 V or lower voltage of sizes 500 MCM or smaller.	1 in.
20 Free air Class 1E cable(s) free air to non-Class 1E cables with the Class 1E cable(s) ~~The upper separation group (i.e., separation group installed above the other separation group), or one separation group in a side-by-side configuration is~~ wrapped in two layers (100% overlap) of silicon dioxide cloth. The non-Class 1E cables are limited to 480 V or lower voltage of sizes 500 MCM or smaller.	1 in.

30

25

Justification for changes to Table 8.3.1.4

Item 1 Paragraph 2 mistakenly equated solid bottom trays to trays with punched bottoms and bottom covers. In solid bottom trays, the cables are in contact with the bottom of the tray. In punched bottom trays with bottom covers, the bottom cover is set off the bottom of the tray by a lip. This provides an air space between the cables and the bottom cover. Solid bottom has been deleted from paragraph 2. In addition, this paragraph did not include the restriction that the non 1E fault cables be located below or along side the class 1E target tray. This restriction reflects the actual test configuration in the Wyle testing.

Paragraphs 3 and 3a mistakenly transposed wording. This has been corrected to indicate that the target cables are in trays or free air.

Item 2 Paragraph 16 addresses free air to free air cables, with one cable wrapped in three layers (200% overlap) of silicon dioxide cloth (Siltemp 188), service voltage 480V or lower, size 500 MCM or smaller. Wyle test 48141 02 configuration 4, test 1a, was conducted with the fault cable wrapped and the target cable unwrapped. Target cables do not require voltage or size limitations, since the test used the most conservative cable as the target cable. Paragraph 16a has been added to remove the voltage restrictions of the target cable

Justification for changes to Table 8.3.1.4 (Continued)

Item 3 Paragraph 17 addresses free air cables to free air control or instrument cables (#8 AWG or smaller). Wyle test 48141 02 configuration 4, test 2, was conducted with a target cable wrapped in two layers (100% overlap) of silicon dioxide cloth (Siltemp 188), and a faulted cable, 480V or lower, size 500 MCM or smaller, unwrapped. The voltage restriction of the faulted cable was inadvertantly left out of the previous change.

Item 4 Wyle test 48141 02 configuration 4, tests 1a and 2 were conducted with approximately 4 feet of fault cable in free air, outside of an enclosure. Target cables were routed over the fault cable. The free air portion of the tested cables was long enough to be applicable to any configuration of cables in free air. The cables being brought to an enclosure have no bearing on the application of the test results. Therefore, the separation criteria restriction of paragraph 20 has been deleted.

When this change is made, paragraphs 20a and 20b are redundant to paragraphs 16 and 17. Therefore, paragraphs 20a and 20b have been deleted. Paragraph 20c has been renumbered to paragraph 20.

The renumbered paragraph 20 addresses free air to free air cables, with the target cable wrapped in two layers (100% overlap) of silicon dioxide cloth (Siltemp 188), and the fault cable, 480V or lower, size 500 MCM or smaller, unwrapped. Wyle test 48141 02 configuration 4, test 2, was conducted with a target cable wrapped in two layers (100% overlap) of silicon dioxide cloth (Siltemp 188), and a faulted cable, 480V or lower, size 500 MCM or smaller, unwrapped. Target cables do not require voltage or size limitations, since the test used the most conservative cable as the target cable. Paragraph 20 has been revised to remove the voltage restrictions of the target cable.