December 16, 1993

Docket No. 50-302

LICENSEE: Florida Power Corporation (FPC)

FACILITY: Crystal River Unit 3 (CR-3)

SUBJECT: SUMMARY OF MEETING ON OCTOBER 28, 1993, REGARDING CABLE SEPARATION CRITERIA AT CRYSTAL RIVER UNIT 3

Representatives of the licensee met with members of the staff on October 28, 1993, in Rockville, MD to discuss cable separation criteria at CR-3.

Enclosure 1 is a list of attendees. Enclosure 2 is a copy of the handouts and other information distributed at the meeting.

The licensee responded to specific staff questions and discussed the status of modifications made and planned. Approximately 80% of FPC-identified non-compliances are expected to be justified by analysis, with the remainder of the 900 non-compliances requiring physical modifications.

Seven work packages are being prepared: three will be completed during the upcoming refueling outage in the spring of 1994 (9R), three in the next mid-cycle outage (10M), and one in the next refueling (10R).

Sincerely,

(Original Signed By R. Croteau For)

Harley Silver, Project Manager
Project Directorate II-2
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosure: As stated

cc w/enclosure: See next page

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Memorandum Dated December 16, 1993

Distribution
Docket File
NRC & Local PDRs
PDII-2 Reading File
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230043

CRYSTAL RIVER UNIT 3

CABLE SEPARATION MEETING

OCTOBER 28, 1993

ATTENDEES

Name	Office
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Rick Croteau	NRR/PDII-2
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Mark Pratt	NRR/EELB
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RESPONSE TO NRC QUESTIONS FOR MEETING ON OCTOBER 28, 1993

CR3 original design criteria during construction was to use conduit as a separation barrier. If there was a separation problem, the cable/wire was installed in conduit. Refer to the attached highlighted sections of "Criteria Relating to Electrical Circuit Physical Separation and Cable Tray Loading" issued on October 6, 1971 with latest revision, dated January 24, 1977, and the "Control Board and Relay Rack Engineered Safeguards Separation Criteria Report issue May 18, 1972 with latest revision on May 19, 1975, which is just prior to startup in March 1977. These two criterias were combined in 1992 to form our Enhanced Separation Criteria.

CR3 FSAR also reflects the fact that conduit is used as a separation barrier with no distances stated. Refer to attached copies of the present FSAR revision and the revision in effect during the NRC Separation Inspection in 1991.

CR3 is licensed to IEEE 279-1968 draft which states that physical separation is required between channels but does not mention separation distances. The same is true for IEEE 279-1971.

Draft IEEE 308-1969 is the licensing document for Class 1E Electrical Systems per FSAR Section 8.1. Draft IEEE 308-1969 refers to "Independence" as "circuits to redundance equipment shall be physically and electrically independent of each other." No separation distances are stated.

CR3 is not licensed to IEEE 384.

RESPONSE TO NRC QUESTIONS

CONDUIT-TO CABLE TRAY

Question

According to the IEEE paper the one (1) inch vertical and one (1) inch horizontal separation for this configuration includes only enclosed trays. Do all of your configurations of this type include enclosed trays? If not, what type of separation criteria is used and what is used for the engineering basis for this criteria?

Response

Per Table C of CR3 Enhanced Separation Criteria, the type of tray may be open or enclosed. Again the basis for this criteria is the original plant design that conduits were to be used as separation barriers. Also the IEEE tests conducted passed even though the recommendations were more conservative.

CONDUIT-TO-CABLE-IN-AIR

Question

The IEEE paper recommends one (1) inch vertical and one (1) inch horizontal separation for this configuration when the conduit is below the free-air-cable. For other configurations, the separation should be twelve (12) inches vertical in a limited hazard area and three (3) inches in a non-hazard area. Do all of your configurations of this type include a conduit that runs below the cable-in-free-air. If not why is one (1) inch used for all conditions in your Separation Criteria. What engineering bases is used to justify deviating from the IEEE paper recommendations?

Response

The CR3 Enhanced Separation Criteria for all configurations in conduit to cable-in-air is per Table C. Again the basis for this criteria is the original plant design that conduits were to be used as separation barriers. Also the IEEE recommendations were more conservative than the test results.

CONDUIT-TO-CONDUIT

Question

Although, there were successful tests at separation distances less than one (1) inch for cables between 12 AWG and 500 MCM. The IEEE paper and IEEE 384 recommend a separation distance of one (1) inch vertical and one (1) inch horizontal. For a cable size of 750 MCM there were no successful tests at separation distances less than one (1) inch. What is your engineering bases for using a separation distance less than one (1) inch for low voltage power cables in this configuration?

Response

The bases for this criteria is the original plant design that conduits were to be used as separation barriers. CR3 is not licensed to IEEE 384.

TABLE C
REDUNDANT RACEWAYS SEPARATION CRITERIA FOR 1E EXTERNAL RACEWAYS AND WIRING

	Edge to Edge Spacing[4]	Low Energy		Control		LV Power Circuits with cable size ≤ 500 MCM		LV Power Circuits with cable size > 500 MCM and All Medium Voltage Power Circuits	
		Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard	Non-Hazardous	Limited Hazard
Conduit to Conduit	Horizontal Vertical	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches 0 inches	0 inches[6] 0 inches[8]	0 inches[6] 0 inches[8]	Note 1 Note 1	Note 1 Note 1
Conduit to Tray/ Cable	Horizontal Vertical	0 inches 0 inches	0 inches 0 inches	Note 2 1 inch	Note 2 1 inch	1 inch 1 inch	1 inch 1 inch	1 inch 1 inch	1 inch 1 inch
Cable to Cable/Tray	Horizontal Vertical	1 inch 3 inch	1 inch 3 inch	1 inch 3 inch	1 inch 3 inch	1 inch 3 inch	6 inch[7] 12 inch[7]	1 inch 3inch	3 feet 5 feet
Tray to Tray	Horizontal Vertical	1 foot 3 feet	3 feet Barriers	1 foot 3 feet	3 feet Barriers	1 foot 3 feet	3 feet Barriers	1 foot 3 feet	3 feet Barriers
Reactor Building Penetrations	Horizontal Vertical	N/A N/A	5 feet[3] 3 feet[3]	N/A N/A	5 feet[3] 3 feet[3]	N/A N/A	5 feet[3] 3 feet[3]	N/A N/A	5 feet[3] 3 feet[3]

NOTES:

1 An air gap (minimum 1/16") to minimize heat transfer between the conduits. Conduits may have 0 inch separation at condulet bodies only.

2 An air gap (minimum 1/16") to minimize heat transfer between the tray/cable to conduit.

3 Measured between centers.

4 All spacings shown are edge to edge of the raceway/cable and do not include attachment hardware.

5 If the two circuits are of a different voltage level, the more stringent separation criteria shall apply. Circuit spacing should also take into account installation and electrical noise concerns (Refer to Section 4.A.2.c.)

6 Conduit to conduit zero inch separation of "low voltage power circuits with cable size ≤ 500 MCM" means that it is only acceptable for conduit to touch for a minimum amount of length (<2 feet) as follows:

A. Conduits crossing each other

B. Condulet bodies touching

7 The horizontal and vertical separation distances are for non-armored cable sizes 2/0 AWG or less. If a tray contains non-armored cable sizes greater than 2/0 AWG, then the horizontal and vertical separation distances should be 3 feet and 5 feet respectively.

(REF. SECT. 4.A.2.i)

10-6-71
Rev. 9-4-73
Rev. 11-15-73
Rev. 1-24-77

CRITERIA RELATING TO ELECTRICAL CIRCUIT PHYSICAL SEPARATION AND CABLE TRAY LOADING

for: CRYSTAL RIVER PLANT - UNIT NO. 3
FLORIDA POWER CORPORATION

by: GILBERT ASSOCIATES, INC.

The electrical supply, control and instrumentation cable for mutually redundant or back-up equipment have physical separation to assure that no single credible event will pr nt operation of the associated function because of electrical conductor damage. Critical circuits and functions include power, control and instrumentation associated with reactor protection, engineered safeguards, and reactor shutdown. Credible events include, but are not limited to, the effects of short circuits, pipe ruptures, fires and missiles. The minimum electrical separation required for protection against design basis accidents is included in the basic plant design.

1.0 Separation

1.1 General Separation Requirements:

1.1.1 Cables for mutually redundant or back-up equipment are run in separate conduits, cable trays, ducts and penetrations.

1.1.2 Where it is impractical for reasons of terminal equipment arrangement to provide separate wireways, cables for mutually redundant or back-up equipment are separated from each other by physical barriers or metallic conduit.

1.1.3 Power and control cable rated at 600 volts or below are not placed in wireways with cable rated above 600 volts.

1.1.4 Low level analog signal cable are not routed in wireways containing power or control cables.

1.1.5 Wireways are identified using permanent markings. The purpose of such markings is to facilitate cable routing identification for future modifications or additions.

1.1.6 Permanent identification of cables and conductors is made at all terminal points.

1.1.7 Cable splices in conduits and trays will not be allowed.

1.2 Specific Separation Requirements:

1.2.1 There is four channel separation for the reactor protection and three channel separation for the safeguards instrumentation circuits. This separation is maintained from the sensor through the analog racks to the logic or relay cabinets. Where wiring in two or more cables is joined for a common alarm or events recorder point, the cables concerned are not routed in more than one safeguards channel tray where routing through safeguards tray is used for necessity or convenience.

CONTROL BOARD AND RELAY RACK
ENGINEERED SAFEGUARD SEPARATION CRITERIA REPORT
NUCLEAR POWER GENERATING PLANT
CRYSTAL RIVER UNIT NO. 3
FLORIDA POWER CORPORATION
MAY 18, 1972

PREPARED BY

E. M. GOOD
I & C ENGINEER

REVIEWED BY: J. H. Miller 5/19/75
I & C ENGINEER DATE

APPROVED BY: John B. Hamilton 5/19/75
PROJECT I & C ENGINEER DATE

Revision 1
July 30, 1973

Revision 2
September 4, 1973

Revision 3
October 29, 1973

Revision 4
March 28, 1974

Revision 5
April 8, 1974

Revision 6
April 11, 1974

Revision 7
January 29, 1975

Revision 8
April 29, 1975

Revision 9
May 19, 1975

GILBERT ASSOCIATES, INC.
READING, PENNSYLVANIA

B. Reactor Protection Equipment

Reactor protection channel circuits are defined as those circuits which make up redundant channels to form a matrix to trip the reactor. These channels are I red, II green, III yellow, IV blue. Each of these channels must be kept separate from every other reactor protection channel. For convenience the Red safeguard and Red reactor protection may run together, likewise, the green and yellow channels may run with the same color engineered safeguard circuits. The blue reactor protection channel however runs alone.

C. Internal Control Board or Relay Rack Rack Wiring Color Code

Wiring inside the control board and relay racks where Class I equipment or Class I related devices are located shall be color coded as follows:

(1) Red (R) wire for engineered safeguards train "A" or reactor protection channel I.

(2) Green (G) wire for engineered safeguards train "B" or reactor protection channel II.

(3) Yellow (Y) wire for engineered safeguards actuation "AB" or reactor protection channel III.

(4) Blue (BL) wire for reactor protection channel IV. | 5

(5) Brown (B) wire for non-safety related circuits running in safeguard train "A" tray but separated from all others.

(6) Orange (O) wire for non-safety related circuits running in safeguard train "B" tray and isolated from all others.

(7) Black (BK) wire for non-safety related circuits running in safeguard actuation "AB" and separated from all other circuits.

(8) Gray wire for non-safety related circuits arrives at the control board or rack in a non-safety related tray. | 5

(9) Black and white small gauge wires (#22AWG) appear on miniature devices for low voltage circuits entirely within the control board. These wires are not safeguard related therefore no separation is required. | 4

(10) If manufacturer's supplied multiconductor, multicolored cables are used, the color coded wires will be refered to in the manufacturer's connection drawings and the colors have no safeguard implication therefore they should be treated as normal nonsafeguard (Grey) wires.

D. Crossover

Where redundant circuits must cross each other, a conduit with a length of six (6) inches on either side of the crossover point or a barrier will be installed. Crossover situations will be avoided wherever possible.

6.2 Components and Wiring

Safeguard or protective system redundant components have been located at a maximum practical distance apart in the sections of the boards or racks in which these devices are located. This distance is a minimum of six (6) inches air space horizontally and twelve (12) inches vertically measured between adjacent near edges. In cases where this spacing cannot be achieved, a suitable barrier shall be installed with neither component physically mounted on that barrier. A suitable barrier for components and/or wiring or cable is defined as:

(1) A divider constructed from a minimum of 16 gauge metal extending at least one (1) inch from the larger device or wire bundle with a minimum of 1/8 inch asbestos affixed thereto, or where the device depths are of a difference of 6" or greater a barrier extending 1" beyond the smaller device.

(2) A divider constructed from two pieces of metal, each piece of which is a minimum of 16 gauge metal extending at least one (1) inch from the larger device or wire bundle with a minimum of a one (1) inch air gap between the metal pieces or where the device depths are of a difference of 6" or greater, a barrier extending 1" beyond the smaller device.

(3) Electrometallic tubing containing wire shall be considered a suitable barrier material.

(4) Asbestos line wireways containing wires of one group which if open in one direction does not face wires of another group.

(5) Flexible conduit.

In the case where a device is in a group or surrounded by a different safeguard or protective circuits or devices, an enclosure box or conduit may be used to maintain the required separation.

6.3 Interface Separation from Incoming Field Cables

Incoming cables from the field arrive at the control board or safeguard relay racks either by tray systems or in conduit via barriered floor openings to maintain separation from the tray through the floor into the board.

A. Cables which enter the control board or safeguard relay rack and terminate on terminal boards within the board or rack fall into three categories; namely, (1) safeguard cables arriving in their appropriately designated safeguard trays; (2) non-safeguard cables arriving in safeguard trays their entire length of travel; (3) and non-safeguard cables arriving in non-safeguard trays.

FSAR Rev in effect at time of NRC inspection in 1991

electrical conductor damage. Critical circuits and functions include power, control, and instrumentation associated with reactor protection, ES, and reactor shutdown. Credible events include, but are not limited to, the effects of short circuits, pipe ruptures, fires, and missiles. The minimum electrical separation required for protection against Design Basis Accidents (DBAs) is included in the basic plant design.

b. General Separation Requirements:

1. Cables for mutually redundant or backup equipment are run in separate conduits, cable trays, ducts, and penetrations in accordance with Draft 1, dated October 20, 1971, Section 8.0 of the proposed Guide for the Design and Installation of Cable Systems in Power Generating Stations.

2. Where it is impractical for reasons of terminal equipment arrangement to provide separate wireways, cables for mutually redundant or backup equipment are separated from each other by physical barriers or metallic conduit.

3. Power and control cable rated at 600 volts or below are not placed in wireways with cable rated above 600 volts.

4. Low level analog signal cables are not routed in wireways containing power or control cables.

5. Wireways are identified using permanent markings. The purpose of such markings is to facilitate cable routing identification for future modifications or additions.

6. Permanent identification of cables and conductors is made at all terminal points.

7. Cable splices in conduits and trays are not allowed.

c. Specific Separation Requirements:

1. There is four channel separation for the reactor protection and a three channel separation for the safeguards circuits. Where wiring in two or more cables is joined for a common alarm or events recorder point, the cables concerned are not routed

7.3.3 Control cables may be mixed with low voltage power cables if their respective conductor sizes do not differ greatly. When this is done in trays, the power cable should be derated as if all cables in the tray were power cable, since position and grouping is not controlled. Complete separation of control cable from power cable is also a common practice. In a vertical stack, control cable trays should be located below the power cable trays.

7.3.4 Low-level analog signal cables should be run in raceways separate from all power and control cables and cables for digital or pulse type signals. In vertically stacked trays, the low-level signal cable tray should be at the lowest level in the stack.

8.0 ISOLATION, SEPARATION AND IDENTIFICATION OF REDUNDANT CABLE SYSTEMS

8.1 Scope

This section suggests methods of isolation, separation and identification for all cabling associated with any redundant equipment in power generating stations.

8.2 Definitions

In this section the term "mutually redundant" is used in connection with systems and equipment which, in order to provide safety to the public and plant personnel and/or to prevent serious damage to equipment or structures, are backed up by one or more systems intended to serve the same objective. For example, a diesel driven fire pump and an electrically driven fire pump are mutually redundant. An a-c bearing oil pump and a d-c bearing oil pump are mutually redundant. However, cables associated with a fire pump and a bearing oil pump are not mutually redundant.

8.3 Criteria

The electrical conductors for mutually redundant systems of a power generating station should have isolation and/or separation to assure that no single credible event will prevent operation of the required number of redundant systems. Redundancy criteria should be applied to partial capacity systems to improve service reliability. The degree of isolation and/or separation required varies with the potential hazards in a particular area of the power generating station. These areas may be classified as follows:

a) Mechanical Damage (Missile) Area

b) Fire Hazard Area

c) Cable Spreading Room

d) Control & Relay Rooms

8.3.1 Mechanical Damage (Missile) Area

Arrangement and/or protective barriers should be such that no locally generated missile can destroy cabling of more than one mutually redundant system. Cables associated with Class 1 Electrical Systems of nuclear generating stations should not be routed through other than Class I structures to prevent tornado or earthquake damage to the cables or systems.

a) In areas where large rotating equipment will be operated or in areas containing high pressure piping, cabling of mutually redundant systems should be separated by a physical barrier or by distance so that one missile cannot destroy more than one system.

Consideration should also be given to other possible missile sources, such as transformers, switchgear and pressure vessels.

b) In any area containing an operating crane, raceways of mutually redundant systems should be separated by a physical barrier or by distance so that the largest dropped load cannot destroy more than one system. Where system redundancy is not required during plant shutdown, loads which will only be lifted during plant shutdown need not be considered.

8.3.2 Fire Hazard Area

Cabling should be arranged to separate the mutually redundant systems so that a given fire cannot damage more than one system or propagate from one to another.

a) Routing of cables for mutually redundant systems through areas where there is potential for accumulation of large quantities of oil or other combustible material (including coal dust) should be avoided. Where such routing is unavoidable, only one system of mutually redundant cables should be routed in the area and the cables should be protected by conduits or tray covers designed to prevent the combustible material from reaching the cables.

b) Cables of mutually redundant systems should have horizontal separation sufficient to prevent ignition of the cables in one system by a fire in the other. If this separation is not attainable, a fire resistant barrier should be installed. Barriers should be constructed of fire resistant materials having a low thermal conductivity coefficient. Asbestos based materials or two sheets of steel with an air space of one inch or more provide reasonable protection.

c) Mutually redundant cables should not be placed in the same vertical stack of trays. Where this is unavoidable, sufficient vertical clearance or fire resistant barriers should be placed between redundant groups to prevent the ignition of cables of one group by cables in the other.

Because of cross-over of one tray over another with which it is redundant, protection should extend to each side of the tray by a distance equal to three times the width of the widest tray involved in either system.

An alternate method is to provide the redundant group routed below with solid steel tray covers and the upper group with solid steel tray bottoms.

8.3.3 Cable Spreading Room

The cable spreading room is the area under the control room where cables leaving the panels are dispersed into their various cable trays for routing to all parts of the plant.

a) Where cables of mutually redundant systems approach each other with space less than adequate to prevent ignition of cables of one redundant system by the cables of the other, either the cables for both systems should be run in rigid conduit until sufficient separation exists or barriers as described in section 8.3.2 should be installed.

b) Cable spreading rooms should be restricted to occupancy by cable systems only. If possible, panels and other equipment should not be located therein.

8.3.4 Control and Relay Rooms

(This section is covered by a discussion prepared by an ad hoc committee composed of interested members of the following working groups:
Working Group on Wire and Cable Systems.
Working Group on Nuclear Power Plant Control and Protection).

Present FSAR.

d. Power circuit cables are sized on the basis of the maximum ambient temperature expected, the current requirements of the respective equipment, and the designed cable tray loading.

e. An ambient temperature of 50°C within the reactor, auxiliary, and intermediate buildings, and an ambient temperature of 40°C in other plant areas is the design basis ambient for all power cable ratings.

Environmental qualification testing used to assure safety related cables located inside containment will operate under the worst conditions of combined temperature, pressure, humidity, and radiation is described in Section 8.2.2.14.

f. The application and routing of control, instrumentation, and power cables are such as to minimize their vulnerability to damage from any source. All cables interlocked armor and rubber insulated are designed using conservative margins with respect to their current carrying capacities, insulation properties, and mechanical construction. Power and control cable insulation rating is 90°C. Appropriate instrumentation cables are shielded to minimize induced voltage and magnetic interference. Wire and cables related to ES and reactor protective systems are routed and installed to maintain the integrity of their respective redundant channels and protect them from physical damage.

8.2.2.12 Separation of Redundant Circuits

a. The electrical supply, control, and instrumentation cable for mutually redundant or backup equipment have physical separation to assure that no single credible event will prevent operation of the associated function because of electrical conductor damage. Critical circuits and functions include power, control, and instrumentation associated with reactor protection, ES, and reactor shutdown. Credible events include, but are not limited to, the effects of short circuits, pipe ruptures, fires, and missiles. The minimum electrical separation required for protection against Design Basis Accidents (DBAs) is included in the basic plant design.

b. General Separation Requirements:

1. Cables for mutually redundant or backup equipment are run in separate conduits, cable trays, ducts, and penetrations in accordance with FPC's Design Criteria, "Electrical Circuit Physical Separation and Cable Tray Loading."

2. Where it is impractical for reasons of terminal equipment arrangement to provide separate wireways, cables for mutually redundant or backup equipment are separated from each other by physical barriers or metallic conduit.