Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381

JUL 29 1994

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

Gentlemen:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

WATTS BAR NUCLEAR PLANT (WBN) - ADDITIONAL INFORMATION ON ELECTRICAL SEPARATION TO SUPPLEMENT FINAL SAFETY ANALYSIS REPORT (FSAR) CHAPTER 8, ELECTRIC POWER SYSTEMS (TAC M89109 AND M89110)

This letter provides TVA's response to the issue of electrical separation that was identified in the NRC request for additional information (RAI) dated March 28, 1994. The RAI presented five issues relating to electric power system design implementation at WBN as described in FSAR Chapter 8. TVA responded to four of these five issues in a letter dated June 29, 1994. TVA noted in the letter that a response to the remaining issue, which was numbered Issue No. 4 in the RAI and involved the electrical separation design criteria in use at WBN, would be delayed. The delay was necessary because the issue had been redefined and expanded during a conference call with Messrs. Virgil Beaston, Fred Burrows, Paul Fredrickson, Fred Hebdon, John Knox, Julio Lara, Peter Tam, and Eric Weiss of the NRC staff on May 12, 1994.

Enclosure 1 to this letter is a general response to Issue No. 4 based on its redefined and expanded scope. Enclosure 2 describes testing of electrical cable and raceway installations at other plants. This testing is used to justify some of WBN's electrical separation design criteria as discussed in Enclosure 1. Enclosure 3 presents a matrix explaining individual requirements in WBN's separation criteria to provide additional details in support of the general response in Enclosure 1. Enclosure 4 is a markup of WBN's FSAR Section 8.3.1.4.2 showing proposed changes which TVA plans to submit in a future FSAR amendment to provide supplementary

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information about separation distances between Class 1E open cable trays and conduit, as requested by the NRC staff.

If you have any questions about the information provided in this letter, please telephone John Vorees at (615) 365-8819.

Sincerely,

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ENCLOSURE 1

REQUEST FOR ADDITIONAL INFORMATION
WATTS BAR NUCLEAR PLANT FSAR CHAPTER 8
ELECTRIC POWER SYSTEMS

NRC ISSUE 4:

In the Safety Evaluation Report (SER) the staff stated that separation between conduits and open-top cable trays was not described in the Final Safety Analysis Report (FSAR) or in additional information provided by TVA. Currently, Section 8.3.1.4.2 of the FSAR states that there is no established minimum separation between open-top non-Class-1E cable trays and conduits containing redundant cables, and that credit is taken for fire-resistant cable coating installed prior to October 18, 1984, together with adequate circuit protective device(s) as meeting the intent of Regulatory Guide (RG) 1.75. Coating is not used after October 18, 1984, on cables which meet IEEE Standard 383-1974, "IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations." Further, there is no discussion in the current FSAR of separation distances between Class 1E open cable trays and conduits.

NRC Inspection Report Nos. 50-390/93-74 and 50-391/93-74 raised concerns related to the minimum separation distance between divisional open cable trays and conduits as described in Watts Bar General Design Criterion WB-DC-30-4, "Separation/Isolation." Appendix C of that document provides the rationale (unsupported by analysis/test) for distances down to one inch when the cable tray is not covered. The appendix states that the metal conduit (twice as thick as a cable tray cover) is sufficient as a heat shield/sink to provide protection for cables contained in the conduit against the physical energy associated with a fault in an open cable tray located as close as one inch to the conduit. The appendix further states that the conduit thickness and the lack of sufficient oxygen needed to support combustion inside the conduit ensure that damage to cables in cable trays as close as one inch is unlikely if a fault should occur inside the conduit. Credit is also taken in the appendix for the fire detection/suppression systems to minimize the propagation of a fire, for the use of fire-retardant material in specific cases, for certain cable passing vertical flame tests, and for the protection provided by primary breakers.

Staff guidance from RG 1.75 states that if the minimum separation distance (much greater than an inch) cannot be maintained, the redundant circuits should be run in solid enclosed raceways (enclosed cable trays, conduits, etc.) that qualify as barriers, or other barriers should be provided with a minimum separation of one inch between the enclosed raceways and between the barriers and raceways.

A comparison between RG 1.75 and WB-DC-30-4 revealed several differences such as the use of a cable tray cover allowed by WB-DC-30-4 versus a completely enclosed tray recommended by RG 1.75. Also, the use of a barrier without an additional one-inch air gap is allowed by WB-DC-30-4. As noted above, the appendix to WB-DC-30-4 allows exceptions (such as no tray cover required between a cable tray and a conduit for separations down to an inch) to the

separation requirements based on a case-by-case analysis without supporting test results, which also deviates from RG 1.75.

In a December 17, 1993, response to the inspection report, the applicant referred to IEEE Standard 384-1992, "IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits," as providing guidance for separation distances between open cable trays and conduits. Although this revision to the IEEE standard has not been formally endorsed by the staff, the staff's review indicated that it does provide guidance (with limiting assumptions) for minimum separation distances based on actual, credible test results. Unfortunately, as noted in the applicant's letter, WB-DC-30-4 allows separation distances less than that supported by the IEEE standard.

Because of the differences noted between WB-DC-30-4 and RG 1.75 pertaining to the separation between open cable tray and conduits, the staff will review TVA's case-by-case justification (supported by analysis/test) for deviations from RG 1.75 with further current industry guidance contained in IEEE Standard 384-1992 and its supporting documentation.

TVA RESPONSE:

In a conference call with Messrs. Virgil Beaston, Fred Burrows, Paul Fredrickson, Fred Hebdon, John Knox, Julio Lara, Peter Tam, and Eric Weiss of the NRC staff on May 12, 1994, the above issue was redefined and expanded. The NRC staff requested that TVA provide a detailed description of all electrical separation criteria in use at WBN. The description is to include a justification, based on test results wherever possible, for each criterion that differs from RG 1.75.

Note that TVA has not committed to follow the recommendations of RG 1.75 or to justify exceptions to RG 1.75 as part of WBN's licensing basis. This position regarding RG 1.75 has previously been presented in FSAR Section 8.1.5.3, Note 2, and in letters dated December 17, 1993, and June 29, 1994. RG 1.75 was originally issued in February 1974 and both Revisions 1 and 2 state that it applies to "construction permit applications for which the issue date of the Safety Evaluation Report (SER) is February 1, 1974, or after." WBN's construction permit (and associated SER) was issued on January 23, 1973. Consequently, much of WBN's design work predates RG 1.75. The original design criteria document that was used for electrical separation at WBN (i.e., WB-DC-30-4, Revision 0) was issued on December 14, 1973.

WBN's design criteria for physical separation of electrical cables and raceways do not encompass all of the recommendations in RG 1.75 since WBN's design criteria were developed prior to and independent of RG 1.75. For instance, WBN's design criteria depart from the specific recommendations in RG 1.75 for:

- non-Class 1E circuits separated from Class 1E circuits,
- enclosed raceways where minimum separation distances cannot be maintained,
- barriers with a 1-inch air gap,
- separation distances less than those stated in IEEE 384,
- justification of deviations by using analysis supported by testing.

Without the benefit of RG 1.75 or similar industry guidance, WBN and other nuclear plants of its vintage focused on the essential purpose of electrical separation. WBN's design criteria meet the intent of General Design Criterion 17, RG 1.6, IEEE 279-1971, and IEEE 308-1971 by maintaining the independence of safety-related circuits in one train/division while assuming a single failure in the redundant train/division of safety-related circuits.

In response to continuing concerns about electrical separation, TVA performed an after-the-fact review of the design and construction practices that have been in use at WBN to address the items of departure from RG 1.75 listed above. Based on this review, TVA determined that the separation of electrical cables and raceways is adequate to satisfy the general intent of the RG 1.75 recommendations. The specific findings of the review were as follows.

- Class 1E cables are protected from thermal damage due to a fault on non-Class 1E cables. This is documented in various calculations such as WBPEVAR9001006, WBPEVAR9001007, and WBN EEB-MS-TI15-0011, which are available onsite for further review if necessary.

- Enclosure 2 describes testing of comparable cable and raceway installations at other plants to demonstrate the adequacy of (1) tray covers/bottoms used in lieu of enclosed raceways, (2) barriers with less than 1 inch of air gap, and (3) separation distances less than those stated in IEEE 384. The NRC staff has accepted this testing as meeting the intent of RG 1.75 and IEEE 384-1974.

Enclosure 3 is a detailed matrix of the electrical separation requirements that are included in the current version (i.e., Revision 13) of WB-DC-30-4. The source or justification for each requirement is noted in the matrix by referring to IEEE 384-1974 or applicable industry tests. Also, relevant FSAR section numbers are identified for the requirements wherever possible.

Enclosure 4 is a markup of FSAR Section 8.3.1.4.2 showing proposed changes that will be incorporated in a future FSAR amendment to describe separation distances between Class 1E open cable trays and conduit.

ENCLOSURE 2

SEPARATION REPORT - OPEN CABLE TRAY AND CONDUIT

SEPARATION REPORT - OPEN CABLE TRAY AND CONDUIT

Industry testing of comparable installations at other Nuclear Plants documents the acceptability of WB-DC-30-4 deviations from RG 1.75 relative to separation. This attachment identifies those deviations and summarizes applicable industry test(s) documenting acceptability of these deviations.

Conduit to Cable Tray (i.e. greater than one inch or one inch plus tray cover or tray bottom in lieu of enclosed raceway)

Wyle Lab conducted tests for Beaver Valley Unit 2 (BV2) of Duquesne Light Company on conduit and cable tray separation (Ref. 1, Section VII, Configuration 6, Test 1 and 2). In the tests a conduit was positioned one inch above a cable tray without a tray cover. Target and fault cables were alternated between tray and conduit. The test demonstrated the acceptability of a design where a conduit passes within one inch of an uncovered ladder cable tray.

Wyle Lab conducted similar tests for Nine Mile Point Nuclear Station - Unit 2 (NMP2) of Niagara Mohawk Power Corporation on conduit and cable tray separation (Ref. 2, Section IV, Configuration 3, Test 1 and 2) with similar results.

Both groups of tests support (1) greater than one inch between a conduit and a cable tray and (2) one inch separation between a conduit and a cable tray with an intervening cover/bottom as an acceptable separation requirement.

Barrier With Less Than One-Inch Air Gap

Wyle Lab conducted tests for BV2 on cable in contact with tray cover on filled cable tray (Ref. 1, Section V, Configuration 4). Target and fault cables were alternated between cable in contact above tray cover and cable under tray cover. The tests demonstrated the acceptability of cable in contact with cable tray cover.

In addition, Wyle Lab conducted tests for BV2 and NMP2 (Ref. 1, Section II, Configuration 1, and Ref. 2, Section III, Configuration 2) respectively, on cable in contact with a barrier (i.e. a wrapped cable). These tests demonstrated the acceptability of cable in contact with approved barriers.

Each of the above tests supports the use of a barrier with less than one inch air gap:

- Between conduit and tray cover/bottom, and
- As indicated in IEEE 384-1974, Figs. 2, 3, and 4 (location only).

Cable Tray to Cable Tray (i.e., less than the required horizontal separation)

Wyle Lab conducted test for BV2 on cable tray separation (Ref. 1, Section VI, Configuration 5). In the test, a horizontal tray and a vertical tray were separated 1 inch without covers on the trays or intervening barrier. Target and fault cables were alternated between horizontal and vertical trays. The test demonstrated the adequacy of 1 inch horizontal separation.

The above test supports the use of (1) a barrier 1 ft above and 1 ft below cable trays with less than the required horizontal separation, and (2) a cover/bottom on the vertical tray 5 ft above in the General Plant Areas (GPA) or 3 ft in the Protected Area and 1 ft below the horizontal tray and a cover and bottom on the horizontal tray for 3 ft (or to wall) where less than the required horizontal separation exists at Pass-bys.

Cable Tray to Cable Tray (i.e., less than the required vertical separation)

Wyle Lab conducted tests for BV2 on cable tray separation (Ref. 1, Section V, Configuration 4). In the test, trays were separated 14 inches (bottom of tray to bottom of tray) with one intervening tray cover. A cable in the tray with the cover was faulted. The test demonstrated the acceptability of a design with a single tray cover between two trays approximately 11 inches apart.

Wyle Lab conducted similar tests for NMP2 on cable tray separation (Ref. 2, Section V, Configuration 4). In the test, trays were separated 13 inches (bottom of tray to bottom of tray) with no intervening tray cover. The test demonstrated the acceptability of a design with two (uncovered) trays approximately 9 inches apart.

Each of the above tests supports the use of 12 inch vertical tray spacing between upper tray with bottom and lower tray with cover. This configuration is used at tray crossings throughout WBN and for redundant channel trays within the WBN auxiliary instrument room.

Each of the above tests supports the use of a barrier extending 3 ft in the GPA or 1 ft in the Protected Area (or to wall) on either side of tray where less than the required vertical separation exists.

Each of the above tests supports the 1 ft (12 in) vertical spacing for non-Class 1E to Class 1E trays, while the BV2 testing supports adequate access (6-9 in) between upper tray with bottom and lower tray with cover.

Conduit to Conduit and Conduit to Cable Tray (i.e., with less than 1 inch separation)

Wyle Lab conducted tests for NMP2 on conduit to conduit to cable-in-air separation (Ref. 2, Section VI, Configuration 5). In the test, conduit and cable were spaced less than 1/4 inch (but not in contact). Target and fault cables were alternated between cables in conduit and in air. The test demonstrated the acceptability of less than 1/4 inch (but not in contact) separation between conduit and cable in air.

Wyle Lab conducted test for Comanche Peak Steam Electric Station (CPSES) on cable in contact with conduit (Ref. 3, Section IV, Configuration 2) and cable tray in contact with conduit (Ref. 3, Section V, Configuration 3) separation. In the test, low energy circuits were utilized. The test demonstrated the acceptability of cable in-contact with cable tray and conduit for low energy circuits (i.e., control and instrumentation).

Each of the above tests supports, on a case-by-case basis, reduction of conduit to conduit and conduit to open cable tray separation to less than 1 in. (touching in isolated instances).

Application of Test Results to WBN

Industry testing has been conducted in support of electrical systems 600 volts and below. The worst case electrical fault postulated is a motor feeder under a sustained motor locked rotor condition and a failed primary protective device. This would result in an overload of approximately six times the motor's rated full load current on the feeder cable. Fault cables were tested at this level. Where required, the overload was increased to two times the secondary protection device rating and subsequently to the maximum rating of testing facility.

This testing is applicable to WBN as discussed below. In addition, such testing can be extended to include WBN's 6.9 KV system based on the rapid clearing of electrical faults at this level when compared to industry test times.

Each 6.9 KV system cable is shielded. Dielectric breakdown of the insulation system would result in arcs internal to the cable (conductor shield which is grounded). These arcs will be interrupted by the operation of either the primary instantaneous ground overcurrent relay or assuming its failure, by the time delayed operation of the ground overcurrent relay of the secondary protective device. Internal heating of the source (faulted) cable will cause dielectric breakdown and ground fault before significant thermal propagation to target cables in adjacent raceways.

In determining the separation at WBN, the results of Wyle Lab tests conducted for BV2 (Ref. 1), NMP2 (Ref. 2), and CPSES (Ref. 3) have been cited. These reports present results of a series of tests which in part demonstrate acceptability of separation configuration less than contained in IEEE 384-1974. These tests have been determined to be acceptable by the NRC (Ref. 4, 5, and 6).

BV2 test used a No. 6 AWG cable as the worst case heat source; NMP2 test used a 2/0 AWG cable as the worst case heat source. The analysis and justification of worst case heat source is contained in the NMP2 report, while the BV2 analysis and justification is contained in a separate submittal to the NRC in June 1985. Worst case cable temperature in actual installations were determined to occur in motor feeders carrying sustained locked rotor currents.

In the BV2 test, the duration of locked rotor currents was limited by motor pigtail conductor fusing time. In the NMP2 test, the test was limited by feeder conductor fusing time. Typical cable jacket temperatures are shown below:

BV2 (Limited By Motor Pigtail)

HEAT RISE TEST	CABLE	LRA	DURATION (MIN.)	MAX TEMP JACKET OF FAULT CABLE
1	500 MCM	1780	16.8	300°F
2	250 MCM	1579	13.5	360°F
3	4/0 AWG	1184	9.5	400°F
4	#2 AWG	501	8.3	460°F
5	#6 AWG	315	8.4	850°F

NMP2 (Limited By Motor Feeder)

HEAT RISE TEST	CABLE	LRA(FC)*	DURATION* (MIN.)	MAX TEMP JACKET OF FAULT CABLE
1	#10 AWG	34(455)	0.6	456°F
2	#8 AWG	51(660)	0.8	615°F
3	#6 AWG	156(660)	1.0	1876°F
4	#4 AWG	156(660)	2.7	1798°F
5	#2 AWG	264(660)	7.7	1896°F
6	1/0 AWG	908(-)	9.6	1855°F
7	2/0 AWG	908(-)	18.7	2206°F
8	3/0 AWG	908(-)	40.4	1739°F
9	4/0 AWG	746(1860)	2.1	1313°F
10	250 MCM	746(2200)	5.8	1494°F
11	350 MCM	746(2200)	11.8	1579°F
12	500 MCM	746(2200)	32.7	1827°F

*Duration is after initiation of fault current (FC) which was applied after a 15 minute period of stabilized temperature at locked rotor current (LRA).

The table below compares the locked rotor currents (LRA) by cable size for WBN, BV2, and NMP2. The cable sizing (i.e., LRA/conductor size) at WBN is clearly more conservative than at BV2 and/or NMP2.

CABLE	LARGEST LRA		
	WBN	BV2	NMP2
400 MCM	1579	---	---
300 MCM	1209	---	---
250 MCM	---	1579	2200
4/0 AWG	912	1184	1860
2/0 AWG	---	---	908
1/0 AWG	869	---	908
#2 AWG	592	501	660
#6 AWG	350	315	660

The table below compares the average cable diameters by cable size for WBN, BV2, and NMP2. The cable diameters (1/c to 1/c, triangular arrangement of 1/c to triplex, 3/c to triplex) are comparable.

CABLE	CABLE DIAMETER*		
	WBN	BV2	NMP2
400	1.01	---	---
300	0.91	---	---
250	---	NA	(0.939) 1.879
4/0	0.76 [1.52]	(0.789) 1.579	(0.858) 1.717
2/0	---	---	(0.743) 1.486
1/0	0.64 [1.28]	---	(0.695) 1.391
#2	0.47 [0.94]	(0.483) 0.966	(0.586) 1.173
#6	0.91	0.739	0.946

* (XXX) - Calculated single conductor diameter for triplex cable
YYY - Average cable diameter
[ZZZ] - Calculated triangular arrangement diameter of single conductor cables

Comparable diameters together with more conservative ampacity requirements prove that the results obtained from BV2 and NMP2 testing can be applied to WBN.

CPSES tests were conducted on low energy (control and instrumentation) circuits. WBN signal level circuits are considered to be comparable to the CPSES low energy circuits tested.

REFERENCES

1. Wyle Lab Report 17666-02, Electrical Separation Verification Testing for Beaver Valley Unit 2 of Duquesne Light Company

2. Wyle Lab Report 47906-02, Electrical Separation Verification Testing for Nine Mile Point Unit 2 of Niagra Mohawk Power Corporation

3. Wyle Lab Report 48037-02, Electrical Raceway Separation Verification Testing for Comanche Peak Steam Electric Station Units 1 and 2 of Texas Utilities

4. Safety Evaluation Report for Beaver Valley Power Station Unit 2 of Duquesne Light Company

5. Safety Evaluation Report for Nine Mile Point Unit 2 of Niagra Mohawk Power Corporation

6. Safety Evaluation Report for the Comanche Peak Steam Electric Station Units 1 and 2 of Texas Utilities

ENCLOSURE 3

MATRIX OF ELECTRICAL SEPARATION REQUIREMENTS
FROM WB-DC-30-4 ("SEPARATION/ISOLATION"), REVISION 13

WATTS BAR CABLE SEPARATION CRITERIA MATRIX

WBN SOURCE/ CONF	PLANT AREA	SEPARATION REQUIREMENT	INDUSTRY SOURCE	CONCLUSION
WB-DC-30-4 (4.1.1.1) FSAR (8.3.1.4.2) Tray-to-Tray 1E-to-1E	GPA	3 ft. Horizontal Where not attainable, a barrier 1ft. above (or to ceiling) and 1 ft. below (or to floor) *384 shows solid tray bottom & no barrier below*	384 (5.1.4) BV2 (Conf. 5)	Meets 384 Meets 384 by analysis based on test
		5 ft. Vertical – plus lower tray solid cover & upper tray solid bottom Where not attainable, a barrier 3 ft. (or to wall) on each side of tray *384 requires a barrier 6 in. (or to wall) on each side of tray plus a 1 in. air gap*	384 (5.1.4) BV2 (Conf. 4) NMP2 (Conf. 4)	Exceeds 384 Meets 384 by analysis based on test
		Pass-by – where 3 ft. horizontal is not attainable, vertical tray: solid cover and/or bottom for 5 feet above (or to ceiling) and 1 ft. below (or to floor) and horizontal tray: solid cover and bottom for 3 ft. on each side of the vertical tray (or to wall). *Not in 384 but meets 384 implied 3 ft. (i.e., horizontal distance in general plant area on vertical)*	BV2 (Conf. 5)	Meets 384 by analysis based on test

WATTS BAR CABLE SEPARATION CRITERIA MATRIX

WBN SOURCE/ CONF	PLANT AREA	SEPARATION REQUIREMENT	INDUSTRY SOURCE	CONCLUSION
WB-DC-30-4 (4.1.1.2)	Protected Area	1 ft. Horizontal	384 (5.1.3)	Meets 384
FSAR (8.3.1.4.2) Tray-to-Tray 1E-to-1E		Where not attainable, a barrier 1 ft. above (or to ceiling) and 1 ft. below (or to floor). *384 shows solid tray bottom & no barrier below*	BV2 (Conf. 5)	Meets 384 by analysis based on test
		3 ft. Vertical-plus lower tray solid cover & upper tray solid bottom Where not attainable, a barrier I ft. (or to wall) on each side of tray *384 requires a barrier 6 in. (or to wall) on each side of tray plus a 1 in. air gap*	384 (5.1.3) BV2 (Conf. 4) NMP2 (Conf. 4)	Exceeds 384 Meets 384 by analysis based on test
		Redundant channels (Aux. Instr. Room) 1 ft. vertical plus lower tray solid cover, upper tray solid bottom *384 requires "enclosed raceway"*	BV2 (Conf. 4) NMP2 (Conf. 4)	Meets 384 by analysis based on test
		Pass-by - where 1 ft. horizontal is not attainable, vertical tray: solid cover and/or bottom for 3 ft. above and 1 ft. below and horizontal tray: solid cover and bottom for 3 ft. on each side of the vertical tray (or to wall). *Not in 384 but meets 384 implied 1 ft. (i.e., horizontal distance in protected area on vertical)*	BV2 (Conf. 5)	Meets 384 by analysis based on test

WATTS BAR CABLE SEPARATION CRITERIA MATRIX

WBN SOURCE/ CONF	PLANT AREA	SEPARATION REQUIREMENT	INDUSTRY SOURCE	CONCLUSION
WB-DC-30-4 (4.1.1.3) FSAR (8.3.1.4.3) Tray-to-Tray Non 1E-to-1E	GPA & Protected Area	1 ft. Vertical *384 5.1.3 requires 3 ft. & 5.1.4 requires 5 ft.*	NMP2 (Conf. 4)	Meets 384 by analysis based on test
		Where not attainable, adequate access (6-9 in) & top tray has solid bottom or bottom cover *384 5.1.3 & 5.1.4 requires "enclosed raceway"*	BV2 (Conf. 4)	Meets 384 by analysis based on test
		6 in. Horizontal *384 5.1.3 requires 1 ft. & 5.1.4 requires 3 ft.*	BV2 (Conf. 5)	Meets 384 by analysis based on test
WB-DC-30-4 (4.1.1.4) FSAR (8.3.1.4.2) Tray-to-Tray 1E-to-1E	GPA & Protected Area	Tray crossing: 1 ft. vertical separation and bottom tray with cover and top tray with solid bottom 3 ft. (or to wall, floor, or ceiling) on each side of crossing *384 5.1.4 allows from 5 ft. to 1 in. with "enclosed raceway" 5.1.3 allows from 3 ft. to 1 in. with "enclosed raceway"*	BV2 (Conf. 4) NMP2 (Conf. 4)	Meets 384 by analysis based on test
		When 1 ft. (12 in.) is not attainable: 1 in. plus totally enclosed trays for 3 ft.	384 (5.1.3 & 5.1.4)	Meets or Exceeds 384
WB-DC-30-4 (4.1.1.5) FSAR (8.3.1.4.3) Tray-to-Tray Non 1E-to-1E	GPA & Protected Area	Barrier: 1/2 in. Marinite *384 5.1.3 & 5.1.4 requires barrier plus 1 inch.*	BV2 (Conf. 1&4) NMP2 (Conf. 2)	Meets 384 by analysis based on test
		Barrier: two sheets of 18-gauge steel with 1 inch airgap	384 (5.1.3 & 5.1.4)	Meets 384

WATTS BAR CABLE SEPARATION CRITERIA MATRIX

WBN SOURCE/ CONF	PLANT AREA	SEPARATION REQUIREMENT	INDUSTRY SOURCE	CONCLUSION
WB-DC-30-4 (4.1.1.8) Tray-to-Tray 1E-to-1E Non 1E-to-1E	GPA & Protected Area	Alternates to 4.1.1.1 - 4.1.1.4 separation requirements require case-by-case analysis Exceptions EX-WB-DC-30-4-1, 5, 7, & 8 present one or more of the following analysis: a) Cables in redundant raceway are associated with the ADGU and will only be energized one set at a time when ADGU replaces an EDGU. b) Minor horizontal separation distance (3 ft.) deviations (1/2 to 3/4 inch) are acceptable because CSR meets requirement for a protected area. c) Redundant divisional cables are signal level cables and do not contain sufficient energy to threaten each other. d) Lack of continuous barrier within transfer switches.	N/A	Meets 384 by analysis Meets 384 by analysis Meets 384 by analysis Meets 384 by analysis
WB-DC-30-4 (4.1.2.1) FSAR (8.3.1.4.2) See Att. B Conduit-to-Conduit 1E-to-1E	GPA & Protected Areas	1 in Horizontal/Vertical	384 (5.1.3 & 5.1.4)	Meets 384

WATTS BAR CABLE SEPARATION CRITERIA MATRIX

WBN SOURCE/ CONF	PLANT AREA	SEPARATION REQUIREMENT	INDUSTRY SOURCE	CONCLUSION
WB-DC-30-4 (4.1.2.2)	GPA & Protected Areas	1 in. plus solid tray cover, tray bottom or side adjacent to conduit for 3 ft. (or to wall, floor, or ceiling) *384 5.1.3 & 5.1.4 requires "enclosed raceway"*	BV2 (Conf. 6) NMP2 (Conf. 3)	Meets 384 by analysis based on test
FSAR (8.3.1.4.2) See Att. B Conduit-to-Tray 1E-to-1E		Greater than 1 in. tray cover or tray bottom not required *384 5.1.3 & 5.1.4 requires "enclosed raceway" below* *5 ft./3 ft. vertically and 3 ft./1 ft. horizontally in GPA/Protected Areas*	BV2 (Conf. 6) NMP2 (Conf. 3)	Meets 384 by analysis based on test

WBN SOURCE/ CONF	PLANT AREA	SEPARATION REQUIREMENT	INDUSTRY SOURCE	CONCLUSION
WB-DC-30-4 (4.1.2.3)	GPA & Protected Area	Where 1 in. is not attainable (i.e., as specified in 4.1.2.1 or 4.1.2.2) a barrier of 1/2-in. marinite (or equivalent) between raceway provided tray has a solid tray cover, tray bottom or side adjacent to conduit	N/A	Meets 384 by analysis based on test
FSAR (8.3.1.4.2) See Att. B (8.3.1.4.3) Conduit-to-Conduit Conduit-to-Tray 1E-to-1E		Alternates to 4.1.2.1or 4.1.2.2 separation requirements require case-by-case analysis		
		Exception EX-WB-DC-30-4-23 allows conduit to conduit and conduit to tray separations less than 1 inch (some touching but the majority above 1/8 in.)	NMP2 (Conf. 5) CPSES (Conf. 2&3)	Meets 384 by analysis based on test
		In addition, the following supplemental analysis is presented:		
		a) Cables in redundant raceways do not actually provide redundant functions.		Meets the Intent of 384
		b) Cables in redundant raceway are signal level cables and do not contain sufficient energy to threaten redundant raceway cables.		Meets 384 by analysis based on test
		c) Cables in redundant raceway are train and same train derived channels.		Meets the intent of 384
		d) Cables have redundant protection.		Meets 384
		e) Cables are protected		WBN calcs WBN-EEB-MS-TI07-0018, WBN-EEB-MS-TI08-0018, WBN-EEB-MS-TI08-0028, WBPEVAR9001006
		f) Cables are not required for operation or shutdown.		WBN calcs WBPEVAR8903046

WBN SOURCE/ CONF	PLANT AREA	SEPARATION REQUIREMENT	INDUSTRY SOURCE	CONCLUSION
WB-DC-30-4 (4.1.2.5) FSAR (8.3.1.4.3) Conduit-to-Conduit Non 1E-to-1E	GPA & Protected Area	Class 1E cables are protected from thermal damage due to a fault on a Non-Class 1E cable routed in a seismic Category I structure	N/A	WBN calcs WBPEVAR-9001006, WBPEVAR-9001007, WBN-EEB-MS-TI15-0011
WB-DC-30-4 (4.1.3) Cable-in-Air to Cable-in-Air Cable-in-Air to Tray	GPA 1E-to-1E	5 ft. vertical/3 ft. horizontal	384 (5.1.4)	Meets 384
	Protected Area 1E-to-1E	3 ft. vertical/1 ft. horizontal	384 (5.1.3)	Meets 384
	GPA & Protected Area Non 1E-to-1E	Class 1E cables are protected from thermal damage due to a fault on a Non-Class 1E cable routed in a seismic Category I structure. Non-Class 1E cables shall not touch Class 1E cables.	N/A	WBN calcs WBPEVAR-9001006, WBPEVAR-9001007, WBN-EEB-MS-TI15-0011

WBN SOURCE/ CONF	PLANT AREA	SEPARATION REQUIREMENT	INDUSTRY SOURCE	CONCLUSION
WB-DC-30-4 (4.1.4) FSAR (8.3.1.4.3) Associated Circuits	GPA & Protected Areas	Associated Circuits (i.e., non-Class 1E cable routed in tray with Class 1E cable, non Class 1E cable not separated from Class 1E cable by 6 inches or barrier inside equipment, or non Class 1E cable touching Class 1E cable in air) Associated circuits shall comply with one of the following: 1. Once they become associated with one division of GSPS cables, the associated circuits shall be separated from the redundant division of GSPS cables from the Class 1E equipment to and including an isolation device. Beyond the isolation device a circuit is not subject to the requirements of this document provided it does not again become associated with a Class 1E system. 2. They shall be analyzed or tested to demonstrate that electrical faults, caused by failure of associated cables will not compromise the independence of redundant Class 1E cable systems. The analysis shall verify that the cable's associated protective device will clear the imposed fault condition of the cable with the least I^2t rating. Class 1E power systems and their distribution circuits shall not be lost or degraded as a result of non-Class 1E cables routed with Class 1E cables. Protective devices for associated cables shall not be located in a harsh environment, unless justified by analysis and shall be of a high quality commensurate with their importance to safety. The cable shall be protected by protective devices consisting of two series connected circuit breakers, a circuit breaker in series with a fuse, a single fuse, or a single circuit breaker which will be tested in accordance with the plant's technical specifications.	384 (4.5) 384 (3)	Meets 384 4.5 (2) Meets 384 4.5 (3) Meets the intent of 384

WBN SOURCE/ CONF	PLANT AREA	SEPARATION REQUIREMENT	INDUSTRY SOURCE	CONCLUSION
WB-DC-30-4 (4.6) FSAR (8.3.1.4.6) Internal to Equipment 1E-to-1E	All	6 in. of free air space Where not attainable, a metal barrier or conduit shall be provided Note train and same train derived channels may be routed together	3.8.4 (5.6&5.7) 384 (5.6&5.7)	Meets 384 Meets 384
WB-DC-30-4 (4.6.1) FSAR (8.3.1.4.6) Internal to Equipment More than one 1E division and non 1E	All	6 in. of free air space Where not attainable within Westinghouse panels, a braided sheath material shall be provided on the Class 1E cables. Cables must not touch. Where not attainable, a barrier shall be provided. Note where non Class 1E wiring terminates on a Class 1E component the non Class 1E cable is treated as an associated circuit.	384 (5.6&5.7) Westing-house E-Spec 952866, 952698, 952367 384 (5.6&5.7)	Meets 384 Meets 384 by analysis based on test Meets 384
WB-DC-30-4 (4.6.2) FSAR (8.3.1.4.6) Internal to Equipment Only one 1E Division and non 1E	All	6 in. of free air space Where not attainable, a barrier shall be provided. Note where not attainable and no barrier is provided, the non Class 1E cable is treated as an associate circuit.	384 (5.6&5.7) 384 (5.6&5.7)	Meets 384 Meets 384

WBN SOURCE/ CONF	PLANT AREA	SEPARATION REQUIREMENT	INDUSTRY SOURCE	CONCLUSION
WB-DC-30-4 (Remaining Sections) FSAR (8.3.1.4.3)	N/A	Alternates to remaining section separation requirements require case-by-case analysis. Exceptions EX-WB-DC-30-4-2, 3, 4, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 24, 25, 26, and 27 present one or more of the following analysis:	N/A	
		a) Non-divisional cables routed with S cables (may be Division A or B but not both) would only challenge one train.		Meets 384 by analysis
		b) NIS cable separation from noise sources will be evaluated by system test.		Westinghouse ltr NEB 830408 603
		c) Non-divisional cables routed with or which do not meet required separation from divisional (i.e., A, B, S, J, K, D, etc.), cables are signal level cables and do not contain sufficient energy to threaten each other.		Meets 384 by analysis
		d) Non-divisional cables routed with divisional cables would only challenge one train and only when ADGU replaces an EDGU.		Meets 384 by analysis
		e) Divisional cables without GSPS designation in turbine building are separated from redundant cables and will be identified on drawings.		Meets intent of 384
		f) Divisional cables/equipment separated by other than required barriers (i.e., grastic, pyro-guard).		Meets 384
		g) ACS cable routed through MCR has redundant cables outside of MCR.		Meets 384
		h) Divisional cables routed with non-divisional cables are protected.		WBN Calc EEB-MS-TI15-0011, WBN-EEB-MS-TI07-0018, WBN-EEB-MS-TI07-0005, WBPEVAR9001006, WBPEVAR9001007
		i) "S" cables (may be Train A or B but not both) and channel cables within chargers and inverters are train and same train derived channels.		Meets the intent of 384
		j) Separation between redundant divisional cables and non divisional and divisional cables within reactor protection system panels has been analyzed.		EX-WB-DC-30-4-19 has detailed analysis
		k) Routing of P&R cables in respective Train A & B raceway is acceptable because Train A(B) is derived from P(R) preferred (offsite) source.		Meets 384
		l) Interaction of CO_2 initiation and DG room exhaust fans has been analyzed. Manual by-pass feature added to negate spurious trips.		Meets intent of 384

ENCLOSURE 4

PROPOSED CHANGES TO FSAR SECTION 8.3.1.4.2

In cases where trays carrying cables of different divisions of separation cross, there is a minimum vertical separation of 12 inches (tray top of lower tray to tray bottom of upper tray) with the bottom tray covered with a solid steel cover and the top tray provided with a solid steel bottom for a minimum distance of 3 feet on each side of the tray crossing. This 12 inch separation may be reduced to 1 inch, if the trays are totally enclosed (solid top & solid bottom) for the distance specified above.

Auxiliary Instrument Room

The auxiliary instrument room is the area under the cable spreading room. Since the auxiliary instrument room is protected from missiles by its seismic Category I walls and there are no internal sources of missiles such as high-pressure piping or heavy rotating equipment, the only potential source of damage to redundant cables is from fire. No combustible materials are stored in this room, and no power cables with a protective device rated greater than 30 amperes are routed in this room unless they are in conduit. Fire and smoke detectors with control room alarm, and a carbon dioxide fire protection system, have been installed.

The auxiliary instrument room contains the process instrument racks, the solid-state protection racks, and associated instrument and relay racks.

A minimum horizontal separation of 1 foot is provided between trays carrying cables of different divisions channels or trains). When the minimum separation distance is not attainable, a fire-resistant barrier is utilized. The barrier extends at least 1 foot above (or to the ceiling) and 1 foot below (or to the floor) the line of communication between the trays carrying redundant division cables.

Whenever it becomes necessary to stack open top train A or B trays vertically, one above the other, there is a minimum separation of 3 feet between these trays carrying cables of different divisions. The lower tray shall have a solid steel cover and the upper tray shall have a solid steel bottom. If 3 feet is not attainable, then a fire-resistant barrier is provided. Whenever it becomes necessary to stack channel I, II, III, or IV trays vertically, one above the other, there is a minimum separation of 1 foot between the tray top of lower tray and the tray bottom of upper tray. The lower tray shall have a solid steel cover and the upper tray shall have a solid steel bottom. If 1 foot is not attainable, then a fire-resistant barrier is provided. These barriers for trays (trains or channels) are either a 1/2-inch minimum thickness of Marinite (or its equivalent), or two sheets of steel with a minimum 1-inch air space separating the two sheets of steel. For vertically stacked trays, this barrier extends a minimum of 1 foot (or to nearest wall) on each side of the tray edge. In cases where redundant trays cross, there is a minimum vertical separation of 12 inches (tray top of lower tray to tray bottom of upper tray). The 12 inch separation may be reduced to 1 inch provided the top and bottom tray are totally enclosed (solid top and solid bottom). As the cable trays or enclosed wireways leave the solid-state protection system rack, they are spread as soon as possible to attain these separations.

INSERT New subsection "OPEN CABLE TRAY AND CONDUIT" (Copy attached)

FSAR CHANGE PACKAGE NO. 1109

INSERT IN SECTION 8.3.1.4.2 AFTER SUBSECTION, "AUXILIARY INSTRUMENT ROOM"

OPEN CABLE TRAY AND CONDUIT

Conduits carrying cables of redundant divisions may cross or run parallel to each other provided a minimum separation of one inch exists between any portion of the raceway, (i.e., boxes, fittings, etc.).

A conduit carrying cables of one division may cross or run parallel to a cable tray containing cables of a redundant division, provided a minimum separation greater than one inch exists between tray and conduit.

A conduit carrying cables of one division may cross or run parallel to a cable tray containing cables of a redundant division with one inch separation, provided the tray has a cover, solid bottom or side adjacent to the conduit. The tray cover or solid bottom shall extend a minimum of three feet or to the nearest wall, floor, or ceiling on each side of the centerline of the conduit, for conduits that cross cable trays. Likewise, when conduits run parallel with cable trays, the tray cover or solid bottom shall extend a minimum three feet beyond each end of the influenced portion of conduit, or until the tray terminates or penetrates a wall, ceiling, or floor.

If the above separation requirements are not attainable, a barrier consisting of 1/2 inch minimum thickness of Marinite (or its equivalent) may be used between the raceways, provided the trays are enclosed as specified above. The barrier shall be continuous until spacial separation is attained and extend one inch on both sides of the raceway (Tray or Conduit) as applicable (or to the wall, floor, or ceiling, as applicable).