TENNESSEE VALLEY AUTHORITY

NUCLEAR POWER

GENERAL DESIGN CRITERIA T29 931117 825

QA Record

NO.: WB-DC-30-4

Watts Bar Nuclear Plant

TITLE: SEPARATION/ISOLATION

ISSUE DATE: December 14, 1973

*Signatures are on file with the original document.

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Title: SEPARATION/ISOLATION		REVISION LOG WB-DC-30-4
Revision Number	**Description of Revision**	**Date Approved**
1	Revised sheets 4, 8, 9, 11, 12, 13 and 26 to update criteria to agree with Sequoyah Nuclear Plant Final Safety Analysis Report, Amendment 24, responses to the Atomic Energy Commission questions.	08/23/74
2	Revised Table of Contents and Sheets 1, 3 through 15, 17, and 19 to update criteria to current design requirements and FSAR responses. Revision includes the requirements of DIM-WB-DC-30-4-1 (sections 4.3.4, 4.4.4, and 4.5.2) and exception EX-WB-DC-30-4-1.	04/23/81
3	Incorporated DIM-WB-DC-4-2 (EEB 820809 904), DIM-WB-DC-30-4-3 (EEB 830728 934) and DIM-WB-DC-30-4-4 (EEB 840719 920) into Sections 4.2.3, 4.2.4, 4.5.1, 4.5.2, 6.16 and 6.17).	08/6/84
4	Incorporated DIM-WB-DC-30-4-5 (EEB 841108 901) into Section 5.2 and Appendix A, and DIM-WB-DC-30-4-6 (B43 850620 909) into Sections 4.2.3, 4.2.5, 4.5.1, 4.5.2, 6.16 and 6.17.	10/3/85
5	This revision incorporates applicable commitments and requirements through May 16, 1986. The revised portions of the document are identified by vertical lines. Incorporated DIM-WB-DC-30-4-7 (B43 851125 911) into Section 4.5.4. Incorporated DIM-WB-DC-30-4-8 (B43 860224 902) into Section 4.1.1.8 and 8.0. Reformatted document, including editiorial and organizational changes. Revised Section 4.0 to address separation of cables in free air. Added Section 4.1.4 to address Associated Circuits. Removed cable tray separation from "Fire Hazard Zone." Added separation requirements for NIS cables in Section 4.4.6 and mineral insulated cables in Section 4.4.7. Revised and added information in Section 4.6 for Separation of Internal Wiring. Added identification requirements to Section 5.0 for cables, conduits and cable trays. Added requirements for Electrical Isolation to Section 6.0 along with Appendix B. Added Quality Assurance requirements to Section 7.0. Revised and expanded Reference Section 9.0.	07/27/88

Title: SEPARATION/ISOLATION		REVISION LOG WB-DC-30-4
Revision Number	**Description of Revision**	**Date Approved**
DCN S-12109-A	DCN RIMS Number B26 900922 806 Revised section 4.3.1, "Mechanical Damage (Missile Zone)", page 11, and section 9.0, "References", page 28, to refer to WB-DC-40-64, "Design Basis Events Design Criteria", section 4.8, "Internally Generated Missiles", for identification and evaluation of potential missiles. Page added: iia	10-05-90
DCN S-13225-A	DCN RIMS Number B26 901025 824 This change adds a statement to Section 5.3 declaring the junction box nameplate drawings the official document for junction box numerical identifiers. Pages changed: iia, 22, and 23	10-25-90
DCN S-14468-A	DCN RIMS Number B26 901116 816 This revision written to implement the corrective action of WBP890355. Criteria for contact-to-contact and contact-to-coil isolation was added to Section 6.2 and Appendix B, Section 1.2, respectively. Added reference 9.4.8. Electrical power isolation criteria was moved from Section 6.0 to Section 6.3 Pages affected: iia, 24, 28, 42 Page added: 24a	11-16-90
DCN S-15370-A	DCN RIMS Number B26 910405 832 Revised Section 4.1.4 to not allow cables for non-Class 1E circuits to be run in cable trays with Class 1E circuits if the protection device for the non-Class 1E cable is located in a harsh environment. Incorporated DIM-WB-DC-30-4-9 (B26 890322 010) into Sections 4.1.1.2 and 4.6.1, DIM-WB-DC-30-4-10 (B26 890411 016) in Section 5.5, DIM-WB-DC-30-4-11 (B26 890512 062) into Sections 5.1 and 9.2, DIM-WB-DC-30-4-12 (B26 890622 506) into Sections 4.6, 4.6.1, and 9.2.5, DIM-WB-DC-30-4-13 (B26 891213 076) into Section 4.4.7, DIM-WB-DC-30-4-14 (B26 900123 080) into Sections 4.4.5 and 4.6, and DIM-WB-DC-30-4-17 (B26 900522 083) into Section 5.5	04/05/91

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Revision Number	**Description of Revision**	**Date Approved**
S-15370-A	Incorporated exception EX-WB-DC-30-4-7, EX-WB-DC-4-8, EX-WB-DC-30-4-9, EX-WB-DC-30-4-10, EX-WB-DC-30-4-11, and EX-WB-DC-30-4-14 into Appendix A. Revised Figure C in Section 2.2 to be included in Appendix B rather than Appendix A. Revised Section 4.1.2.1 to maintain a 1-inch separation between any portion of the raceway system which includes boxes, fittings, etc. Pages changed: iia, v, viii, 5, 7, 8, 16, 17, 18, 19 20, 21, 22, 23, 24, 24a, 26, 27, 28 & 45. Pages added: iib, 16a, 19a, 23a, 26a, 26b, 41a, 41b, 41c, 41d, 41e, 41f, 41g, 41h, 41i, 41j, 41k, 41l, 41m, and 41n.	
6	Revised the definition of associated circuits; revised Sections 4.1.1.4, 4.1.1.5, 4.1.2.2, 4.1.4, 4.2.1, 4.6.2, 4.3.3, 4.3.4, 4.3.6, 4.4.5, 8.2, and 9.4; incorporated exceptions EX-WB-DC-30-4-13 and EX-WB-DC-30-4-16; and renumbered pages. Clarified Section 4.1.1.4 in order to resolve an apparent conflict between the Design Criteria and the FSAR. The apparent conflict was due to the 1 inch spacial distance, previously discussed here in, compared to the 12 inch separation, discussed in the FSAR. The 12 inch separation, discussed in the FSAR, can be reduced to 1 inch, provided the involved trays are totally enclosed. This clarification has no known impact on previous design, construction, or commitments (see page 6). Extent of condition is addressed in corrective action per WBP900304PPER (See DCN M-05480). Added Source Note for WBNEEB8701 (390/87-15) and WBP880567 (391/87-16), see Section 4.2.5 (See page 10 and 73). Pages Revised: iv, v, vi, vii, viii, x, 6, 8, 9, 10, 12, 13, 17, 22, 32, 34 Pages Added: 59, 60, 61, 65, 66, 67, 73	08/23/91
DCN S-16007-A	DCN RIMS NUMBER T56 911004 800 Revised Section 4.1.3 to adequately address Cable in Free Air Separations. Pages changed: iv, 8	10/03/91

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Revision Number	**Description of Revision**	**Date Approved**
7	Revised Section 4.4.4 to clarify requirements for P&R cables per Vertical Slice Deficiency Report Number 189 and CAQR WBP880675SCA. Incorporated Exception EX-WB-DC-30-4-15 into Appendix A and renumbered pages. Pages revised: i, vi, vii, viii, ix, x, xi, 15, 32, 67 through 75 Pages added: v, 65, and 66	11/14/91
8	Added Appendix C addressing one-inch minimum separation distance between a conduit and an open top cable tray containing redundant divisions of Class 1E cables, see Section 4.1.2.2 and pages 75 through 81. Pages Revised: i, v, vi, ix, 7, and 75 Pages Added: 76, 77, 78, 79, 80, 81, and 82	12/04/91
9	Incorporated exception requests EX-WB-DC-30-4-17, EX-WB-DC-30-4-18, EX-WB-DC-30-4-19, EX-WB-DC-30-20, EX-WB-DC-30-4-22 into Section 8.0. Added approval DATE/RIMS no. for all exceptions and deleted Appendix A in accordance with NEP 3.2 Revision 1. Clarified the requirements for Section 4.1.1.6. Pages revised: i, v, vi, viii, ix, 6, 27, 28, 29, 30 Pages added: 31 Pages deleted: (Appendix A page no. 35 through 69 of Revision 8). Renumbered pages of text and Appendix B and C (due to retyping and removal of Appendix A, page no. 35 through 69 of revision 8).	08/05/92
10	Incorporated exception request EX-WB-DC-30-4-12, EX-WB-DC-30-4-23 and EX-WB-DC-30-4-24 into Section 8.0. Revised the gauge of cover material to agree with Design Criteria WB-DC-30-22 and other sections of this criteria, see Section 4.1.1.5. In addition, added Appendix D for justification of Barriers specified for use by this criteria. Revised Section 9.4 references as applicable to address OICP-0028 R0 & R1. Corrected typing errors.	02/13/93

Title: SEPARATION/ISOLATION		REVISION LOG WB-DC-30-4
Revision Number	**Description of Revision**	**Date Approved**
10 (cont'd)	Pages revised: i, v, vii, viii, ix, x, 1, 5, 6, 7, 8, 12, 19, 24, 25, 28, 31, 33, 35, 36, 42, Pages added: vi, 34, 49, 50 Pages deleted: None NOTE: Due to revision on page 12, the data shifted to subsequent pages. Only pages with actual text revisions are indicated as revised pages.	
11	Revised criteria to reflect additional Source Noting and incorporated outstanding exceptions EX-WB-DC-30-4-17 R1, EX-WB-DC-30-4-23 R3, and EX-WB-DC-30-23 R4. Pages Revised: i, vi, vii, 1, 2, 3, 4, 6, 8, 14, 28, 32, 33, 34, and 51 Pages Added: None Pages Deleted: None	9/9/93
12	Revised criteria to address separations when electrical conduit seal assemblies are used on devices with only one opening, see Section 4.1.2.4 and incorporated outstanding exception EX-WB-DC-30-4-23, Revision 5. Pages Added: None Pages Revised: i, vi, vii, 8, and 35. NOTE: Due to revision on Page 8, the text data shifted to subsequent pages. Only pages with actual text revisions are indicated as revised pages.	NOV 17 1993

COORDINATION LOG

Document No: WB-DC-30-4

Title: SEPARATION/ISOLATION

Revision: 12

R-Denotes review

A-Denotes approval/ agreement

~~WATTS BAR ENGINEERING PROJECT (WBEP)~~ Corp. Eng. [handwritten initials] 11/17/93

CE		EE		M/N		Contracts Section							
R	A	R	A	R	A	R	A	R	A	R	A	R	A
		JAK	[signature]										

PROJECT ENGINEERING (PR ENG)

BFEP		BLEP		SOEP		WBEP/LME		WP		PSB		WBEP/MOE			
R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A
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OPERATIONAL ENGINEERING						NQA									
EO		M/W/C		Safety											
R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A

STAFFS						OTHER ORGANIZATIONS									
BACS		ERIS		PSS		BFN	NSD	BLN	NSD	SON	NSD	NO		NC	
R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A

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ABBREVIATIONS

ADGU - Additional Diesel Generator Unit
DBE - Design Basis Events
ERCW - Emergency Raw Cooling Water
ESAS - Essential Supporting Auxiliary Systems
ESF - Engineered Safety Features
GSPS - Generating Station Protection System
NIS - Nuclear Instrumentation System
NRC - Nuclear Regulatory Commission
PAM - Post Accident Monitoring
PVC - Polyvinyl Chloride
RPS - Reactor Protection System

DEFINITIONS

Associated Circuits	Non-Class 1E circuits that share power supplies, enclosures, or raceways with Class 1E circuits (see section 4.1.4 for other details).
Barrier	A device or structure interposed between Class 1E equipment or circuits and a potential source of damage, to limit damage to Class 1E systems to an acceptable level.
Class 1E	The safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling and containment and reactor heat removal, or are otherwise essential in preventing significant release of radioactive material to the environment.
Design Basis Events	Postulated events specified by the safety analysis of the station used in the design to establish the acceptable perforance requirements of the structures and systems.
Engineered Safety Features	Features of a unit, other than reactor trip or those used only for normal operation, that are provided to prevent, limit, or mitigate the release of radioactive material.
Isolation Device	A device in a circuit which prevents malfunctions in one section of a circuit from causing unacceptable influences in other sections of the circuit or other circuits.
Redundant	An equipment or system that duplicates the essential function of another equipment or system to the extent that either may perform the required function regardless of the state of operation or failure of the other.

1.0 SCOPE

The purpose of this document is to define the design requirements for electrical separation/isolation of the distribution equipment and wiring (control, power, and signal cables) for Class 1E electric systems and components of the Watts Bar Nuclear Plant. Class 1E electric systems include all electric equipment that is essential to the safe shutdown and isolation of the reactor or whose failure or damage could result in significant release of radioactive material. This equipment and these cable systems must provide an extremely reliable network for power, control, and signal circuits within the plant. This document is intended to provide guidance in determining separation requirements of the electrical power, control, signal, and instrumentation installations which will enable these systems to meet their functional requirements under the conditions produced by any design basis event (any event that would threaten the safe shutdown and isolation of the reactor).

If a discrepancy exists between this design criteria and another plant specific design criteria the Lead Electrical Engineer should be notified by memo, in order for appropriate action to be taken.

2.0 FUNCTIONAL DESCRIPTION[4]

The nuclear power generating station protection system (GSPS) includes the reactor protection system (RPS), engineered safety features (ESF), essential supporting auxiliary systems (ESAS), and Class 1E electric systems as defined in IEEE 308 (Reference 9.3.2). These systems are required for the safe shutdown of the reactor. Redundant systems of GSPS are provided so that single failures including failure of a redundant subsystem will not result in failure to safely shut down the reactor. In order to ensure that the total installed system will satisfy the single failure criterion, as stated in paragraph 4.2 of IEEE 279 (Reference 9.3.1), complete isolation or separation of the components of one redundant system from the components of the other redundant system(s) shall be provided. The isolation or separation shall be physical as well as electrical. This document establishes minimum criteria for physical arrangement, separation, protection, and identification of the Class 1E electric power, control, signal, and instrumentation circuits of the GSPS. The intent is to supplement, but not supplant, good wiring practices.[3]

The RPS is the overall complex of instrument channels, power supplies, logic channels, trip actuators and actuators together with their interconnecting wiring which automatically initiates a reactor trip. The ESF and ESAS take automatic action to isolate the reactor and to provide the cooling necessary to remove the thermal energy and thus enable the containment of fission products within the reactor vessel and primary containment in the event of a serious reactor accident. Certain ESAS systems may also be on continuous duty to prevent, as well as to

2.0 FUNCTIONAL DESCRIPTION (continued)

mitigate reactor accidents. Examples of ESAS systems are component cooling water (CCW) and emergency raw cooling water (ERCW) together with their supporting electrical power and control systems.

The ESF system consists of sensor instrument channels, power supplies, actuation channels, trip actuators, and actuators together with their interconnecting wiring involved in the operation of the ESF equipment. Redundant ESF systems are actuated by separate actuation channels. Each coincidence network energizes an ESF actuation device that operates the associated ESF equipment (e.g., motor starter, valve operator, etc).

The Class 1E electric systems provide the electric power used to safely shut down the reactor and limit the release of radioactive material following a design basis event. The electric systems included are comprised of the following interrelated systems:

1. Alternating-current power systems.
2. Vital dc power systems.
3. Vital ac instrumentation and control power systems.

3.0 DESIGN CONSIDERATION[4]

All Class 1E electric equipment shall have physical separation, redundancy, and protection to limit resulting damage that would threaten the safe shutdown of the reactor. No internally generated fault shall propagate from Class 1E electric equipment to its redundant counterpart during any design basis event. All Class 1E equipment required to operate during a design basis flood shall be located above the maximum probable flood level unless it is designed to operate submerged in water, or otherwise protected.

Class 1E electrical loads performing the same safety function shall be fed from two or more redundant load divisions (channels or trains). The number of divisions shall be determined by the number of independent sources of power required for a given function. The redundant electrical equipment shall be separated by sufficient physical distance or protective barriers. The separation distance shall be determined by the severity and location of hazards. The environment in the vicinity of the equipment shall be controlled or protection provided such that no environmental change or accident will adversely affect the operation of the equipment.

The RPS, ESF actuation system, ESAS, and Class 1E electric systems must function to initiate shutdown of the reactor and initiate engineered safety features, if required, under the conditions produced by the design basis event occurring before, during, or after the abnormality requiring protective action.

3.0 DESIGN CONSIDERATION (continued)

As a minimum, the RPS must initiate shutdown of the reactor and initiate safeguards action, if required, while suffering the loss of any single component. Class 1E electric systems, common to several engineered safety features, must provide their intended function while assuming failure of any component in the system. In analyzing such systems, consideration must be given to system failures which may affect several RPS and ESF subsystems.

Electrical wiring for the GSPS shall be segregated into separate divisions (channels or trains) such that no single event, such as a short circuit, fire, pipe rupture, missile, flooding, etc., is capable of disabling sufficient equipment to prevent safe shutdown of the reactor, removal of decay heat from the core, or to prevent isolation of the primary containment. The degree of separation required for GSPS electrical cables varies with the potential hazards in a particular zone or area of the power plant. These criteria do not attempt to classify every zone or area of the nuclear plant, but specifies minimum requirements and guidelines to be applied with good engineering judgment as an aid to prudent and conservative layout of electrical cable trays, wireways, conduits, cables, etc., throughout the plant (both inside and outside containment).

4.0 SEPARATION REQUIREMENTS[4]

The redundant divisions of GSPS cables must have such physical separation as is required to assure that no single credible event will prevent accomplishment of the required safety function.

4.1 Separation For Electrical Raceway and Wiring

4.1.1 Cable Tray Separations

4.1.1.1 In any room or space (except the Auxiliary Instrument Room and the Annulus) in which the only source of fire is of an electrical nature, cable trays containing redundant divisions of GSPS cables shall have the following minimum separation distances:

Horizontal Separation

Cable trays carrying redundant divisions of GSPS cables shall have a minimum horizontal separation of 3 feet.[2] When this separation distance is not attainable, a fire resistant barrier as defined in Section 4.1.1.5 shall be used which extends at least 1 foot above (or to the ceiling) and 1 foot below (or to the floor) the line-of-sight communication between trays carrying the redundant divisions of GSPS cables.

4.1.1 Cable Tray Separations (continued)

Vertical Separation

Vertical stacking of trays carrying cables of redundant divisions (channels or trains) of GSPS cables should be avoided where possible. However, whenever it becomes necessary to stack open top trays vertically, one above the other, there shall be a minimum vertical separation of 5 feet[2] between 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 a vertical separation of 5 feet is not attainable, a fire-resistant barrier as defined in Section 4.1.1.5 shall be provided. This barrier shall extend a minimum of 3 feet (or to the nearest wall) on each side of the tray edge.

Pass-Bys

Where horizontal cable trays and vertical cable trays (pass-bys) carrying redundant divisions of GSPS cables have a horizontal separation of less than 3 feet (horizontal tray to vertical tray), the vertical cable tray(s) shall have a solid steel cover and/or bottom for a minimum distance of 5 feet above and 1 foot below the horizontal cable tray(s), or to the ceiling and the horizontal cable tray(s) shall have a solid steel cover and bottom for a minimum distance of 3 feet on each side of the vertical cable tray(s) or to the wall(s).

4.1.1.2 Cable trays in the auxiliary instrument room and the annulus (see Sections 4.3.4 and 4.3.6) containing redundant divisions of GSPS cables shall have the following minimum separation distances:

Horizontal Separations

Cable trays carrying redundant divisions of GSPS cables shall have a minimum horizontal separation of 1 foot. When this separation distance is not attainable, a fire resistant barrier as defined in Section 4.1.1.5 shall be used which extends at least 1 foot above (or to the ceiling) and 1 foot below (or to the floor) the line of sight communication between the trays carrying the redundant divisions of GSPS cables.

4.1.1 Cable Tray Separations (continued)

Vertical Separation

Vertical stacking of trays carrying cables of redundant divisions (channels or trains) of GSPS cables should be avoided where possible. However, whenever it becomes necessary to stack open top trays vertically, one above the other, there shall be a minimum vertical separation of 3 feet between the trays carrying cables of different divisions, except for channelized tray in the auxiliary instrument room. The lower tray shall have a solid steel cover and the upper tray shall have a solid steel bottom.

Redundant channel trays stacked vertically in the auxiliary instrument room shall have a minimum separation of 1 foot between the tray top of the lower tray and the tray bottom of the upper tray. The lower tray shall have a solid steel cover and the upper tray shall have a solid steel bottom.

If the above vertical separations are not attainable, a fire-resistant barrier shall be provided. See Section 4.1.1.5. This barrier shall extend a minimum of 1 foot (or to the nearest wall) on each side of the tray edge.

Pass-Bys

Where horizontal cable trays and vertical cable trays (pass-bys) carrying redundant divisions of GSPS cables have a horizontal separation of less than 1 foot (horizontal tray to vertical tray), the vertical cable tray(s) shall have a solid steel cover and/or bottom for a minimum distance of 3 feet above and 1 foot below the horizontal cable trays(s), and the horizontal cable tray(s) shall have a solid steel cover and bottom for a minimum distance of 3 feet on each side of the vertical cable tray(s) or to the wall(s).

4.1.1.3 Non-Class IE and Class IE

The minimum standard separation between non-Class 1E and Class 1E cable trays stacked vertically shall be 12 inches, tray bottom to tray bottom. When this spacing is not possible, spacing may be decreased provided adequate access for cable installation is maintained (typically 6 to 9 inches tray bottom to tray bottom, see note below) and the top tray has a solid bottom or bottom cover. However, the standard 12 inch spacing should be resumed as soon as practical. The spacing between horizontal cable trays shall be 6 inches (side rail to side rail).

4.1.1 Cable Tray Separations (continued)

4.1.1.3 Non-Class IE and Class IE (continued)

NOTE: Tray spacings less than the above minimum standard, are to be generally avoided. Deviations should be limited to facilitate changes in elevation of the tray stack or to avoid interferences, e.g., pipe, supports, heat and vent ducts, etc.

4.1.1.4 Tray Crossings

In cases where trays carrying cables of redundant divisions of GSPS cable cross, there shall be a minimum vertical separation of 12 inches (tray top of lower tray to tray bottom of upper tray).[2] The bottom tray shall be covered with a solid steel cover and the top tray provided with a solid steel bottom for a minimum distance of 3 feet[2] or to the nearest wall, floor, or ceiling on each side of the tray crossing. When this 12-inch minimum separation cannot be maintained, the separation may be reduced to 1-inch, if the raceways are totally enclosed (solid top and bottom) for the distance specified above.

4.1.1.5 Barriers

Where the minimum separation distances in Sections 4.1.1.1 through 4.1.1.3 are not attainable, fire resistant barriers shall be used. This barrier shall be either a 1/2-inch minimum thickness of Marinite 36, Marinite I (or their Engineering approved equivalent), or two sheets of minimum 18-gauge steel with a minimum 1-inch air space separating the two sheets of steel (See Appendix D).

4.1.1.6 Divisional

Within a division, vertical spacing between cable trays in a stack should be 12 inches, tray bottom to tray bottom. Since the purpose of this requirement is to provide access for cable installation only, when this spacing is not possible, spacing may be decreased provided adequate access for cable installation is maintained. However, the 12-inch minimum standard spacing should be resumed as soon as practical. The horizontal spacing between cable trays within a division should be 6 inches. This separation is not a requirement, but is included as good design practice for ease of cable installation.

The note in Section 4.1.1.3, also applies to this section.

4.1.1.7 The minimum separation distances specified in Sections 4.1.1.1 and 4.1.1.2 should be achieved as soon as practical by spreading the trays.

4.1.1 Cable Tray Separations (continued)

4.1.1.7 Divisional (continued)

When solid tray covers are required between redundant divisions of GSPS cables, they shall overlap the siderail by a minimum of 1/8 inch.

4.1.1.8 Analysis

As an alternate to maintaining the separation requirements defined in Section 4.1.1.1 through 4.1.1.4, a case by case analysis shall be made to ensure that redundant Class 1E circuits are not degraded below an acceptable level. The analysis should include consideration of the potential energies of the circuits involved; the physical and electrical isolation provided for the circuits by the cable insulation, the cable jacketing systems, and the cabling shielding; or the degree of environmental qualification and fire retardant characteristics of the cables.

4.1.2 Conduit Separations

4.1.2.1 Conduits carrying cables of redundant divisions may cross or run parallel to each other provided a minimum separation of 1 inch exists between any portion of the raceway, (i.e., boxes, fittings, etc.).

4.1.2.2 A minimum separation of 1 inch is also required when a conduit of one division crosses or runs parallel to a cable tray containing cables of a redundant division, provided the tray portion has a cover or is solid on the side adjacent to the conduit, see Appendix C herein. The tray cover or solid bottom shall extend a minimum of 3 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 3 feet beyond each end of the influenced portion of conduit, or until the tray terminates or penetrates a wall, ceiling or floor.

4.1.2.3 If the above separation requirements (Sections 4.1.2.1 & 4.1.2.2) are not attainable, a barrier consisting of 1/2-inch minimum thickness of Marinite-36, Marinite I (or their equivalent) may be used between the raceways, provided the trays are enclosed as specified in Section 4.1.2.2. The barrier shall be continous until spacial separation is maintained and extend 1 inch on both sides of the raceway (Tray or Conduit) as applicable (or to the wall, floor or ceiling as applicable). As an alternate, a case-by-case analysis shall be made to ensure that redundant Class 1E circuits are not degraded below an acceptable level. This analysis shall be consistent with the analysis referenced in Section 4.1.1.8.

4.1.2 Conduit Separations (continued)

4.1.2.4 Cables for Non-Class 1E functions shall not be run in conduit used for GSPS circuits except at equipment terminations where only one conduit entrance is available.. In some cases, devices with only one opening require an electrical conduit seal assembly (ECSA). These ECSAs are supplied with pigtails for connection to the field cable and pass through the seal into the device. As a result, it is acceptable for conductors of GSPS cables of one safety-related division and conductors of non-Class 1E cables to be connected to adjacent conductors of the ECSA pigtail. When the pigtail is required to be scheduled, see Reference 9.2.21, Section 7.3.15.10-2, the pigtail identifier shall include the alpha designation for the division of separation of the involved GSPS field cable, see Reference 9.2.21, Section 7.3.15.1. The Non-Class 1E cable shall be separated from the GSPS cable as near to the terminal equipment as practical.

4.1.2.5 Non-Class IE circuits routed in Category I structures are evaluated in order to determine if they are to be classified as associated circuits, see Section 4.1.1 below (Reference 9.4.9, 9.4.10, 9.4.11). As a result, no specific minimum separation distance is required between conduits carrying cables for Non-Class 1E functions and conduits or cable trays carrying GSPS cables.

4.1.2.6 Embedded conduits carrying cables of redundant divisions shall be embedded in seismic Category I reinforced concrete. Design requirements for embedded conduits are defined in Design Criteria WB-DC-20-1 "Concrete Structures" (Reference 9.2.7).

4.1.3 Cable in Free Air Separations

Redundant divisions of GSPS cables routed in free air (external to equipment and/or raceway) shall not violate the minimum separation distances of 1-foot horizontal and 3-foot vertical for the Auxiliary Instrument Room and the Annulus or 3-foot horizontal and 5-foot vertical for all other plant areas. Non-Class 1E cables and Class 1E cables routed in free air should be separated to the maximum extent practical, but as a minimum they shall not touch or be able to migrate with time to touch, unless they are associated (Reference 9.4.9, 9.4.10, and 9.4.11). The above separation shall also apply between cable in free air and cable tray. Separation by voltage level should be maintained, such that cables of different voltage levels do not physically touch, unless analysis can show that voltage level separation is not required.

4.1.4 Associated Circuits[2]

If a non-Class 1E cable, is routed in a cable tray with a Class 1E cable; or is not separated from Class 1E cable by 6-inches or a barrier inside equipment; or touches Class 1E cable in free air, that cable shall be classified as an associated cable or associated circuit. That cable or any other cable in the same circuit shall not subsequently be routed with a different division of GSPS cables. Protective devices

4.1.4 Associated Circuits (continued)

for associated cables shall not be located in a harsh environment (Reference 9.1.1), unless justified by analysis and shall be of a high quality commensurate with their importance to safety. The cables 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.

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 (see Section 6.0).

4.2 Separation for Specific Equipment

4.2.1 6900-Volt Equipment

The diesel generators and 6900-volt shutdown boards shall be designed for a two-division (train A and train B) separation. The 6900-volt shutdown equipment shall be located in seismic Category I structures. Each diesel generator shall have a reinforced concrete barrier separating it from the adjacent unit, and have no single credible hazard available that would jeopardize more than one unit. The 6900-volt shutdown boards shall be located in the auxiliary building above the probable maximum design basis flood level.

The 6900-480 volt shutdown board transformers shall be designed for a two-division (train A and train B) separation. The 6900-480 volt shutdown board transformers shall be located above the probable maximum design basis flood level. A reinforced concrete wall shall be used to separate train A 6900-480 volt shutdown board transformers from train B 6900-480 volt shutdown board transformers.

A minimum distance of 10 feet shall be used to separate shutdown board 1A-A from shutdown board 2A-A, and shutdown board 1B-B from shutdown board 2B-B. A reinforced concrete wall shall be used to separate 6900-volt shutdown boards 1A-A and 2A-A from shutdown boards 1B-B and 2B-B. Electrical requirements for 6900-volt equipment are defined in Design Criteria WB-DC-30-28 "Low and Medium Voltage Power System." (Reference 9.2.4).

APPENDIX C
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BASIS FOR USING A ONE INCH MINIMUM SEPARATION DISTANCE BETWEEN A CONDUIT AND CABLE TRAY CONTAINING REDUNDANT DIVISIONS (CHANNEL OR TRAIN) OF CLASS 1E CABLES:

C1.0 INTRODUCTION:

Watts Bar's (WBN) raceway separation requirements are the same, in many respects, as those contained in Regulatory Guide (RG) 1.75; for example, tray to tray and conduit to conduit separation distances are identical to Reg. Guide 1.75 requirements when the trays/conduits contain redundant divisions of Class 1E cables (see Ref. 9.5.2). However, the WBN design preceded the issuance of RG 1.75; consequently, as stated in Note 2 of FSAR Section 8.1.5.4, WBN is not committed to complying with the requirements of this Regulatory Guide. Raceway separations at WBN are based upon meeting the intent of RG 1.6, Revision 0, and references 9.3.1 and 9.3.2 of this document - 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. To ensure this independence is achieved in a conduit/tray configuration (see Section C2.6), a one inch minimum separation distance shall be used. The following reasoning/rational is provided to justify the acceptability of this one inch minimum separation distance, provided the portion of the tray adjacent to the conduit is solid (via siderail or top or bottom cover as applicable). In addition, this rationale also provides reasoning for no cover (top or bottom) for separation distances greater than one inch. Note: RG 1.75 does not address separation requirements for conduit/tray configurations.

C2.0 DEFINITIONS:

The following definitions apply to the terms as used in this Appendix.

C2.1 Fault - A condition in which an electrical component (cable or piece of equipment) has experienced a malfunction (short to ground, phase to phase short, etc.) and the primary protective device does not operate or operate properly to clear the condition.

C2.2 Electrical Isolation - Protection of Class 1E cables against the electrical energy (potentially a fire) associated with a fault in a redundant division of Class 1E cables.

C2.3 Physical Isolation - Protection of Class 1E cables against the physical energy (inertia) associated with a fault in a redundant division of Class 1E cables.

C2.4 Use of the term "tray" in this Appendix will be understood to refer to an open cable tray having a ladder bottom and no cover and to contain Class 1E cables.

C2.5 Use of the term "conduit" in this Appendix will be understood to contain Class 1E cables.

C2.6 Use of the term "conduit/tray configuration" in this Appendix will be understood to consist of an installation involving a conduit in close proximity to a tray. The conduit will be assumed to contain one division of Class 1E cables and the tray to contain a redundant division of Class 1E cables.

C3.0 TECHNICAL BASIS:

Minimum separation distances are necessary to provide physical and electrical isolation for redundant divisions of Class 1E cables. These distances are designed to prevent a fault on a cable in one raceway (conduit, tray, etc.) from propagating to a raceway containing cables from the redundant division. Since Watts Bar is not committed to RG 1.75, the following reasoning/rationale is used as the basis for a minimum separation distance of one inch in a conduit/tray configuration.

C3.1 Conduits in exposed applications at Watts Bar are metallic. Per reference C5.1, thin wall conduit (EMT) is not allowed in a Category I structure and intermediate metal conduit (IMC) is only recommended for use outside of Category I structures. Consequently, the metal conduit at Watts Bar (primarily rigid steel with some applications involving aluminum) is sufficient to provide protection for the cables contained therein against the physical energy associated with a fault on a cable in a tray. The converse is also true. Therefore, physical isolation is achieved in a conduit/tray configuration and will be addressed no further.

C3.2 A conduit has a limited amount of internal space. When cables are installed in conduit, this internal space is reduced (consumed by the cables). This reduction will be equal to or less than 53 percent (see Reference C5.3). Consequently, space available inside the conduit for the oxygen (necessary to support combustion) is limited. In addition, many conduits are required to be sealed for fire protection purposes or have a Conax fitting at the end device for environmental qualification purposes, or both. If a fault did occur causing a cable inside of a conduit to reach auto-ignition temperature, the oxygen level might be sufficient to allow a fire to start but is not likely to be sufficient to support combustion. Thus, the likelihood of propagating an internally initiated fire outside of the conduit would be extremely remote. Therefore, the probability of damage to redundant Class 1E cables in an adjacent tray due to a fault on a cable in a conduit is sufficiently remote to conclude that electrical isolation is achieved.

C3.3 Based on Section C3.2, and provided the conduit and tray are sufficiently separated to avoid unacceptable heat transfer, electrical isolation is achieved in a conduit/tray configuration when the fault occurs on a cable routed in the conduit. A one inch minimum separation distance should be more than ample to dissipate the heat radiated from the conduit. (The heat should be minimal, since sustained combustion is not expected inside the conduit.)

C3.4 V1 and V2 cables are signal level cables and do not contain sufficient energy for a fire to occur under faulted conditions (i.e., the cable insulation would never reach auto ignition temperature due to a fault. Therefore, a fault on a tray containing V1 and V2 cables would not threaten redundant Class 1E cables routed in a conduit. See Reference C5.2 for definition of voltage levels. Therefore, ensuring electrical isolation for V1 and V2 cables in any raceway configuration is of no concern and will be addressed no further.

C3.5 Cables enter primary containment via the annulus; all V3, V4, and V5 cables are required to have primary and secondary protective devices for penetration protection (see Section 5.2 of Reference C5.2); consequently, a fault as defined in this Appendix, will not occur on cables in the annulus, since it would be interrupted by the secondary protective device. Therefore, electrical isolation for conduit/tray configurations in the annulus is of no concern.

C3.6 There are no trays containing Class 1E cables inside primary containment or the steam valve vaults. Therefore, electrical isolation for conduit/tray configurations inside primary containment and the valve vaults is of no concern.

C3.7 As a general rule, faults having sufficient energy to electrically initiate a fire are most likely to occur in V4 and V5 cables. In the cable spreading room of the control building, there are no V4 or V5 trays and in the auxiliary instrument room, cables with a protective device rated greater than 30 amps must be routed in conduits (see Section 4.3.4 of this document). Therefore, conduit/tray configurations for which electrical isolation would be most critical are non-existent in the cable spreading room and the auxiliary instrument of the control building.

C3.8 In References 9.4.9, 9.4.10. and 9.4.11 of this document, it is proven that Class 1E cables are protected from thermal damage due to a fault on non-Class 1E cables routed in the same tray. Each Non-Class 1E cable routed with 1E cables shall be protected with a fuse, two circuit breakers in series or a single circuit breaker which is tested periodically.

NOTE: References 9.4.9, 9.4.10, and 9.4.11 are calculations and are updated via WBN's design process when future design changes are made.

C3.9 RG 1.75 allows a 1 inch minimum separation distance between enclosed raceways. Trays with covers and solid bottoms are enclosed raceways and may be as close a 1 inch for purposes of electrical separation. Therefore, the thickness of material between the cables within the two trays is two thicknesses of tray (typically 16 to 18 gauge for WBN). When actual distance between a tray and a conduit is greater than one inch in a conduit/tray configuration, the tray is not required to be enclosed per Section 4.1.2.2; however, rigid conduit thickness is approximately equal to or greater than two thickness of tray cover (dependent on conduit size and type).

C3.10 For a fire in a tray to be a significant threat to redundant Class 1E cables in a conduit, it must be sustained; a sustained fire in a tray resulting from an electrical failure is not likely. In the unlikely event that a sustained, electrically initiated fire did ever occur in a tray, the following would allow additional time for measures to be taken which would help ensure that electrical isolation was maintained.

C3.10.1 A conduit would temporarily serve as a heat shield for the cables contained therein. In addition, the conduit, along with its supports, would temporarily serve as a sink to transfer heat away from the source, thereby minimizing hot spots, provided the conduit and tray were not touching.

C3.10.2 The fire detection system would provide early notification of the problem. In addition, activation of the suppression system would occur and/or the fire brigade would be dispatched to assess the situation and take appropriate actions. Therefore, the distance a fire would propagate along the tray would be minimized.

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C3.10.3 For the following reasons, the probability is high that the fire would not propagate a significant distance:

- Cables routed in a seismic category I structure are required to, as a minimum, pass the vertical flame test of Section 6.19.6 of ICEA S-19-81 per Section 3.1 of Reference C5.2.

- After 07/13/88, new cables routed on cable trays in a seismic category I structure are required to pass the vertical flame test requirements of IEEE 383-1974 per Reference C5.2.

- Prior to 07/13/88, Non-IEEE 383 qualified cables routed on a tray in a seismic category I structure were required to be coated with a flame retardant material when the number of uncoated cables exceeded nine or ten as applicable (see Reference C5.4). The amount of combustables associated with 10 uncoated cables is insignificant, thus keeping the temperature of the heat source low.

- Actuation of the fire suppression system.

- To comply with other electrical separation requirements, certain trays have covers and/or solid bottoms which would restrict the oxygen available to support combustion.

- To comply with Appendix R separation requirements, certain trays have a one-hour or three-hour fire wrap installed around the tray.

- Penetration fire stops/pressure seals, (installed in walls and floors designated as fire barriers and/or pressure seals), are designed to prevent propagation of a fire beyond the seal.

C3.11 In general, the physical arrangement of redundant Class 1E equipment in all plant areas of Category I structures helps to minimize conduit/tray configurations which could compromise the electrical isolation of redundant Class 1E cables. For example, the Unit 1 train A 6.9KV shutdown board is located between column lines S and T while the train B counterpart is located between column lines R and S on EL 757.0 of the auxiliary building; the Unit 1 train A 480V shutdown boards are located between column lines S and U while the train B counterparts are located between column lines Q and S on EL 757.0 of the auxiliary building; etc.

C4.0 CONCLUSION:

The reasoning and rationale provided above establishes that the probability of an unacceptable interaction in a conduit/tray configuration due to a one inch minimum separation distance is sufficiently remote to conclude that the independence of redundant safety-related cables is achieved and that the safe shutdown of the plant is not degraded to an unacceptable level. The following provides additional credibility to this conclusion. To adversely impact safe shutdown of the plant, all of the following conditions would have to exist simultaneously. The probability for this to occur is extremely remote.

- A cable or piece of equipment would have to experience a malfunction, and
- The primary breaker would have to malfunction or not operate properly, and
- The faulted cable would have to be routed in a tray (see Section C3.2), and
- The faulted cable would have to result in a fire in the tray, and
- The fire in a tray would have to occur at the same location (or burn long enough to propagate along the tray to the same location) as a conduit containing cables for the redundant Class 1E equipment, and
- The temperature inside the conduit in a conduit/tray configuration would have to be sufficiently elevated to prevent the cables from performing their intended safety function.

In addition, redundant Class 1E cables required for safe shutdown of the plant in the event of an Appendix R fire have already been/will be analyzed and made to comply with Appendix R separation (see Reference 9.2.8). In general, Appendix R separation requirements are much more stringent than the separation requirements necessary to cope with a fire initiated by a fault on a cable.

Consequently, one inch will be used as the minimum separation distance between a conduit containing one division of Class 1E cables and a tray containing a redundant division of Class 1E cables provided the portion of the tray adjacent to the conduit is solid. In addition, when more than one inch of separation exists, between the conduit and tray, a top or bottom cover is not required.

C5.0 REFERENCES:

C5.1 EEB-G-22.2-27, "Electrical Engineering Branch Guidelines for Conduit System Design" (B43 871001 925).

C5.2 WB-DC-30-5, R5, "Power, Control and Signal Cables For Use in Category I Structures."

C5.3 DS-E13.1.4, R1, "Conduit - Maximum Cable Diameter For Various Rigid Steel Conduits."

C5.4 Design Drawings (See DCN P-03542-A).

ENCLOSURE 2

TVA

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

William J. Museler
Site Vice President, Watts Bar Nuclear Plant

DEC 17 1993

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

Gentlemen:

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

WATTS BAR NUCLEAR PLANT (WBN) - TVA'S POSITION INVOLVING TWO NRC IDENTIFIED ISSUES IN RELATION TO REGULATORY GUIDE 1.75

The purpose of this letter is to provide TVA's position involving two NRC issues regarding Regulatory Guide 1.75 identified during inspection 390, 391/93-74. The enclosure provides a discussion of these two issues. The first issue involves TVA's practice of cable splicing in certain raceways. The second issue involves the relationship of TVA's design criteria for conduit to open top tray separation to the Final Safety Analysis Report (FSAR).

If you should have any questions, contact P. L. Pace at (615)-365-1824.

Very truly yours,

W. J. Museler

William J. Museler

Enclosure
cc: See page 2

~~9401060022~~ 5P.

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ENCLOSURE

TVA'S POSITION
IN RESPONSE TO NRC ISSUES
IDENTIFIED IN INSPECTION 390,391/93-74

During the subject NRC inspection, two issues were identified which involve TVA's position regarding Regulatory Guide (RG) 1.75 at WBN. The first issue involves TVA's practice of cable splicing in certain raceways which may not meet the requirements of RG 1.75. The second issue involves the relationship of TVA's design criteria for conduit to open top tray separation in the Final Safety Analysis Report (FSAR). Responses to each issue are provided below:

ISSUE 1

Drawing 45W883-3, Revision 3, and Specification G-38 permit cable splicing in conduit raceways. This may not meet the requirements of RG 1.75 which prohibits splicing in raceways without NRC approval.

RESPONSE

As stated in the implementation section of RG 1.75, January 1975, this guide applies to construction permit applications for which the issue date of the Safety Evaluation Report is February 1, 1974, or after. Since the construction permit for Watts Bar was issued January 23, 1973, and RG 1.75 was issued after the Watts Bar design was complete, WBN is not committed to complying with the requirements of this Regulatory Guide. This is stated as Note 2 of FSAR Section 8.1.5.3.

Raceway separations at WBN are based upon meeting the intent of RG 1.6, Revision 0, IEEE Std 279-1971 and IEEE Std 308-1971. This information was previously provided to the NRC in response to FSAR question 040.25 and is documented in FSAR sections 7.1.2.2 and 8.3.1.4. However, it is noted that RG 1.75, Revision 0 established the minimum separation distances for conduit to conduit and for tray to tray carrying cables of redundant divisions. These distances are based on cable splices in raceways being prohibited. RG 1.75, Revision 1 supplemented this basis as follows:

> "Splices are not, by themselves unacceptable. If they exist, the resulting design should be justified by analysis. The analysis should be submitted as part of the Safety Analysis Report."

TVA concurs with the above position and generally disallows splicing within raceways except for the following cases:

1. In accordance with Standard Drawing SD-E12.5.1-2, Revision 1, splices in conduit banks may be made in manholes, cable trays in manholes or in handholes. Cables in the Class 1E conduit duct banks to the intake pumping station and diesel generator building are spliced in the cable trays within

the duct bank manholes. The redundant duct banks have a fire rated barrier between the train A and B sections within a manhole or have completely separate manholes. Since the nearest manhole/handhole is approximately 80 feet or more away, the splices in the duct banks into the auxiliary building, intake pumping station and diesel generator building are sufficiently isolated from these areas. Therefore, a fire as a result of a splice failure in one divisional raceway would not propagate to another Category 1 structure.

2. In accordance with General Engineering Specification G-38, splices are not to be installed in conduits, except for termination to pigtail leads and pigtail extensions which can be made in flex conduits which connect to the end device. In accordance with Standard Drawing SD-12.5.1-3, Revision 1, it is acceptable for the pigtail extension splice to be located in flexible conduit connecting to the equipment. Drawing 45W883-3, Revision E, allows splices in a short rigid conduit connection adjacent to a device when a Conax Electrical Conductor Seal Assembly is used to provide an environmental moisture seal.

   When splices are installed in flexible conduits or, in the case of a conductor seal assembly, a short rigid section of conduit adjacent to the device, the cable being spliced is dedicated to the one device. Therefore, due to separation and/or protection requirements, a fire caused by a splice failure in the conduit section would be sufficiently isolated from the redundant safety related circuit that it would not compromise that circuit. Since the installation of the spliced sections of cable are installed in flex at end devices or short rigid sections for conductor seal assemblies, those sections are installed by sliding the conduit over the cable rather than pulling it into the raceway thereby minimizing potential for damage to the splice due to excessive pull force. Additionally, in the case of instrumentation circuits, there is a low probability of fire due to low energy levels.

3. Finally, standard drawing SD-E12.5.9, Revision 0, details splicing methods that can be used in cable trays in areas other than that allowed by standard drawing SD-E12.5.1-2. In the two methods used for splicing in cable trays, the splice is either contained in a rigid conduit sleeve within the tray with a fire seal at each end of the conduit sleeve or it is located in the tray with a solid metal barrier between each spliced cable section and other cables. A fire seal is located at each end of the tray section containing the splices. A cable tray cover is required to be mounted on the top and bottom of the tray sections containing the splice if it is not contained in a rigid conduit sleeve. Due to the restrictions on splicing in raceways detailed on standard drawing SD-E12.1.5-2, the methods of splicing in cable trays detailed of SD-E12.5.9 are to be used only in extraordinary situations with engineering approval required.

In conclusion, even though WBN is not required to meet RG 1.75, sufficient engineering requirements exist, as explained above, that analysis for splicing in raceways does not need to be included in the FSAR.

ISSUE 2

Are class 1E conduit to open top tray separation requirements, as described in design criteria WB-DC-30-4, adequate and properly reflected in the FSAR?

RESPONSE

As mentioned in the above response to Issue 1, RG 1.75 , Revision 0 (and the current Revision 2) provides guidance for spatial separation requirements between class 1E conduit to class 1E conduit and between tray to tray configurations. In addition, these documents discuss separation requirements for enclosed raceway and associated circuits. However, guidance for spatial distances between conduit and open top trays is not included. WBN's design criteria provides requirements for spatial separation between conduit and open top trays. The rational basis for these separation requirements was added to the criteria (Appendix C) in Revision 8 on December 4, 1991. However, since the above regulatory guidance does not address conduit to open top tray spatial separations, TVA chose not to include this information in the FSAR.

Furthermore, IEEE documents did not include guidance for conduit to open top tray separations until issuance of IEEE-384-1992 in December of 1992. The separations required by WB-DC-30-4 are in some cases less than that recommended by IEEE-384-1992. This IEEE document acknowledges that lesser separation distances can be established based on listed features of the installation. The rational provided in WB-DC-30-4, Appendix C, although issued a year prior to IEEE-384-1992, takes credit for many of the same listed features (e.g., cable flame retardant characteristics, raceway fill, and mitigation measures [such as sprinklers]). The above provides the technical basis for TVA's criteria of minimum 1 inch separation between class 1E conduits and open cable trays.

Therefore, it is TVA's conclusion that the separations requirements specified are adequate and that inclusion in the FSAR is not required.

ENCLOSURE 1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W., SUITE 2900
ATLANTA, GEORGIA 30323-0199

Report Nos.: 50-390/93-74 and 50-391/93-74

Licensee: Tennessee Valley Authority
6N 38A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Docket Nos.: 50-390 and 50-391 License Nos.: CPPR-91 and CPPR-92

Facility Name: Watts Bar 1 and 2

Inspection Conducted: October 17 through November 20, 1993

Inspectors: for G. A. Walton, Senior Resident Inspector, Construction — 12/16/93 Date Signed

for P. K. Van Doorn, Senior Resident Inspector, Operations — 12/16/93 Date Signed

M. M. Glasman, Resident Inspector, Watts Bar
P. G. Humphrey, Resident Inspector, Watts Bar
K. D. Ivey, Resident Inspector, Watts Bar
J. F. Lara, Resident Inspector, Watts Bar

Consultant: R. L. Gilbert, Beckman and Associates (paragraph 6)

Approved by: for P. E. Fredrickson, Section Chief, Division of Reactor Projects — 12/16/93 Date Signed

SUMMARY

Scope:

This routine resident inspection was conducted in the areas of construction activities; walkdown verification for damaged, loose, or missing hardware; significant corrective action reports; pre-operational test program implementation; auxiliary feedwater system minimum flow design; plant operations; Nuclear Safety Review Board; system turnover program; and actions on previous inspection findings.

10p

Results:

Two non-cited violations were identified during this report period. The first non-cited violation involved inadequate maintenance instructions for the replacement of the auxiliary feedwater turbine trip and throttle valve closure spring (paragraph 2.c). The second non-cited violation involved the failure to ensure that modification inspection data sheets were included in a completed workplan (paragraph 4.b).

The review of unresolved items resulted in the identification of two examples of previously issued violations. The first involved an additional example of violation 50-390/93-63-02 regarding the installation of ServicAir flexible conduits (paragraph 10.f). The second was an additional example of violation 50-390/93-63-04 for the failure to provide procedures or instructions to ensure the turnover of Unit 1/Unit 2 interface points from Startup to Operations (paragraph 10.g).

Inspector reviews of licensee activities resulted in three unresolved items which require further follow-up. One unresolved item questioned the adequacy of vendor manual instructions for auxiliary feedwater turbine maintenance (paragraph 2.c). A second unresolved item involved (1) the corrective actions for Significant Corrective Action Report WBP890363 and (2) the adequacy of permitting electrical splices to be installed in raceways (paragraph 4.a). The third unresolved item questioned the adequacy of the auxiliary feedwater minimum flow design (paragraph 6).

The inspector accompanied an area walkdown team to determine if the walkdown was being performed in accordance with procedure MAI-1.9. This walkdown was being performed on top of the SG-1 and SG-4 missile shield. The inspector found that the walkdown team was knowledgeable of procedure MAI-1.9 requirements, and, based on the inspector's observations, were correctly identifying and documenting deficiencies in accordance with procedural requirements. Over 400 items were identified as a result of the upper containment walkdown. The inspector also verified that the participants were trained to the requirements of procedure MAI-1.9.

The inspector performed a confirmatory walkdown inside the pressurizer missile shield to determine if the licensee was properly identifying and documenting deficiencies in accordance with procedure MAI-1.9. The inspector found that the licensee did not detect a loose conduit fitting at the top of junction box 1-JB-293-4511 or a loose condulet cover on conduit 1-VC-2009-B. These items were considered by the inspector to be minor in significance. The walkdown inside the pressurizer missile shield conducted by the licensee identified over 140 items. Based on these observations, the inspector concluded that the licensee's walkdown of this area was conducted in accordance with procedure MAI-1.9.

To determine if QA was adequately monitoring the DLMH walkdown process, the inspector held discussions with licensee QA personnel. The inspector found that QA prepared an assessment plan to monitor the DLMH walkdown process. Objectives included verification of training; walkdown observations; document reviews, including reviews of scope of planned work orders; and independent inspections of areas that were walked down to ensure adequate identification of deficiencies. At the time of this inspection, QA had observed portions of walkdowns, performed in-field verification of all areas walked down by the DLMH teams to date, and reviewed training of walkdown participants. QA did not identify any significant discrepancies as a result of their inspections.

The above results indicated that the three completed walkdowns were adequate to identify all significant instances of DLMH in the bounded area. The inspectors will continue to monitor the licensee's walkdown activities as well as subsequent actions to correct identified deficiencies as a result of these walkdowns.

Within the areas reviewed, no violations or deviations were identified.

4. Significant Corrective Action Reports (92720)

The inspector reviewed the licensee's implementation of corrective actions for two SCARs involving the splice replacement program. One of the SCARs, WBSCA930158, also involved incomplete electrical modification work identified after system turnover to the Startup group for functional testing. The SCARs reviewed are discussed below.

a. SCAR WBP890363SCA

This SCAR documented several conditions adverse to quality pertaining to design and installation of 10 CFR 50.49 electrical cables. Based on the review conducted, the inspector identified deficiencies associated with the implementation of the corrective actions for the SCAR.

The deficiencies identified in the SCAR were initially documented in several SCRs, which collectively were incorporated into SCAR WBP890363SCA. Collectively, the deficiencies associated with the SCRs were reported to the NRC pursuant to 10 CFR 50.55(e) as construction deficiency reports WBRD 50-390/86-61, 50-391/87-12. SCR WBNEQP8627 was included in the SCAR and identified a deficiency regarding the use of extension wiring when field cable is not long enough to be terminated. The addition of extension wiring (pigtail extensions) was permitted by electrical standard drawings at the time of the installations and did not require engineering approval. Therefore, the additions were not documented nor shown on connection drawings. Consequently, the environmental qualification of the added wiring and associated splices was unknown. The corrective actions for Revision 2 of SCAR WBP890363SCA, and the licensee's 10 CFR 50.55(e) final report, were to walk down the 10 CFR 50.49 electrical equipment identified in SCR WBNEQP8627 to obtain data for the equipment extension wiring. The data was then to be evaluated by NE for acceptability. The data to be obtained included the following:

- Device/equipment ID
- Cable ID
- Mark and contract number of extension wiring
- Splice data (pigtail to extension wiring)
- Splice data (extension wiring to field cable)

In addition, revision 2 of SCAR WBP890363SCA also stated that its corrective actions were to be implemented with SCAR WBP880676SCA corrective action, which included repairs for 10 CFR 50.49 splices. These splice repairs were being implemented by design document QDCN Q-17111-A, which identifies the scope of repair.

The inspector reviewed the equipment identified in SCAR WBP890363SCA and compared the components against the splice list (and associated components) in the QDCN. The inspector noted that while the QDCN identified the affected SCAR components, it did not, however, require the inspection for pigtail extensions. On the QDCN, some of the SCAR components were identified as having pigtail extensions while other were not. The following is a partial list of SCAR components included on the QDCN and the applicable notes stated in the QDCN.

SCAR Component	System	QDCN Q-17111-A Splice Note
1-FSV-3-185B	03	No Note
1-FSV-3-186A	03	No Note
1-FSV-3-236A-A	03	Note 1
1-FSV-3-236B-B	03	No Note
1-TE-68-2A	68	No Note
1-TE-68-2B	68	No Note
1-FSV-68-305-A	68	Note 1
1-FSV-68-307-A	68	Note 1
1-FSV-68-308-A	68	Note 1

QDCN Note 1: Intermediate splice is a field cable to a pigtail extension wire and is located in the conduit run near the device.

The above comparison indicated that although components were identified in the SCAR as possibly having pigtail extensions installed, and therefore requiring walkdown inspections, some of the components were not identified in the QDCN for inspection.

The above listing is only a partial listing of the components which required walkdown inspection for pigtail extensions by the SCAR. The inspector identified a total of 11 components in system 03, and 16 components in system 68 that required walkdown by the SCAR. These were listed on the QDCN but were not required to be walked down by the QDCN. Other affected systems included 01, 03, 30, 31, 32, 43, 61, 62, 63, 65, 67, 68, 74, and 90. Therefore, based on the above comparisons, the inspector concluded that QDCN Q-17111-A was incomplete and the implementation of corrective actions for SCAR WBP890363SCA was inadequate.

Although the corrective actions for SCAR WBP890363SCA required inspection of equipment for installations of wiring extensions, it was not known if there were any such wiring extensions and electrical splices installed. At the end of the inspection period, the licensee had begun document reviews and field inspections to determine if any such wiring extensions were installed. Therefore, this issue is identified as example one of URI 50-390/93-74-03, Walkdown Inspections for Wiring Extensions and Splices, pending the NRC review of the licensee determination if any such wiring extensions were installed for the identified components in SCAR WBP890363SCA.

During the above review, the inspector noted that engineering specification G-38, Installation, Modification, and Maintenance of Insulated Cables Rated Up to 15,000 Volts, Revision 12, Section 3.4.1.10, stated that the installation of splices was acceptable in flexible conduits where electrical device pigtail leads and pigtail extensions were terminated. This typical configuration was also shown on conduit drawing 45W883-3, Revision D. NRC RG 1.75, Physical Independence of Electric Systems, states the NRC position that splices in raceways should be prohibited. However, if splices do exist in such configurations, the design should be justified by analysis and submitted as part of the Safety Analysis Report. Although the issuance of the WBN construction permit predates the issuance of RG 1.75, the licensee has committed to meet the general intent of the RG, with some exceptions. The present WBN FSAR does not describe the design of installing electrical splices in raceways such as flexible conduits. Therefore, this issue is identified as example two of URI 50-390/93-74-03, Walkdown Inspections for Wiring Extensions and Splices, pending NRC review of the licensee's basis for the use of electrical splices in raceways.

b. SCAR WBSCA930158

As discussed in IR 50-390, 391/93-63, Section 4, CAP and SP Quality Assurance Assessments, QA Assessment NA-WB-93-0078 documented examples of splices requiring inspection and rework which had not been inspected or reworked prior to releasing the associated systems for functional testing. This condition, and other examples of incomplete modification work, were documented in SCAR WBSCA930158. The examples of incomplete modification work included the following:

- Splice inspections were not performed prior to the transfer of systems for testing.

- Jumpers not installed in LS amptectors. WPs written to implement DCNs M-18152 and M-12212 did not implement all of the work. Causes for this example have been documented in SCAR WBSCA930043.

- A temporary pipe support was not removed and the associated documentation was not completed prior to system release. Causes for this example have been documented in PER WBPER930296.

- Engineering and Modifications adequacy of the Unit 2 systems required for Unit 1 was not established. Design Engineering expanded the Unit 1 boundary without Modifications being aware of changes to the boundaries. Causes for this example have been documented in SCAR WBSCA930015.

- No procedural controls were established to prevent working bend radius inspections out of sequence. Causes for this example have been documented in PER WBPER930266.

- Cable 1V3087A was not terminated on a lift/reland data sheet prior to system turnover.

In summary, the inspector concluded that the turnover program covered appropriate attributes, and the SPOC I process program requirements were met for the systems reviewed. No significant problems were identified during this inspection.

Within the areas reviewed, no violations or deviations were identified.

10. Actions on Previous Inspection Findings (92700, 92701)

a. (Closed) IEB 50-390, 391/81-03, Flow Blockage of Cooling Water to Safety System Components by Carbicula Sp. (Asiatic Clams) And Mytilus Sp. (MUSSEL)

The licensee responded to IEB 81-03 in a letter to the NRC dated March 21, 1983. The response specified a chlorine treatment of the raw water systems during the clam spawning season for clam control. This treatment consisted of achieving a chlorine concentration of 0.6-0.8 ppm in the raw water. However, an option was included that allowed for changes in the concentrations based on results of further studies and experience. Based on that response, the IEB was closed in IR 50-390, 391/88-01.

In 1989 the NRC issued GL 89-13, Service Water System Problems Affecting Safety-Related Equipment. The licensee responded to the GL in a letter dated January 26, 1990. The response included a reduction of chlorine concentration from that specified in the response to the IEB 81-03 from 0.6-0.8 ppm to a concentration of 0.1-0.3 ppm in the raw water systems. This lower concentration was determined by the licensee to be adequate to kill the larva clam and sufficient to control the asiatic clam population in the raw water systems.

In October 1992, the licensee implemented a MIC program to further preserve the raw water systems at WBN. This program and the results achieved were inspected by the NRC and were found to be acceptable as documented in IR 50-390, 391/93-67. The inspection effort consisted of inspections of the inside diameter of piping and equipment that had been in contact with the raw water systems since the reduction of chlorine concentration and implementation of the MIC program. In addition, the licensee's inspection reports, photographs, and videos of these systems were reviewed. The results indicated that the program with reduced chlorine concentrations had been effective. Based on these results, the issue of reducing the commitment presented by the licensee in the response to IEB 81-03 is closed.

b. (Open) CDR 50-390/86-61, 50-391/87-12, Cable Configuration Control

This CDR involved the discovery of documentation deficiencies for 244 cables located in harsh environments. The recurrence controls for this CDR were previously reviewed by the NRC and found to be satisfactory as documented in IR 50-390, 391/91-31.

The scope of this CDR includes several SCRs including WBN-EQP-8627. During this inspection period, the inspector reviewed the implementation of the corrective actions associated with SCR WBN-EQP-8627 as described in SCAR WBP890363SCA. Deficiencies in the implementation of the associated corrective actions were identified as discussed in paragraph 4.a of this report.

c. (Closed) IFI 50-390, 391/87-17-02, Licensee's Interface Program With Engineering Shell Contractors

This IFI identified a question regarding the adequacy of interface controls between contractors Bechtel, Ebasco, Stone & Webster, and Sargent & Lundy.

This IFI was not specifically addressed; however, the onsite contractors' employee concerns programs and their effectiveness was reviewed by the NRC and documented in IR 50-390, 391/93-54. The inspection evaluated onsite contractors Ebasco Services, Incorporated; Ebasco Constructors, Incorporated; Stone and Webster Engineering Corporation; and Rust Pullman Cleveland. The report concluded that the licensee's CRS was effectively monitoring contractor implementation of their employee concerns programs. The report did identify a weakness in relation to contractor awareness of the employee concerns program and identified IFI 50-390, 391/93-54-01 to track the licensee's resolutions of the identified weakness. Based on the reviews of the licensee's contractors, discussed in IR 50-390, 391/93-54, this IFI is closed.

d. (Open) CDR 50-390/89-11, Significant Trend Associated with Damaged, Loose, or Missing Hardware

This CDR reported the discovery of significant deficiencies involving damage to permanent plant equipment and related hardware, and loose and missing parts of components and systems thought to be complete. Details of the licensee's efforts to resolve this item are found in paragraph 3 of this report. This item remains open.

e. (Open) URI 50-390/90-22-01, Verification of Electrical Separation Audits

The item involved Class 1E raceway separation violations identified during licensee field audits. This item was previously reviewed and updated in IR 50-390/91-31. The licensee's Electrical Issues CAP addresses various concerns related to electrical installations at WBN. One of the CAP issues pertains to physical cable separation. This item is being updated to include the concern of the acceptability of design criteria established for physical separation between redundant division Class 1E conduits and open Class 1E trays.

During this inspection period, the inspector identified a concern regarding the acceptability of the established design criteria for separation between redundant Class 1E raceways. Chapter 8 of the WBN FSAR describes the established design for providing physical separation between redundant Class 1E raceways. It describes the criteria in various plant locations depending on the present area hazards. The FSAR criteria is also described in design criteria WB-DC-30-4, Separation/Isolation. In 1982, the NRC issued the SER (NUREG-0847) for WBN. Section 8.3.3.3, Physical Independence, documented the staff's evaluation of the WBN compliance with GDC-17. FSAR Question 40.25 pertained to the licensee's extent of conformance with RG 1.75. WBN was requested to provide the technical basis for exceptions where WBN design did not meet the recommendations of RG 1.75. The licensee's response to the FSAR question was that RG 1.75 was issued after the WBN construction permit was issued and after the WBN design was complete. Therefore, the WBN design was not in full compliance with the recommendations of RG 1.75; however, the WBN design basically met the RG 1.75 recommendations with some exceptions. These exceptions were evaluated by the NRC as documented in the 1982 SER.

The inspector reviewed FSAR Section 8.3.1.4.2, Cable Routing and Separation Criteria, to determine what criteria was established for separation requirements between redundant Class 1E raceways. The inspector could not identify any criteria for separation between open Class 1E cable trays which are crossed by redundant division Class 1E conduits. The NRC SER likewise did not address this configuration. The inspector determined that the only criteria documented for this configuration was described in design criteria WB-DC-30-4, Separation/Isolation. Section 4.1.2.2, Conduit Separation, stated the following criteria:

> "A minimum of 1 inch is also required when a conduit of one division crosses or runs parallel to a cable tray containing cables of a redundant division, provided the cable tray portion has a cover or is solid on the side adjacent to the conduit, see Appendix C herein."

If the one inch separation cannot be met, a barrier may be used between the raceways, or a case-by-case analysis shall be made to ensure that redundant Class 1E circuits are not degraded below an acceptable level. The inspector determined that this criteria was acceptable for the configuration of enclosed raceways (enclosed cable trays to conduits and conduit to conduit). The inspector also reviewed WB-DC-30-4, Appendix C which was incorporated into the design criteria in December 1991. Appendix C, Basis for Using a One Inch Minimum Separation Distance Between A Conduit and Cable Tray Containing Redundant Divisions (Channel or Train) of Class 1E Cables, which provided the reasoning/rationale to justify the acceptability of the one inch minimum separation distance when the portion of the tray adjacent to the conduit was solid. In addition, the Appendix also stated the following:

> "In addition, this rationale also provides reasoning for no cover (top or bottom) for separation distances greater than one inch. Note: RG 1.75 does not address separation requirements for conduit/tray configurations."

The above criteria has been incorporated into drawing series 1-45W3000-1 and 1-45W3000-2, Revisions 0.

As stated above, Chapter 8 of the FSAR does not describe the established criteria for physical separation between redundant Class 1E conduits and open Class 1E cable trays. The NRC SER also does not address the conduit/open tray configuration. The separation criteria for this configuration has not been reviewed by the NRC because it was not incorporated into WB-DC-30-4 until December 1991. Therefore, this URI 50-390/90-22-01, Verification of Electrical Separation Audits, will remain open pending further NRC review of the original cable separation concerns and further NRC review of the adequacy of the WB-DC-30-4, Appendix C, minimum separation criteria of greater than one inch for conduit/open tray configurations.

f. (Closed) URI 50-390/93-63-01, Walkdowns for ServicAir Flexible Conduits

This item involved the concern that Class 1E flexible conduits manufactured by ServicAir (manufacturer name) and installed outside the containment, annulus, and main steam valve rooms were not required to be replaced.

The RWL item for WP M5688-1 was to walkdown Class 1E conduits outside containment, identify any flex conduits manufactured by ServicAir, and replace these conduits with those manufactured by American Boa. These actions were being performed to implement the corrective actions for PER WBP871301PER. However, ServicAir flex conduits outside containment in areas other than the annulus or main steam valve rooms were not being identified by the licensee for replacement. This was based on the licensee's assumption (later proven to be incorrect) that ServicAir flexible conduits were not installed in such areas, and therefore there was no need to look for them.

On October 20, 1993, PER WBPER930357 was issued and documented the following related conditions:

- WO 93-09832-02 erroneously identified Class 1E flexible conduit 1PLC1571B as being manufactured by American Boa; it was actually manufactured by ServicAir. In addition, the WO documentation indicated that bonding (grounding) jumper