TENNESSEE VALLEY AUTHORITY
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JUN 29 1990

WBRD-50-390/82-80
WBRD-50-391/82-76

10 CFR 50.55(e)

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

Gentlemen:

In the Matter of the Application of)
Tennessee Valley Authority)

Docket Nos. 50-390
50-391

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2 - CABLE BEND RADIUS DEFICIENCIES - WBRD-50-390/82-80 AND WBRD-50-391/82-76 - REVISED FINAL REPORT

References:
1. NRC letter dated August 15, 1986, "Shielded Power Cable Bend Radius Deficiency"
2. TVA letter to NRC dated June 27, 1989, "Revision to Corrective Action Program (CAP) Plan for Cable Issues"
3. TVA letter to NRC dated June 15, 1990, "Electrical Cable Damage - Assessment and Resolution Plan"
4. TVA letter to NRC dated June 15, 1990, "Supplemental Information on WBN Cable Issues"

The subject deficiency was initially reported to NRC Inspector R. V. Crlenjak on July 29, 1982, in accordance with 10 CFR 50.55(e) as Nonconforming Condition Report (NCR) WBN 4194R. The final report was submitted on September 13, 1983. NRC closed the WBN 4194R licensee-identified item based on an inspection performed September 13-16, 1983 (see NRC inspection report 50-390/83-37 and 50-391/83-26 dated October 8, 1983). Because of employee concerns regarding cable issues at WBN, NRC Region II issued a letter dated August 15, 1986 (Reference 1), reopening the item and requesting a revised final report and additional information.

Enclosure 1 provides TVA's revised final report regarding the cable bend radius issue (WBN 4194R) and a description of the corrective actions regarding the sidewall bearing pressure (SWBP) issue identified in NCR WBN 6347. Enclosure 2 addresses the 11 NRC questions identified in Reference 1.

Resolution of these items is being implemented by the CAP Plan for Cable Issues (Reference 2), supplemented by TVA's submittals to NRC on June 15, 1990 (see References 3 and 4). Specifically, Sections 4.1.7 and 4.1.9 of the CAP provide the details of TVA's plan to resolve the cable bend radius issues and the SWBP issue at WBN, respectively.

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As indicated by TVA letter dated November 4, 1987, TVA requested the closure of Construction Deficiency Reports (CDRs) 390/85-63 and 391/85-59, (W-290-P) and 390/85-44 and 391/85-43 (WBN 6295), since resolution of these issues will be completed and tracked as part of the implementation of the CAP plan which includes WBN 4194R. Similarly, TVA letter to NRC dated June 22, 1988, requested that CDRs 390/85-55 and 391/85-52 (WBN 6347) be closed and tracked with CAP implementation.

No new commitments to NRC are contained in this report.

Should you have any questions, please telephone R. J. Stevens at (615) 365-8650.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

R. H. Shell

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ENCLOSURE 1

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2
BEND RADIUS, SIDEWALL BEARING PRESSURE ISSUE
NCRs WBN 4194R, 6347, W-290-P, AND 6295
10 CFR 50.55(e)
REVISED FINAL REPORT

Description of Deficiency

Deficiencies associated with the design and installation requirements for electrical cables have been identified at Watts Bar Nuclear Plant. The following describes specific concerns documented in WBN nonconforming condition reports (NCRs):

- Electrical Cable Bend Radius (NCRs WBN 4194R, W-290-P, and 6295).

  Various TVA inspections and reviews and NRC inspection findings have indicated programmatic violations of bend radius standards. Specifically, TVA engineering standards lacked a documented basis for deviations from industry bend radius standards, and installations exist where bends are in violation of the relaxed TVA standards. In addition, WBN cable installation procedures have not always been consistent with the applicable design requirements.

- Electrical Cable Sidewall Bearing Pressure (NCR WBN 6347)

  Sidewall bearing pressure (SWBP) was not properly addressed in the design and installation process at WBN. As a result, radial forces exerted on the insulation of a cable at a bend during pulling around a raceway bend or sheave may have exceeded allowable SWBP values.

Safety Implications

Excess bending or exceeding the allowable SWBP of safety-related cable is of concern due to the potential adverse impact on the performance of the cables in question. Therefore, the above deficiencies represent a condition which could adversely affect the safe operation and/or shutdown of the plant.

Corrective Action

The corrective action for each issue is summarized as follows:

- Bend Radius

  Design output documents and implementing procedures for cable installations were assessed (Nuclear Engineering [NE] calculation WBPEVAR8904018) to determine if proper cable inspection attributes existed for the inspection of electrical cable bend radii.

From the above-mentioned calculation, it was concluded that procedures for cable installation had not always been consistent with design requirements. Therefore, NE calculation WBPEVAR8904064 was issued to define a selection of equipment and raceway to be walked down to determine the extent of the condition to which installed cables do not comply with electrical design standard DS-E12.1.5, Revision 3, "Minimum Radius For Field-Installed Insulated Cables Rated 15,000 Volts and Less." This standard reflects the industry standard bend radius values.

A Condition Adverse to Quality Report (CAQR), WBP 900019, was issued to document those cable installations where bends were in violation of the TVA design standard (see Maintenance Request [MR] A-480214 for walkdown details). Furthermore, during the root cause analysis of this CAQR, it was determined that TVA engineering standards lacked documented bases for deviations from industry bend radius standards. This review and analysis resulted in the establishment of a comprehensive program which is generic to all safety-related cables and consists of testing, analysis, inspection, and rework, where necessary, to provide additional confidence that no significant degradation exists due to the bend radii conditions at WBN. TVA's submittal to NRC dated June 15, 1990, provides further discussion of the technical aspects, method of resolution, and long-term program to evaluate cable bend radius conditions at WBN (see Reference 4 to this transmittal letter).

- SWBP

TVA performed a walkdown to identify the worst-case configurations for conduits containing Class 1E cables where the potential for exceeding allowable SWBP may have occurred.

Using isometric sketches of the conduits walked down, a calculation for expected pulling tension and SWBP for these worst-case conduits was performed (see NE calculation WBPEVAR8603006). This calculation indicated that cables in some conduits exceeded typical manufacturers' SWBP limits. As a result, a test to determine increased allowable SWBP values, based on actual cables used at TVA nuclear plants, was performed (see TVA report dated May 30, 1986, "Cable Sidewall Bearing Pressure Tests").

Upon test completion, an independent review was performed to corroborate the results of TVA's SWBP tests (see David A. Silver & Associates, Inc., report dated November 21, 1986, "Final Report Review and Analysis of TVA's Cable Sidewall Pressure Tests Reports Dated May 1986"). This third-party review concluded that the above test results could serve as a basis for consideration of higher SWBPs for cables of similar construction.

Subsequent to the TVA SWBP test, a third-party review of the test, and comparison of the calculated higher SWBP values to typical manufacturers' limits, TVA established higher allowable SWBP values and revised General Construction Specification G-38, "Installing Insulated Cables Up to 15,000 Volts," to require that SWBPs be limited to these values. In addition, WBN site installation procedure WBN-CPI-8.1-E-102, "Installation of Low and Medium Voltage Power, Control and Instrumentation Cables," was revised to limit SWBP to the values contained in the construction specification.

To close the cable SWBP issue at WBN, TVA will revise the aforementioned calculation to address the remaining open items as documented in TVA's June 15, 1990 submittal (see Reference 3 of this transmittal letter).

Action Required to Prevent Recurrence

Site installation procedures were revised to reflect the requirements of Electrical Design Standard DS-E12.1.5, Revision 3, which incorporates industry standard values for cable bend radius (see WBN-CPI-8.1.8-E102 and WBN-CPI-8.1.8-E100A).

Site procedure WBN-CPI-8.1.8-E102 governing installation of low and medium voltage power, control and instrumentation cables was revised to provide explicit cable SWBP restrictions to cable pulling limits.

In addition, Nuclear Engineering Procedure (NEP)-5.1 requires that design output (such as the requirements for bend radius and SWBP for cable installations) be traceable to the design input, and that the design input be technically justifiable.

ENCLOSURE 2

CABLE BEND RADIUS ISSUE
RESPONSE TO QUESTIONS IN
NRC'S AUGUST 15, 1986 LETTER TO TVA

As requested, this enclosure provides the following TVA information to address the 11 questions outlined in NRC letter to TVA (Reference 1 of this transmittal letter):

- Questions 1 and 2 requested information related to WBN's Quality Assurance/Quality Control (QA/QC) Program with regards to bend radius.

  TVA provided a specific response to questions 1 and 2 in a December 29, 1987 submittal (see WBRD-50-390/82-80 and WBRD-50-391/82-76 - Partial Response To NRC Request For Information).

  In addition, TVA developed CAP plans (Reference 2 to this transmittal letter) to comprehensively evaluate aspects of the design, installation, and inspection of safety-related cables at WBN. In accordance with the plan outline in Section 4.1.7 of the CAP plan, implementing documents were revised, where necessary, to ensure bend radius requirements are adequately addressed at WBN.

- Questions 3, 4, 5, and 10 requested information related to the adequacy of design output and/or installation.

  Results of TVA's assessment, as discussed in TVA calculation WBPEVAR8904018, indicate that previous procedures governing design output and inspections were inadequate. Therefore, specific responses to these questions concerning previous procedures and CAQs written after 1982 are not provided. However, TVA's submittal dated June 15, 1990 (Reference 4 to this transmittal letter), provides a technical discussion covering a generic program to resolve the bend radius issue with regards to reinspection/acceptance of previously installed cables. This program includes an inspection/acceptance criteria based on defined degrading mechanisms and testing to establish the point of onset for the degrading mechanism. New installations are performed in accordance to site procedures which reflect industry standard minimum bend radius values as reflected in Electrical Design Standard DS-E12.1.5 R3.

- Questions 6, 7, 8, and 9 requested information related to the technical bases/or rationale for accepting bend radius values below industry standard values.

  As documented in the June 15, 1990 submittal to NRC (Reference 4 to this transmittal letter) and the root cause analysis of CAQ WBP 900019, TVA's standards lacked a documented basis for deviations from industry bend radius standards. Therefore, a specific response to the above questions is not provided. However, Reference 4 to this transmittal letter provides the technical rationale and basis for reinspection/acceptance criteria of previously installed cable at WBN. The bases discussed in the above submittal are documented in NE calculation WBPEVAR9004013 and/or its references, e.g., the TVA test report job number 90-1014.

- Question 11 requested that TVA reevaluate the reportability of the cable bend radius issue.

  TVA has addressed the cable bend radius issue in the revised 10 CFR 50.55(e) final report (Enclosure 1 of this submittal). For additional technical information on the bend radius issue see TVA's Cable Issues CAP Plan and the submittal dated June 15, 1990 (References 2 and 4, respectively, to this transmittal letter).