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DEC 21 1993

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Gentlemen:

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

WATTS BAR NUCLEAR PLANT (WBN) - CABLE ISSUES CORRECTIVE ACTION PROGRAM (CAP) PLAN

The purpose of this letter is to provide results of the cable jamming inspections and to document the resolution for the damage identified during the implementation of the Cable Issues Corrective Action Program (CAP) Plan.

Enclosure 1 provides the results of the cable jamming inspection and addresses TVA's corrective actions for the damage found during these inspections. Enclosure 2 provides the list of commitments made in this submittal.

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

Very truly yours,

W.J. Museler

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Enclosures
cc: See page 2

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ENCLOSURE 1

CABLE ISSUES CAP
IMPLEMENTATION

Background

Part of the purpose of the Cable Issues Corrective Action Program (CAP) Plan is to address the potential for undetected damage since installation documents at WBN did not address a possible jamming condition. Jamming is a consideration when three single conductor cables of the same diameter are being pulled into a conduit. The ratio of conduit inner diameter to cable outside diameter (D/d) is defined in IEEE-690-1984 as the jam ratio. When this ratio is 2.8 to 3.1, the cables may align in a flat configuration such that they become wedged within the conduit. This condition, depending upon the amount of pulling force, could potentially result in damage to the cables.

TVA used the following criteria for selection of representative worst-case Class 1E conduit/cable configurations with the potential for cable jamming:

- The conduit contained three cables of the same size.
- Each cable contained conductors larger that #10 AWG.
- The ratio of inside diameter of conduit (D) divided by the average outside diameter of one of the cables (d) was in the range of 2.8-3.1.
- Conduit length greater than 10 feet.

Using this criteria, class 1E conduits were evaluated to determine which have a configuration where damage might have occurred and yet gone undetected. Isometric drawings were made and sidewall bearing pressure (SWBP) values calculated for those conduits which met this criteria. This population was then ranked according to their resultant SWBP's.

The cables in some conduit segments of the above identified population were scheduled to be replaced as a result of other issues. A population of these cables which were routed in high-ranked conduits were chosen to be visually inspected during removal to identify any degradation indicative of jamming damage. The worst-case conduit configuration of this group exhibiting no visible jamming damage was to be considered the "bounding" configuration. All lower-ranked configurations of the above identified population were to be considered enveloped by this inspection.

Of the 76 conduit configurations identified, 24 representing approximately 32 percent of the total were selected for inspection. These 24 conduits were distributed throughout the entire ranking. Nine of the highest 20 ranked conduits, including the "worst case," were within this inspection group. The removal and inspection of the cables from these conduits were controlled to preclude damage during removal.

Inspection Findings

The cable numbers associated with the 24 conduits mentioned above and involved in the inspection were: 1PL4961A, 1PL4975A, 1PL4982B, 1PL4985B, 2PL4975A, and 2PL4978A. More than one conduit is associated with each of these cables. Since inspections revealed no visible damage indicative of jamming, TVA considers the remaining population to be bounded with no further actions being required for the jamming issue except for the documentation of the inspection results and closure.

However, inspection of the cables revealed the following conditions:

- Cable 1PL4975A had jacket and slight insulation damage at the conduit to tray interface possibly caused by a rope burn from installing cables in tray.

- Cables 1PL4982B, 1PL4985B, 2PL2975A, and 2PL4978A had insulation damage in the conduits or junction boxes within the conduit run. Analysis of this damage is provided in the next section.

Cable 1PL4961A was inspected and no damage was found. As a result of the above identified cable damage, Problem Evaluation Report WBPER920162 was initiated.

Analysis of Damage

To assist in determining a cause, these damaged cable sections were inspected at TVA's Central Laboratories. Upon a visual inspection, each section exhibited one or more of the following conditions:

- Kinks with some examples of flattening of the cable jacket. Slight to severe "bird-caging" of the conductor under the kinked areas. "Bird-caging" is the radial enlargement of the conductor as a result of separation of the different layers of stranding following a severe twist or kink.

- Taped repairs of deep cuts in the insulation exposing the conductor.

- A Raychem sleeve which covered a splice. The splice was pull tested at 4795 pounds. A second sleeve covering a slit in the jacket and the underlying insulation that penetrated all the way to the conductor.

- Marks ("stranding" and other marks appearing to be a result of the cable being pressed against flex conduit), indentations, and scratches on the cable jacket.

- "Stranding marks," thinning, compression, and scratches to the cable insulation.

Based upon these laboratory inspections, it was determined that the damage was most likely the result of kinks which occurred during the installation of large stiff cables in highly filled conduits. This situation resulted in high tensions due to the passage of those kinks through the conduits.

In order to bound and establish the extent of condition of this damage, TVA has taken a number of actions. The first action was to develop a ranking system for class 1E cables, 300 MCM and larger and installed prior to 1987 which are not scheduled for reroute or replacement, based upon the following criteria:

- Conduit fill greater than or equal to 25% - This point was chosen since the propensity for damage as the result of a kink would increase rapidly as a function of fill.

- Cable in conduits greater than or equal to 30 feet in length - This point was chosen since the increased tension associated with the projected damage mechanism would be very noticeable on short pulls with low tension and less noticeable on longer/more complex high tension pulls.

The review focused on class 1E cables since the identified taped repairs would not have been qualified for 10CFR50.49 applications. The size break point was chosen due to the relative stiffness of 300 MCM cables compared to 4/0 AWG which was the next smaller size used at WBN during the time period of concern.

When this ranking was completed, the damaged cables fell within the top 7% of the population. This ranking also identified other cables which were suspect.

TVA performed field walkdowns of those suspect cables which require environmental qualification for a harsh environment and which had not been previously removed or inspected. This walkdown was to inspect cable access locations such as junction boxes, equipment, or duct banks for indication of additional examples of damage and to determine which cables were located in harsh environments. The results of these inspections and analysis were as follows:

Minor jacket scuffs and cuts which did not penetrate the cable jacket were found in junction boxes and equipment. Kinks and twists were found on some conductors in the junction boxes but those were bounded by the condition on cable 1PL4985B. A taped conductor of cable 1PL4983B was found in a duct bank manhole but the underlying damage was restricted to penetration of the jacket only with no damage to the insulation.

Undocumented repair sleeves were found on cable 1PL4979A in a 480V switchgear. Upon subsequent removal of this cable section (for ampacity concerns), additional damage was identified. This cable section was sent for laboratory analysis with the following results:

- A kink which was less severe than that on cable 1PL4985B.

- Jacket damage and a "stranding pattern" on the insulation which was covered by Raychem repair sleeves. The areas were located in conduit. The insulation thickness in the area of the "stranding pattern" was 31 mils, which is greater than the 30 mil required EQ thickness.

- A gash through the insulation exposing the conductor. This gash had been taped and covered with Raychem repair sleeves.

- Cuts through the jacket exposing the insulation with no damage to the insulation.

Except for cable 1PL5200B, the walkdown confirmed that the suspect population was located in an essentially mild environment.

CONCLUSIONS

From the inspection evidence, the following can be concluded:

- Large low voltage cables (300, 400, 500, and 750 MCM) were installed under difficult pulling conditions into conduits with high fill. Conduits and pull points used in these pulls were located on the ceiling in highly congested areas. Poor craft practices combined with the lack of flexibility of the subject cables, the high fill and difficult access resulted in the development of kinks as the cables were fed back into the raceway at the pull points. The observed damage is the result of the subsequent high forces which the cables experienced due to the passage of those kinks through the conduits.

  TVA has determined that this damage is limited to the above cable sizes. This is apparent because previous inspection data reveals no documented instances of kinks in 4/0 AWG cable. This was expected given the relative flexibility of 4/0 AWG cables compared to those 300 MCM and larger.

- The craft which installed the cable had observed the damage. The most significant areas were repaired by tape or Raychem sleeves.

  Taped repairs consisted either of a rubber tape over the damaged insulation with an overall covering of polyvinyl chloride (PVC) tape or PVC tape placed directly over the damaged insulation. TVA determined by review of Power Stores records that the type of PVC tape used was most likely Scotch 33 and the rubber tape used was most likely Scotch 23. Though the repairs would not meet current requirements, they are located in essentially mild environments where the tape provides adequate insulation to have ensured cable functionality.

- The major area of concern is for large cables in highly filled conduits in 10CFR50.49 service in harsh environments, where the adequacy of repair to current requirements cannot be assured. Because of this concern, the only remaining cable which meets the above criteria, 1PL5200B, will be replaced under DCN M20909-A prior to fuel load.

The engineering evaluation of these results is documented in Problem Evaluation Report WBPER920162, R2.

SUMMARY

No cable damage was found associated with cable jamming and therefore, TVA considers this issue closed. Damage due to installation practices related to large cables in conduits with high fill was found. The craft which installed the cable had observed the damage and repaired the most significant areas. Although the repairs would not meet current day requirements for environmental qualification, they were adequate to ensure functionality in mild environments. In all instances of unrepaired damage, the remaining wall thickness was adequate to have ensured that the cables would have performed their intended safety function within mild and essentially mild environment areas. In order to ensure that the remaining 10CFR50.49 cable in harsh environment service, 1PL5200B, is adequate for its intended service, it will be replaced prior to fuel load.

ENCLOSURE 2

LIST OF COMMITMENTS

1. In order to ensure that the remaining 10CFR50.49 cable in harsh environment service, 1PL5200B, is adequate for its intended service, it will be replaced prior to fuel load.