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POLICY ISSUE
(Information)

September 12, 1986 SECY-86-1E

For: The Commissioners

From: Victor Stello, Jr.
Executive Director for Operations

Subject: STATUS OF STAFF ACTIONS REGARDING TVA

Purpose: To provide the Commission with the sixth status report on activities in response to issues associated with TVA.

Background: On December 13, 1985, Chairman Palladino directed the staff to prepare periodic written reports summarizing the major NRC plans, schedules, and organizational assignments related to all TVA plants. The staff identified a number of major TVA issues requiring resolution prior to the restart of any of the TVA reactors and has provided periodic status reports to the Commission, the most recent of which was issued July 15, 1986 (SECY-86-1D). The staff last briefed the Commission on these issues on June 6, 1986, and stated that TVA expects Sequoyah Unit 2 to be the first reactor ready to resume operation. TVA last briefed the Commission on their activities on March 11, 1986, and briefed the ACRS on July 10, 1986. TVA submitted Revision 2 to their Corporate Nuclear Performance Plan and Revision 1 to the Sequoyah Nuclear Performance Plan on July 17, 1986.

Discussion: The staff remains heavily committed to a substantial review and inspection of TVA activities. Sequoyah Unit 2 is expected to be the first TVA facility to be restarted. Major TVA and staff activities in the past two months are summarized in the following paragraphs.

I. Corporate Activities

The staff review of the Corporate Nuclear Performance Plan is essentially complete and the NRC Safety Evaluation of the Corporate Plan will be issued within a few weeks.

Contact:
Hugh Thompson, NRR
492-9595

~~8610280152~~

8p.

The TVA Corporate Plan is generally acceptable to the staff, subject to our review of TVA implementation in the coming months.

Conflict of interest issues in connection with TVA's arrangements with Stone and Webster, Bechtel, and others remain unresolved. The TVA Inspector General (TVA IG) and General Counsel are investigating this matter in response to the U.S. Office of Government Ethics concerns. Related to this matter is a reduction in Bechtel staff level effort on the resolution of employee concerns.

The ACRS issued its report on TVA and recommendations to the Commission on August 12, 1986. The ACRS agreed with the TVA diagnosis of their management problems, believes that immediate technical and management issues are being addressed, and provided comments to the staff. The staff has requested that TVA respond to the ACRS comments and will consider the TVA response in its ongoing review.

TVA responded to the Commission's evaluation of harassment and intimidation (H & I) at TVA on August 15, 1986, providing their response to staff concerns and stating their strong views on prohibiting harassment and intimidation in the workplace. The TVA IG is investigating the H & I and wrongdoing issues prior to recommending action by TVA line management. Additionally, on August 8, 1986, TVA responded to the staff's Notice of Violation and Proposed Imposition of Civil Penalty (issued July 10, 1986) regarding certain discriminatory acts. TVA paid the civil penalty and stated their corrective actions, including Mr. White's strong position against H & I. The staff is reviewing these responses.

In response to the TVA IG's expressed need to contact concerned individuals directly as part of his investigative process in the H & I area, the staff contacted selected concerned individuals in an attempt to establish communications between the individual and the TVA IG. Arrangements for direct contact between concerned individuals who responded to the staff and the TVA IG are in process. Selected H & I cases have been transferred from the NRC Office of Investigations (OI) to the TVA IG. OI will monitor the TVA IG's investigation of these issues.

Other recent corporate developments include the resignation of the TVA General Counsel and the Assistant General Counsel, on August 19, 1986. The Deputy General Counsel announced his intent to retire in October 1986.

II. Sequoyah

TVA submitted Revision 1 of the Sequoyah Nuclear Performance Plan on July 17, 1986. As part of that submittal, Mr. White stated that TVA expected to complete actions necessary for the restart of Sequoyah Unit 2 earlier than the announced date of January 1987. The staff believes the TVA target of early November 1986 to be optimistic. TVA has slipped completion targets for certain issues, e.g., employee concerns applicable to Sequoyah and design verification issues. Also, an increasing number of items are forecast to be completed in late September or early October and the sheer number of items will probably result in the delay of some.

Sequoyah is receiving priority attention by both TVA and the staff. Staff resources will be severely impacted in order to complete the number of Sequoyah issues being readied by TVA in a short period.

Major issues are described below:

- Employee Concerns Program

  On August 29, 1986, TVA submitted their revised program for management of employee concerns received prior to February 1, 1986, including those applicable to Sequoyah. The first group of Sequoyah employee concerns element evaluation reports was received in early September. The pacing group of Sequoyah employee concerns involves engineering and design control issues and most of these element reports are not expected before early November. The staff believes the TVA program is generally acceptable but that resolution of many individual issues may impact the Sequoyah restart. Staff technical review teams are assigned and, in some cases, the staff is reviewing draft documents at the site to stay abreast of TVA progress.

  On July 17, 1986, TVA submitted their revised program for management of new employee concerns received beginning February 1, 1986. The staff believes this program is generally acceptable, subject to our review of TVA implementation in the coming months.

- Design Control

  TVA submitted its Design Baseline and Verification Program (DBVP) and the staff found the TVA approach generally acceptable. Staff concerns remain unresolved

regarding TVA interim criteria for small bore piping and cable tray supports. TVA is implementing the DBVP and ongoing inspections will continue in September and October. This item may impact Sequoyah restart, depending on the progress of TVA implementation and the extent of corrective actions.

o Welding

TVA and staff activity in this area is nearing completion. Notwithstanding their innocuous nature, the number of weld discrepancies found during TVA reinspections (and not identified during the original construction) has led the staff to consider the need for an accelerated completion date for the first 10-year inservice inspection program for both Sequoyah units. This will further assure the quality of welds in ASME-scope piping, pipe supports, and major component supports.

o Technical Specification Surveillance Requirements

NRC inspection efforts identified deficiencies regarding the adequacy of the licensee's surveillance test program. TVA acknowledged these concerns and has developed a program to reassess the adequacy of Sequoyah surveillance procedures and their performance. This program is designed to ensure that surveillance procedures are technically adequate prior to Sequoyah restart. Due to the significance of this issue, an enforcement conference was held in the Region II office on August 25, 1986. As part of the NRC emphasis in this area, additional inspection is scheduled during October.

o Containment Isolation Valves

During a recent inspection at Sequoyah, the staff found that valves in the reactor coolant pump seal injection lines and an RHR return line may not provide adequate assurance of containment isolation in certain accident situations. TVA and the staff are evaluating the adequacy of the isolation provisions to determine if any corrective measures are required prior to restart. This configuration also exists at Watts Bar, and may exist on other similar Westinghouse facilities.

III. Watts Bar

Based on informal discussion with TVA, Watts Bar Unit 1 is not expected to be ready for licensing before May 1987. Pacing items are expected to be TVA completion of the Design Baseline and Licensing Verification Program, reanalysis of piping and supports, and resolution of employee concerns. Formal schedules regarding Watts Bar have not been received and the submittal date for the Watts Bar portion of the Nuclear Performance Plan remains uncertain. TVA also believes their inability to hire sufficient contract personnel may result in delays to their internal schedules.

Major issues are described below:

- Design Baseline and Licensing Verification Program

  To address and reconcile various problems related to design control and licensing issues at Watts Bar, TVA is developing a comprehensive Design Baseline and Licensing Verification Program (DBLVP). TVA met with the NRC staff on August 21, 1986, to discuss their proposed program which is being created to supplement and confirm the effectiveness of existing design, construction, and licensing processes. TVA intends to confirm that licensing, design, and construction activities appropriately implement requirements and that Watts Bar 1 is ready for power operation. This includes verification of licensing commitments, design bases, design documents, construction, and configuration control.

  The staff is in general agreement with the TVA approach; however, review of the docketed program and inspection of implementation remains to be accomplished. TVA schedules and milestones for this effort are not definite but the program is extensive and may be the pacing item to licensing.

- Employee Concern Program

  As discussed under Sequoyah issues, changes to the employee concern program have been made and TVA is in the process of evaluating Watts Bar concerns. The level of effort by TVA contractor staff personnel has been impacted by conflict of interest and contractual matters between TVA and Bechtel. Periodic inspections of TVA progress are ongoing.

o Welding

TVA continues to reinspect welds at Watts Bar. Although their data is incomplete, TVA expects to expand the scope of the weld inspection effort in the structural area by about 1200 components and is evaluating the need for further expansion in different population groups on the basis of discrepancies found in the initial sample (the initial sample involved about 1700 components in various systems). TVA is expected to respond to staff questions regarding the Watts Bar program within the next few weeks. The Region I NDE van has been onsite, and staff and consultant inspections of TVA weld activities are ongoing.

o QTC Employee Concern Records

The staff completed the screening and expurgation of QTC employee concern files and has transmitted expurgated files to the TVA IG. Details of this effort are being provided separately to the Commission.

IV. Browns Ferry

TVA submitted the Browns Ferry portion of the Nuclear Performance Plan on August 28, 1986, and an initial staff review is in progress. Although no TVA schedule for Browns Ferry restart is available, TVA stated that Unit 2 is expected to be the first unit to be ready (summer 1987). The staff will meet with TVA at the Browns Ferry site in mid-September to coordinate the staff review and inspection schedule with TVA.

Major issues are described below:

o Probabilistic Risk Assessment (PRA)

The staff met with TVA regarding the (undocketed) draft PRA performed by TVA and their contractor in the early 1980s. TVA and the staff agreed to a plan and schedule for review of the draft PRA and the additional TVA analysis needed to establish the severe accident characterization of the facility. TVA and the staff will meet periodically to discuss status, progress, and direction of the additional analysis. A final report on the severe accident characteristics will be submitted prior to the restart of any of the Browns Ferry Units. On August 15, 1986, TVA was requested to provide the draft PRA for staff review. This effort is consistent with, and will support the NRR initiative on improvement of BWR containment performance.

o Configuration Management/Design Control

All but a few facility modifications have been suspended pending system walkdown and verification that the design drawings reflect the as-built plant components. Walkdown activities for the baseline program which had been suspended pending review of procedures, are expected to resume in September. Delays in this program, in turn, could impact some modifications and the program to revise operating and surveillance procedures. The whole baseline program is being reevaluated for purpose and depth, and TVA has not briefed the NRC staff on the Browns Ferry program.

o Weld Inspections

Staff mandated (Generic Letter 84-11) inspection for intergrandular stress corrosion cracking (IGSCC) in Unit 2 recirculation system piping found a number of nozzles with numerous crack indications. TVA is considering options for replacement or permanent weld overlay and will meet with the staff prior to submitting a recommended course of action for staff review.

The reinspection of other system piping and structural welds is near completion. The staff is planning on a team inspection of the current TVA activities in about two months.

o Fire Protection

Representatives of NRR, IE, and RII met with TVA personnel at the Browns Ferry site in late June to review the modifications and actions proposed by TVA in early 1986 to meet Appendix R requirements. While the general concept appeared reasonable, the NRC staff requested that TVA submit additional documentation regarding the fire hazards analysis combustible loadings calculations for each area and manual operations that would be required to support shutdown. The staff is continuing to evaluate the fire protection program. Fire protection could be a limiting issue for startup if TVA's request for specific exemptions cannot be found acceptable.

o Drywell Penetration and Cables

Replacement of three drywell electrical penetrations to meet EQ requirements was scheduled to start the week of August 25, 1986. This could be a critical path item if

replacement penetrations are not delivered on schedule. All safety-related drywell cables are being replaced with qualified cable. This work has not started pending approval of and training on procedures that meet TVA specifications.

Conclusion

Although TVA targets for completing critical actions and submittals have continued to slip at Sequoyah, the staff believes that a scheduled restart date of January 1987 appears achievable. Staff resources will be strained to assure timely and comprehensive review of TVA activities and submittals in the next few months.

Where activities at other TVA facilities have progressed sufficiently to allow meaningful staff review, the staff has committed the necessary resources to facilitate prompt evaluation and feedback to TVA.

The staff is currently conducting normal inspection activities at all of the TVA facilities and conducting special inspections or reviews of particular TVA issues, as described above. More information on activities will be provided in subsequent reports.

Victor Stello, Jr.
Executive Director
for Operations

TASK ASSIGNMENT NO. TA-6

TASK ASSIGNMENT SHEET
BELLEFONTE PROGRAMS SECTION

ngineer	Info Only	Principal Engineer for Task	To Assist Principal Engineer	Review and Comment	RELATED DOCUMENTATION Attached [X] Yes [ ] No (Partially)
		✓			1) NCR 2003 (Attached Corresp) 2) NCR 2372 (Attached)
	✓				3) NUMEROUS CABLEBEND NCRS in your file
					Reference: J. Erpenbach (QIS) has large amt. of Back-ground data.
J Erpenbach	✓				
✓ WET/JSC	APPROVAL REQUIRED [✓] Yes [ ] No				

SUBJECT Cable Bend Radius Problems AT BLN

DATE ASSIGNED 8-3-83 DATE DUE 9-16-83 DATE COMPLETED 10/13/83 — To QIS - on 10/17. via JSC memo Re quality prob.

PRIORITY Right Behind Audit Followups.

ASSIGNED BY _____ MANAGEMENT REVIEW DATE (if applicable) N/A

INSTRUCTIONS Please get Copies of all CableBend NCRS and Correspondance for BLN you Can find. Determine 1) the nature of the Problems 2) Cause of the Problem (Absolute Root Cause) 3) Action taken by TVA To Correct the problem. 4) determine if a fix to one type problem is Causing another or if Retro-fit should be done and is not being done. i.e. - determine if, from a big picture point of view, the TVA Corrective Action is Satisfactory.

I will help you in any Way I Can. If you see that above scope needs to be Expanded, please notify me.

8/3/83

PRINCIPAL ENGINEER - ATTACH WRITTEN ASSESSMENT AND RETURN TO WET

15.6

FOR — NAME — DATE 10/13/83

ADDRESS — ☐ Call ☐ M S ☐ Know ☐ Not

Fold here for return

FROM — NAME — EXTENSION

ADDRESS — ☐ Call ☐ M S ☐ Know ☐ Not

- Cable Bend Study -

Here is another study for your comments. - How do we report on this typo thing & How do we communicate results to ENDES & QIS - I think QIS has this listed as a Quality Problem. - Maybe we should meet w/ QIS and decide on a course of action - I don't know.

INSTRUMENT TUBING
&
CABLE BEND STUDIES

JC Sent results to TAM 10/17/83
- Sent QIS further instruction
[illegible] 10/17/83

TVA 45D

DRAFT: 9/26/83 10/4/83

PRELIMINARY

BELLEFONTE NUCLEAR PLANT UNITS 1 AND 2
CABLE BEND RADIUS PROBLEMS

INTRODUCTION

Multiple NCRs have been initiated concerning violation of the minimum bend radius for installed power cable at Bellefonte Nuclear Plant as specified in construction specification G-38, "Installing Insulated Cables Rated Up to 15,000 Volts Inclusive." A review of all NCRs associated with cable bend radius, discussions with appropriate electrical engineers and study of other associated materials, i.e., standards, construction specifications, and NRC reports, was made to gain insight into this problem:

PROBLEM TYPES

The following categories of cable bend radius problems were noted:

1. Cables routed in cable trays.
2. At points of transition from cable tray to conduit or equipment.
3. Cables pulled through or into condulets and pull boxes that allow insufficient cable bend radii.
4. Cables entering and terminated within electrical equipment terminal boxes or housings.

DISCUSSION

Cables installed in the Bellefonte cable tray system have an inherent problem because the cable tray system was installed with all 12-inch fittings. These fittings limit the minimum bending radius of the cables. Shielded power cable larger than 1-inch in diameter could likely violate minimum bending radius criteria as specified in construction specification G-38. Also vertical drops or riser from the cable trays are made with the

cable bend exceeding the minimum bending radius. NCRs 1[illegible]9, 2330, and 2331 document this deficiency. To resolve this problem the cable manufacturers were requested to give their recommendations. In most cases the requirements as specified in construction specification G-38 were relaxed. The following instructions were supplied to CONST: "For the BLN installed shielded power cable and the on-hand shielded power cable yet to be installed from Okonite Company and Collyer Insulated Wire, the minimum training radius by cable size is as follows:

— where is end of quote?

BLN - SHIELDED POWER CABLES (V5 Level)

Cable Manufacturer	2/0 AWG	4/0 AWG	300 MCM	400 MCM	500 MCM
Okonite Company (4.4 x cable OD)	4.94	5.43	5.84	6.38	6.89
Collyer Insulated Wire (8.0 x cable OD)	9.10	N/A	N/A	N/A	N/A

The above tabulated values are acceptable at BLN regardless of where the training radius occurs (e.g., in standard cable tray fittings, in nonstandard manufactured cable tray fittings, in transitions from tray to tray or tray to conduit, in conduit boxes, in cable wireways, in electrical equipment, etc.). These values are based on information provided by the respective cable manufacturer.

Z43269.02

The above information is quoted from R. M. Hodges' memorandum to L. S. Cox dated July 28, 1983, "Bellefonte Nuclear Plant Units 1 and 2 - Minimum Cable Bend Radius for Installing Insulated Cable" (EEB 830729 925). NOTE: This memorandum is a "standalone quality information" memorandum. This is a misuse of "quality information" memorandum which apparently violates EN DES-EPs 1.28, 1.50, and 3.04. R. M. Hodges was informed of this misuse by L. J. Cooney's memorandum dated August 23, 1983, "Use of Memorandum to Convey Design Information - Apparent Violation of Procedures" (ESB 830823 004). In cases where relaxation of cable bend radius is not obtained from the cable manufacturer and the cable bend cannot be justified, the cable is reworked to meet the acceptable criteria.

Cables pulled and trained in equipment supplied with insufficient space for training cables without violating minimum bend radii are reworked. This rework may be only to the equipment, such as moving terminals, etc., or adding larger or new compartments. NCRs 1196, 1439, 1703, 2053, 2103, 2154, 2297, 2308, 2345, 2372, 2410, and 2446 are in this category. Also relaxation of bend requirements apply in this case where applicable.

NCR 2189 was initiated to document exceeding cable minimum bending radius for electric motor leads. EEB wrote letters to various electric motor manufacturers with a TVA proposed criteria derived from the requirements of table 2-1 of NEMA WC8-1976 for a minimum bending radius for motor leads in the main terminal box of class 1E motors. The manufacturer's recommendations were requested. In general, the motor manufacturers were

not aware of the conductor and cable size used to feed power to electric motors. Sometime larger size cable is used to prevent excessive voltage drop to the motor, it is therefore TVA's responsibility to state size of terminal box required for each motor individually. The terminal boxes for medium voltages are almost always adequate because the vendor is required to supply boxes large enough for stress cones. Low voltage terminal boxes are the main concern. TVA must handle the terminal box size requirement in a controlled design document, i.e., design standard, etc. At present, there is no existing criteria approved except for a "standalone quality information" memorandum (EEB 830718 928) from F. W. Chandler to R. M. Hodges dated July 18, 1983. This memorandum was endorsed to CONST for use as design criteria on July 25, 1983 (BLP 830725 039). NOTE: This again is a misuse of "QI" memorandums and violates EN DES-EPs 1.28, 1.50, and 3.04.

There are multiple condulets and pull boxes used in cable installation at Bellefonte Nuclear Plant. Cable pulled in many of these may exceed the recommended minimum bend radius of the cable. Relaxation of the cable bend requirements per cable manufacturer's recommendations is utilized where possible. Also, a computer program is being developed to verify correct installation. All cable installations with condulet and pull box size are entered in this program.
Bellefonte is in the process of collecting data
for this program, which will classify the installation as a go, no go, or probable. The probables will bear investigation. Data has already been collected and run for Watts Bar Nuclear Plant. There were less than .5 percent "probables" all others were "go."

SUMMARY

A cable bend radius task force has been organized to study the cable bend radius problem. This task force consists of two electrical staff engineers from EEB, one each from Bellefonte and Watts Bar Design and one each from Bellefonte and Watts Bar CONST. Their responsibility is to review and make recommendations concerning the problem of cable exceeding minimum bend radius. It is apparent that most problems concerning medium voltage are being dispositioned adequately. The task force has just begun to study low voltage cable bend radius. Walkdown downs are being performed to locate problems that may not be documented. Also inspectors are present during cable installation to document installation.

EEB is developing a new design standard DS-E12.1.5, "Minimum Radii for Field Installed Insulated Cable Rated 15,000 volts or Less," which will address cable bend radii. It will cover transfer of cable and specifications for cable for Bellefonte and Watts Bar because of the 12-inch radius tray system. It will also cover design criteria information previously transmitted to CONST by "standalone quality information" memorandums.

EN DES-SEP 83-08, "Identification, Evaluation, and Resolution of Cable Bend Radius Problems at Watts Bar and Bellefonte Nuclear Plants," was issued on August 4, 1983. This SEP establishes a program for identifying, evaluating, and resolving cable bend radius problems or deviations from the cable bend radius values specified in construction specification G-38.

The cable bend radius task force developed an implementing procedure, "OEDC Program to Identify, Evaluate, and Resolve Cable Bend Radius Problems at WBN and BLN" (EEB 830805 929). The contents of this program are incorporated in EN DES-SEP 83-08. This program identifies cables by cable mark number, cable size, and cable diameter, and gives the bend radius required by Construction Specification G-38. To determine the degree of cable bend radius problem of each category, an inspection (sampling) program is to be conducted on BLN Unit 1. The results are to be evaluated and resolutions recommended to problem areas at BLN and WBN.

CONCLUSIONS

During the course of this study, the following questions and concerns remained unanswered:

(1) Are Sequoyah and Browns Ferry Nuclear Plants being investigated for items in categories 2, 3, and 4? It is apparent that as many problems would not exist for the cable tray systems because of the use of 18-inch radius fittings. There was no criteria in existence for motor leads at the time of construction for Sequoyah and Browns Ferry. Watts Bar is being investigated parallel with Bellefonte Nuclear Plant concerning this problem.

To verify "quality related" and "associated" cable worls previously installed, walkdowns and sampling inspections are to be conducted, especially for low voltage and other cables. Apparently the installation of medium voltage cables is well in hand.

(2) "Associated" cable apparently lacks documented inspection by CONST due to a misinterpretation of G-38. Regulatory Guide 1.74 interprets "associated" cable as being equal to full class 1E cabling when it is installed in class 1E cable trays.

(3) Once cable insulation has been stressed by over bending, what method other than meggering is there to assure that the cable has not been deteriorated? Will overstressing increase the effect of radiation?

(4) The Okonite Company letter to F. W. Chandler dated June 7, 1983, on contract 79K5-82-5903 (EEB 830610 014) indicates that incomplete slippage may cause wrinkles in the tape but does not indicate that incomplete slippage may cuse the tape to tear.

RECOMMENDATION

(1) Several instances of misuse of "QI" memorandums were noted. Evidently, EN DES-EP 1.50 is subject to being misinterpreted. We recommend revision of EP 1.50 to prevent misuse by interpretation. Also, an NCR must be issued to document previous misuse of "QI" memorandums.

(2) There is no inspection sampling quantity indicated. The sampling quantity should be at least based on standard statistical methods be made part of the SEP 83-08.

John,
Any recommendation for QA or EN DES action on WPPSS BOP? - I.E. Do you think DPG should perform a similar evaluation on WBN?

General Comments: [illegible]

243269.02

(3) A program should be set up to investigate Sequoyah and Browns Ferry for items related to their installation such as, motor leads, condulets, drops from cable trays, etc. ~~At least~~ As a minimum, a justification for ~~a~~ not performing program ~~not being required should be stated.~~ Such an investigation should be addressed by EN DES.

(4) Construction Specification G-38 does not distinguish between pulling bend radius and training bend radius. G-38 should be revised to explain pulling and training bend radius even though the value may remain the same.

REFERENCES

(1) G-38, "Construction Specification for Installing Insulated Cables Rated Up to 15,000 Volts"

(2) EN DES-SEP 83-08, "Identification, Evaluation, and Resolution of Cable Bend Radius Problems at Watts Bar and Bellefonte Nuclear Plants"

(3) Watts Bar and Bellefonte Nuclear Plants - "Implementation Procedure for the Identification, Evaluation, and Resolution of Cable Bend Radius Problems"

Attachment 1

WBN 790430 114

DESIGN INFORMATION REQUEST

TO : , Sequoyah and Watts Bar Design Projects Manager, 204 CH-K

FROM : , Jr., Project Manager, Watts Bar Nuclear Plant CONST

DATE : APR 30 1979

SUBJECT: CABLE MINIMUM BENDING RADII - DESIGN INFORMATION REQUEST (DIR) - No. 2-9

Description of Information Requested: Design standard DS-E13.1.2 "Cable Bending Radii for Pulling in Conduit", gives minimum bend radii for pulling cable. Can we interpret this to mean that after the cable is pulled, the minimum tie down radii can be 50 percent of the pulling radii. In many instances the pulling radii must be exceeded when tying down cable in cable trays and when forming the cable for termination in junction boxes and cabinets.

Initial Contact Between J.R. Winsyard (CONST Engr) and K.E. Munroe (EN DES Engr) on 4-24-79 (Date)

Information: Required Date 5-15-79 Promised Date N/A

Drawings Affected: N/A

Approved for Transmittal to Engineering Design _____ Construction Engineer 4-26-79 Date

SWP 790522 045 Project Manager 4/27/79 Date

790525A0306 (1)

Engineering Design Disposition: After the cable has been pulled it shall be permissible to use a minimum tie down value of 50 percent of the pulling radii. For additional guidance for bending cable at terminal equipment, follow equipment manufacturer's recommendation as described in section 2.2.6 of G-38.

EN DES Engineer 5-22-79 Date

Design Project Manager 5-22-79 Date

Copy 1—Retained by CONST
Copy 2—Retained by EN DES
Copy 3—Return to CONST (Transmit copy to P PROD Plant Superintendent)

MEDS, E4B37 C-K

810519 938

UNITED STATES GOVERNMENT

Memorandum

TENNESSEE VALLEY AUTHORITY

810522A0154 (2)

TO: , Project Manager, Watts Bar Nuclear COMST (3)

FROM: , Sequoyah and Watts Bar Design Projects Manager, 204 GB-K

DATE: May 18, 1981

SUBJECT: WATTS BAR NUCLEAR PLANT - DESIGN INFORMATION REQUEST (DIR)-NO. E-9, REVISION 1

Please refer to subject DIR, Thomas B. Northern, Jr., to R. M. Pierce dated April 30, 1979 (WBN 790430 114).

The referenced DIR is related to the minimum bending radii of insulated/jacketed cable, when being formed for termination in junction boxes and cabinets, or being tied down in cable trays after cables have been pulled. After further evaluation of the "training" radius of cable, we have determined the recommended values of Insulated Cable Engineers Association (ICEA) are applicable. The training radius is the minimum to which a cable should be bent without tension on the cable. Thus, Engineering Design Disposition (EWP 790522 045) is revised to read as described below; please attach this revision to your original DIR-No. E-9, which should be marked revision 1.

The applicable Insulated Cable Engineers Association (ICEA) training radii for insulated cables is as follows:

12 times the completed cable diameter for shielded power cables (e.g. 8-kV power cables).

Cable training radii for other 600 volts or less cables depend on insulation thickness and overall cable diameter:

Insulation Thickness (inches)	Overall Diameter of Cable (inches)		
	1.000 and Less	1.001 to 2.000	2.001 and Over
	Minimum Training Radius as a Multiple of Cable Diameter		
0.155 and less	4	5	6
0.170 - 0.310	5	6	7
0.325 and over	-	7	8

Cable tray fittings at WBN are provided with a 12-inch radius. Therefore, cables can be "trained" to not be less than the above radii before tying them down in cable tray.

DEPOSITION EXHIBIT 3

8 9 5 5

Triangle PWC, Inc.
New Brunswick, New Jersey 08903

EEB '83 0228 014

February 18, 1983

Tennessee Valley Authority
400 West Summit Hill Drive, W8C126
Knoxville, TN 37902

Subject: TVA Contracts 74C7-85069-2
72C7-75228-1

Dear Mr. Chandler:

Regarding your letter dated October 27, 1982, concerning the referenced contracts for cable incorrectly installed at the WATTS BAR NUCLEAR PLANTS, we feel that, in order to attain optimum service life, high voltage shielded power cable should be installed in strict conformance with the minimum bending radius guidelines that are defined in the ICEA standards, which were developed by knowledgeable cable engineers based upon viable historical data. Any deviation from this referenced established practice would, in our opinion, shorten the service life of the cable.

To the best of our knowledge, there is currently no real viable test that could effectively simulate the operating conditions of those cables presently installed at the WATTS BAR nuclear plants. Without this information, we would be unable to predict the actual impact on the cable's service life as a result of your referenced installation condition.

We regret that we cannot be of any further assistance in this area.

Very truly yours,

TRIANGLE PWC, INC.

Peter P. Deschner
Sales Manager-Special Cable Products

/cb
cc: W. Zehe

2/28/83 - FWC:PAD
cc: J. C. Standifer, 20h GB-K
MEDS, W5B63 C-K

DD1
2 14

8308310197 (2)

Rome Cable
CORPORATION

421 Ridge Street
Rome New York 13440
Telephone 315 337-3000
Post Office Box 71
TWX 510 243 0232

August 24, 1983

REB '83 0828 024

Tennessee Valley Authority
400 West Summit Hill Drive
WBC12G
Knoxville, TN 37902

Gentlemen:

This is in reply to your letter regarding cable installations at the Watts Bar and Bellefonte Nuclear Plants. Your letter addresses some concern over the fact that some of the bends where cables pass through conduits may be less than those covered in the appropriate ICEA Specifications. Apparently your investigations have confirmed the fact that some bends are indeed less than those specified and you have some concern that future movement and settling of the cables may cause additional changes in the bending radii.

We believe that the bending radius recommendations in Section L of ICEA Specification S-66-516 and its companion standards are sound engineering recommendations and were established with due consideration for cable performance and satisfactory service life. Cables which do not conform to these recommendations may be subject to mechanical forces which could affect performance. Obviously, each cable system has its own characteristic installation and operating conditions which can additionally influence cable life, either adversely or favorably. In view of the lack of additional information, we do not feel that we can supply information regarding shortened cable life nor can we identify any particular mechanisms by which failure could take place.

Regarding in situ testing such as insulation resistance and continuity tests, we comment as follows:

1. IR testing would not provide any conclusive favorable information concerning the integrity of the cables unless they are fully shielded. If the cables are not shielded, the IR measurement will not be meaningful unless it indicates a near short circuit or grounded condition.

2. Continuity testing does not appear to be practical, if I am correct in assuming that the test refers to the continuity of each copper conductor from one end of the circuit to the other. Bending radius recommendations

Cont'd.....

Rome Cable
CORPORATION

421 Ridge Street
Rome, New York 13440
Telephone 315/337-3000

Post Office
TWX 510/2

EEB '82 1115 0

November 12, 1982

Tennessee Valley Authority
400 West Summit Hill Drive, W8C126
Knoxville, TN 37902

ATTENTION: Mr. F. W. Chandler, Chief, Electrical Engineering Support Branch
Mr. Kent Brown, Electrical Engineering Support Branch

Gentlemen:

In reply to your letter of October 27, 1982 there is reason to expect your installation using less than the minimum training radius and bending radius for medium voltage power cables, as recommended by ICEA, would have a shorter service life than an installation that met the ICEA bend radius standards.

Mechanisms that would cause a shorter life would involve the following. Damage to the metallic shielding tape causing reduced conductance, separation of the extruded insulation shield from the insulation causing voids where ionization could take place, electrical stress plus increased physical stress (tension) in the outer periphery of the cable at the bend, electrical stress plus increased physical stress (compression) at the inner circumference of the bend.

All of the above negative factors would be increased by the load cycling which would occur during the life of the cable.

Mr. Kent Brown of your office advised me on November 9th, 1982 that the cable involved is a 2/0 with a bending radius of 10.9 times the diameter of the cable rather than the 12 times the diameter of the cable as specified by ICEA. The negative effects on this cable would be considerably less than the effects on the 300 MCM cable with a bending radius of 8.2 times the diameter of the cable as described in your letter.

Very truly yours,

JAM:ds

11/15/82 - FWC:PAD
cc: MEDS, W5B63 C-K

11 8:4

EEB '83 0106 013

Rome Cable
CORPORATION

421 Ridge Street
Rome, New York 13440
Telephone 315/337-3000

Post Office Box 71
TWX 510.243-8732

January 3, 1983

8301110093 (1)

Tennessee Valley Authority
400 West Summit Hill Drive, WBC126
Knoxville, TN 37902

ATTENTION: [illegible]
Chief, Electrical Engineering Support Branch

Dear Mr. Chandler:

Refer to your letter of December 30, 1982 concerning the training radius of 8 kV power cable.

The installation of the size 2/0 AWG cable at an installed bend radius of 10.9 times the cable OD rather than the minimum recommended bending radius of 12 times the cable OD should cause no ascertainable difference in cable service life.

If there is anything additional you require, please advise.

Very truly yours,

[illegible]
Application Engineer

JAM:ds

1/6/83 - FWC:MBC
cc: MXD8, W5B63 C-K

COMPUTED ____ DATE 4-12-85

CHECKED ____ DATE

List of Manufacturers That Received Letters and Photos Concerning Low-voltage Cable Bends

1) American Insulated Wire	Reply dated 8-25-83 ✓
✓ Anaconda-Ericsson, Inc.	Reply dated 9-9-83 ✓
✓ Belden Corp.	Reply dated 9-12-83 ✓
✓ Boston Insulated Wire	Reply dated 9-1-83 ✓
✓ Brand-Rex Company	Reply dated 8-29-83 ✓
✓ Carolina Wire and Cable	No Reply ✓
✓ Collyer Insulated Wire	No Reply ✓
✓ Delco Wire and Cable	Reply dated 8-31-83 ✓
✓ Eaton Corporation	Reply dated 10-13-83 ✓
✓ ITT Surprenant	No Reply ✓
✓ Okonite Company	Reply dated 9-29-83 ✓
*✓ Pirelli Cable Corp. (General Cable Cimco Wire & Cable)	No Reply ✓
*✓ Rockbestos Company (Cerro Wire)	Reply dated 9-8-83 ✓
✓ Rome Cable Corp.	Reply dated 8-24-83 ✓
✓ Teledyne Thermatics	Reply dated 9-7-83 ✓
✓ Tensolite Company	No Reply ✓
✓ Thermo-Electric	No Reply ✓
✓ Triangle-PVC	No Reply ✓
19) United Technologies, Essex	No Reply ✓
TIMES WIRE & CABLE	
GENERAL ELECTRIC	

*Companies in parentheses were purchased by the manufacturers listed. That may be where your 2 extras came from.

TIMES WIRE & CABLE
GENERAL ELECTRIC

W12 AB C-K

WB C126 C-K

June 11, 1986

CLASS 1E CABLE BEND RADIUS

Description of Issue: NSRS Report No. I-86-06-WBN-01

Starting in 1973 an evolutionary process characterizes cable bend radius requirements in TVA specifications. Present specification requirements are based on minimum values specified by cable manufacturers or by ICEA standards. In some instances, these values have been violated, i.e., non-conforming conditions identified within the TVA QA Program. Based on recent studies and by utilizing recognized cable properties, we believe that the cable bend radii issue should not affect restart. Our rationale is provided below. Furthermore, we believe that this approach will provide a 40-year qualified life for the vast majority of our cable.

The basis for our approach stems from the fact that the property "retention of elongation" of cable insulation is the accepted method of measuring (and establishing) the end of life in cables. Typical cable insulation materials have unaged elongation properties which vary from 250 to 500 percent. It is accepted that after thermal aging, mechanical stress, radiation, and postulated accident environment, elongation properties degrade to a degree depending on the specific insulation material.

A cable bent to a given radius produces an elongation stress on the outer surface of its insulation. This can be calculated. A cable having a bending radius of one times its diameter has an elongation stress of 33 percent. This stress has been shown to have a minor effect on the qualified life of the cable.

Our analysis will show that for the worst-case (minimum allowable) cable bending radius (one times its outer diameter), the resulting stress from the bend radius will not affect the qualified life of the cable. We strongly believe that this analysis will conclusively show that cables have a qualified life of at least 30 years with the vast majority qualified for 40 years.

Our worst-case bending radius was based on the fact that cable installation in condulets within a conduit system subjects a cable to the smallest possible radius. Minimum bend radius within each condulet size was determined. Condulet radii was then established for each safety-related conduit installation at WBN. Out of approximately 10,500 conduits all had radii greater than 1.5 times the diameter of any installed cable.

Practically speaking it is very difficult to bend a cable to less than one times the cable outside diameter. A surveillance program will be established to detect and correct deviations to this new minimum bend requirement in locations outside the raceway system, specifically with terminating compartments.

UNITED STATES GOVERNMENT

Memorandum

TENNESSEE VALLEY AUTHORI

: ., ---------, Nuclear Manager's Review Group, 716C EB-C (2)

M : ., Director of Nuclear Engineering, W12 A12 C-K

: June 18, 1986

B43 '860609 927

SUBJECT: WATTS BAR NUCLEAR PLANT (WBN) - INVESTIGATION OF AN EMPLOYEE CONCERN REGARDING CABLE ROUTING, INSTALLATION, AND INSPECTION - NUCLEAR SAFETY REVIEW STAFF REPORT NO. I-85-06-WBN

References: 1. R. W. Whitt's memorandum to R. M. Pierce dated July 9, 1985 (Q01 850709 050).

2. R. M. Pierce's memorandum to R. W. Whitt dated July 8, 1985 (F01 850708 604).

This is to supplement R. M. Pierce's memorandum (reference 2 above) with regard to the cable sidewall pressure issue. DNE instituted the following actions to evaluate the effect of excessive tensions and sidewall bearing pressures (SWP) on cables.

Cable Pulling Force (I-85-06-WBN-02)

A design calculation to determine the acceptability of SWPs exerted on Class 1E cables in existing conduit installations at Watts Bar Nuclear Plant was initiated followed by a sampling program involving approximately 10,400 conduits. Screening calculations (Reference WBN Document "Sidewall Pressures of Class 1E Cables in Conduits" (343 860310 936)) reduced the number of conduits to 1914 which were considered potential candidates for high sidewall bearing pressure. From these 1914 conduits, a field inspection team consisting of CE, QC, and QA/QC personnel conducted a walkdown of 778 conduits to determine the worst-cases and selected 82 conduits for analysis. The 82 conduits consisted of approximately 20 conduits each from voltage levels V2, V3, V4, and V5. Conduits from voltage level V1 were not considered as there are no Class 1E cables in voltage level V1.

Based on the isometric sketches furnished by NU CON for routing of these 82 conduits, tension and SWP calculations were performed analytically for each cable to determine the worst-case SWP. The calculated SWPs were compared with the SWP limits recommended in the construction specification G-38. It was noted that 21 cables in 12 of the 82 conduits exceeded the SWP limits.

The TVA Central Laboratories performed extensive tests on the above 21 samples in addition to representative samples selected from SQN, BFN, and BLN nuclear power plants to include different cable types (power, control, signal and instrumention, and coaxial), types of insulation, jacket materials and manufacturers. These tests established allowable SWP limits in excess of that required within margin. TVA test results are also consistent with EPRI Report No. EL-3333 where allowable were determined to be 4-5 times higher than previous manufacturers' limits.

The test was performed in a fixture containing four 90° horizontal bends was set up and cables were pulled through the conduit with tension forces from 2 to 12 times more than the recommended values in G-38. The cables were subjected to pulling tension values very near the ultimate breaking strength of cable. Each cable, after being pulled, was inspected, dimensioned, carefully stripped to examine individual conductors of multi-conductor cable and subjected to dielectric breakdown test. The dielectric breakdown values of the tensioned cable was compared with the dielectric breakdown value of the virgin cable of same sample. The average dielectric breakdown value of all the 32 cables tested was within 20 percent of the average dielectric breakdown value of the respective virgin cable sample, thus meeting the acceptance criteria set for the test per ASTM D 149. Further, none of the cables revealed any significant degradation of insulation. The results of the test are presented in the 'Cable Sidewall Bearings Pressure Tests' report prepared by the Central Laboratories of the TVA, dated May 30, 1986 (E13 860604 001).

It is noteworthy that the results reflect extreme conservatism as the cables were subjected to SWPs far higher than the values normally recommended. Typical values obtained were:

		Range of Test Values lb/ft	Present G-38 Values lb/ft
600V	Control and Power	2027	300
		602	300
8 kV	Power	3104	300
		2889	300
	Instrumentation	1496	100
		447	100
	Coax	1242	100
		373	100

R. [illegible]erling
Ju[illegible]1986

WATTS BAR NUCLEAR PLANT (WBN) - INVESTIGATION OF AN EMPLOYEE CONCERN REGARDING CABLE ROUTING, INSTALLATION, AND INSPECTION - NUCLEAR SAFETY REVIEW STAFF REPORT NO. I-85-06-WBN

As evidenced by the calculation and the SWP test, it is clear that excess pulling tensions and SWPs on cables did not cause any damage to the cable insulation and so is not and should not be a concern for Watts Bar Nuclear Plant.

W. C. Drotleff

WSR:FBR:BB
cc: RIMS, SL 26 C-K
J. A. Kirkebo, W12 A8 C-K
E. A. Putkonen, W12 A19 C-K
W. S. Raughley, W8 C126 C-K
H. L. Rayfield, P-104 SB-K
D. W. Wilson, DNE, DSC-A, Sequoyah
J. P. Stapleton, A10-BFN ENG
R. R. Hoesly, 9-113 SB-K
F. B. Rosenzweig, W8 C158 C-K

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