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AUG 30 1991

U. S. Nuclear Regulatory Commission
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Washington, DC 20555

Gentlemen:

In the Matter of the Application of)	Docket No. 50-438
Tennessee Valley Authority)	Docket No. 50-439

BELLEFONTE NUCLEAR PLANT (BLN) - TRANSMITTAL OF TVA'S RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION ON ELECTRICAL CABLES (TAC NOS. 79281, 79282, AND 79284)

REFERENCES:
1. TVA letter to NRC dated May 16, 1991, "Transmittal of TVA Position Regarding Cable Pullby (TAC #79281)"
2. TVA letter to NRC dated May 16, 1991, "Transmittal of TVA Position Regarding Cable Sidewall Bearing Pressure and Jamming (TAC #79282)"
3. TVA letter to NRC dated May 23, 1991, "Transmittal of TVA Position Regarding Cable Bend Radius (TAC #79284)"
4. NRC letter to TVA dated August 7, 1991, "Request for Additional Information on Electrical Cables - Bellefonte Nuclear Plant (BLN), Units 1 and 2, (TAC Nos. 79281, 79282, and 79284)"

In accordance with TVA's letter to the NRC staff dated December 4, 1990, references 1, 2, and 3 submitted position papers regarding electrical cable issues. On July 25, 1991, TVA met with the NRC staff and discussed various questions from the staff. Reference 4 requested TVA to formally document the responses to the questions. Enclosure 1 provides TVA's response to the staff's questions discussed at the July 25, 1991 meeting.

Subsequently, in a phone conversation on July 31, 1991, the NRC staff requested additional specific information regarding cable installed in conduit. Enclosure 2 provides the requested information.

Enclosure 3 identifies the commitments contained within this submittal.

A001 1/1

If you have any questions please telephone Bruce Schofield at (205) 574-8058.

Very truly yours,

W. J. Museler

W. J. Museler

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ENCLOSURE 1

RESPONSE TO NRC QUESTIONS ON CABLE ISSUES IN NRC'S LETTER DATED AUGUST 7, 1991

Note: NRC questions appear in bold.

Please provide clarifications of the following items contained in references in the three TVA position papers on Electrical Cables (TAC Nos. 79281, 79282, and 79284).

A. CABLE PULLBY DAMAGE

1. Reference 10 related to parachute cord.

Inspections and tests at the Watts Bar Nuclear Plant (WBN), Sequoyah Nuclear Plant (SQN), and Browns Ferry (BFN) plants have indicated that pullby damage occurred only at WBN and only in conduits where nylon parachute cord was used. Investigations at BLN have demonstrated that parachute cord was never used. This fact provides further confirmation that pullby damage has not occurred at BLN. The NRC questions pertain to the BLN investigations which were performed.

Reference 10 is a TVA memorandum (J. L. Langston to R. C. Miles) dated February 5, 1991; "Bellefonte Nuclear Plant, Electrical Cable Installation Pull Ropes, Nylon Parachute Cord."

a) Question

Was any cord supplied before 1980?

Response

Reference 10 documents a search of warehouse records which was performed to determine if parachute cord was received or stocked at BLN. The search revealed that no parachute cord was received or stocked at BLN at any time, either before or after 1980.

At the same time, Reference 10 generally characterizes the types of cable installation pull ropes used at BLN. Reference 10 lists a sample of the contracts which supplied pull rope for BLN. The particular sample contains only contracts dated 1980 or later. Since some cable was pulled prior to 1980, the NRC question is directed at the type of pull rope which was used during that earlier period.

There is no significance to the 1980 date. It relates only to the sample of pull rope contracts which was presented. In response to the question however, an informal search was performed to identify pull rope ordered before 1980. This search revealed the following orders:

CONTRACT	DATE	TYPE	QUANTITY
77X70-547385-2	8/18/78	3/4" Polypro Rope	3600 ft.
79K8C-785116	9/13/79	3/16" Polypro Rope	50,000 ft.

These pull ropes are the same or similar to those which were ordered at later times, and do not include parachute cord.

b) Question

Can samples of conduits and cables installed before 1980 be identified and inspected?

Response

The installation dates for BLN cables can be identified from the cable pull cards. In response to the NRC question, TVA will perform additional walkdowns and inspections at accessible points of a sample of cables and conduits which were involved in pullbys, to further confirm that pullby damage has not occurred. The sample will consist of conduits drawn from the 135 conduits which BLN has identified as having some credible chance to have sustained pullby damage. This sample will include cables pulled both before and after 1980, although, as mentioned above, TVA attaches no significance to the 1980 date.

c) Question

Were any tests done to determine whether pullcord used at BLN could cause pullby damage and mechanism of such a damage?

Response

TVA has not performed tests to determine whether pull rope used at BLN could cause pullby damage, nor has testing been performed to determine how that damage could occur. TVA concludes that such testing is not necessary based on the TVA evaluation of the existing installation as described in the position paper on pullbys. Specifically:

1. Industry experience indicates that pullbys are common and the instances of pullby damage are rare.

2. The extensive investigations of this issue at all the TVA nuclear plants shows that the materials and methods used for pulling cables have been sufficiently conservative to avoid cable damage due to pullbys except in a few of the instances when nylon parachute cord was used as a pull rope. No evidence of the use of parachute cord at BLN has been discovered.

3. Review of construction records for cables which were involved in cable pullbys, and which were pulled back at BLN for other reasons, indicate no damage caused by pullbys.

4. Cable pulling practices at BLN were sufficient throughout the period of cable installation to prevent pullby damage.

Requirements which will apply to future cable pulls will further limit the chances for damaging cables due to pullbys. In particular, the following requirements in TVA General Construction Specification G-38 will be implemented to further assure against pullby damage:

1. In general, pullbys will be avoided.

2. Cable pull tensions are limited based on the conductor strength and sidewall bearing pressure limits for the cable.

3. When pullbys are judged appropriate by BLN engineering, they will only be permitted under close engineering guidance and supervision.

4. In no case will pull ropes already installed in conduits be used.

It is also noted that Specification G-38 now includes requirements for insulation resistance testing (i.e., megger testing) for new cables installed in conduits with existing cables and for the existing cables if the pull tension for the new cables is greater than 300lbf. This testing is performed after pulling has been done, while the pull lubricant is still wet. Thus, in the future, testing will be performed to detect if damage has occurred during the pulling operation and, in the unlikely event that pullby damage occurs, the damaged cables will be replaced.

2. Reference 12

A walkdown was performed at BLN of a sample of conduits for the purpose of determining if parachute cord was installed. The results of this walkdown are reported in Reference 12, which is a Gilbert/Commonwealth letter to MPR Associates (R. A. McNabb to R. M. Carritte) dated February 25, 1991; "Walkdown of BLN Safety Related Conduits for Nylon Parachute Cord." These questions pertain to the results of that walkdown.

a) Question

Please provide clarification for the number of conduits in the summary on page 3 of the refereuce.

Response

Reference 12 determined that no parachute cord was installed in any of the conduits which were walked down. This supports the results of the search of warehouse records, and the discussions with personnel involved with the BLN cable installation, which indicated that no parachute cord was used at BLN.

Reference 12 characterized the conduits which were inspected, and the categories into which they fell are as follows:

15	CATEGORY 1:	Conduits filled with foam yielding no observation
67	CATEGORY 2:	Empty conduits containing no cable or pull rope
325	CATEGORY 3:	Conduits containing cable but no pull rope
42	CATEGORY 4:	Conduits containing pull rope
449	Total	

The 42 conduits of Category 4 were further characterized as follows:

14 = Number of pull ropes whose size and type Reference 12 reported could not be specifically identified during the walkdown.

The actual walkdown result showed that only one pull rope fell in this category. Reference 12 is being corrected accordingly. It is further noted that the walkdown did confirm that the one unidentified pull rope was not parachute cord.

43 = Number of pull ropes for which size and type were determined during the walkdown. (Two conduits contained two pull ropes.) None of the pull ropes were parachute cord.

To summarize, the number of pull ropes which were found in the Category 4 conduits is as follows:

Number of Conduits	Number of Pull Ropes	Description
1	1	Conduits w/one pull rope of unidentified size & type
2	4	Conduits w/two pull ropes of identified size & type
39	39	Conduits w/one pull rope of identified size & type
42	44	Total Category 4 conduits and pull ropes, 43 identified and 1 unidentified

3. Reference 18

Reference 18 is a Gilbert/Commonwealth letter to MPR Associates (K. E. Shuman to R. M. Carritte) dated May 2, 1991, "BLN Cable Pullby Calculation BLN-GC-CBL-01." This calculation identifies BLN conduits and cables which are considered most susceptible to pullby damage (conduits which are long in length and which contain significant numbers of cables). It then compares the parameters for these conduits and cables with SQN and BFN parameters for conduits and cables which have been identified as most susceptible to pullby damage. These comparison results are used in the TVA licensing position paper on pullbys. As discussed in the position paper TVA concludes that the comparison shows that the BLN cable and conduit are similar to those at SQN and BFN. TVA therefore concludes that the results of field inspections at SQN and BFN (which identified no pullby damage) are applicable to conduits and cables at BLN. (Note: Reference 18 is undergoing minor revision. Conclusions based upon it will not change.)

The NRC questions relate to the comparisons among cable and conduit and the conclusions which are drawn from those comparisons.

a) Question

What is the conclusion regarding pullby damage?

Response

The mechanism which produces pullby damage is not completely understood, because its occurrence is extremely rare. However, aside from the issue of parachute cord (which has been discussed earlier) the factors included in the comparison in Reference 18 which could influence pullby damage are as follows:

- Conduit Length
- Conduit Size
- Number of Cables per Conduit
- Number of Pullbys per Conduit

The importance of each of these factors in increasing the probability of pullby damage is not known although, based on industry experience the risk from any of the factors is extremely small. TVA concludes that cable pulling practices employed at BFN and SQN were sufficiently controlled to prevent pullby damage for the conduit and cable configurations at those plants, since inspections at BFN and SQN indicate that no pullby damage has occurred. Since the conduit and cable configurations (i.e., the factors discussed above which influence pullby damage) at BLN are similar to those at BFN and SQN, TVA concludes that there is reasonable assurance that pullby damage has not occurred at BLN. Since the cable pulling practices at BLN are as good as (or better than) those at BFN and SQN, and considering additional factors delineated in the position paper, TVA concludes that pullby damage will not occur in the future.

b) Question

What are the average, minimum, and maximum number of cables in the conduits?

Response

The average, minimum, and maximum number of cables in the conduits are 13, 4 and 46, respectively. This compares favorably with BFN and SQN.

c) Question

How does the data confirm that there is no pullby damage in cables in 135 conduits, as stated on page 97 of the reference?

Response

Reference 18 provides data concerning cables in the population of BLN safety related conduits which are most likely to have experienced significant pull tensions and multiple numbers of pullbys. Conclusions concerning pullby damage at BLN are drawn in the TVA licensing position paper. The data which were gathered by Reference 18, the way in which those data were used by the position paper, and the conclusions which were drawn are summarized below.

As part of the cable pullby evaluations performed at SQN and BFN, TVA initially screened the safety related conduits which are long in length and contain significant numbers of cables. Conduits "long in length" and "containing significant numbers of cables" were used as criteria for screening these conduits for the purposes of identifying conduits with the potential for multiple numbers of pullbys and significant pull tensions. TVA performed high potential tests on cables in selected conduits identified by this screening process at both BFN and SQN. No cable damage due to pullbys was found during these tests.

As part of the pullby evaluations conducted at BLN in 1991, TVA: 1) identified safety related conduits required for Unit 1 fuel load that are long in length and contain significant numbers of installed cables, and 2) compared the attributes of these conduits with the attributes of the conduits identified at BFN and SQN. The specific attributes chosen for comparison were the number of conduits, the conduit lengths and sizes, the number of cables per conduit, and the number of pullbys per conduit. These comparisons were made to determine if the population of conduits at

BLN has attributes similar to the population of conduits at BFN and SQN, which were extensively evaluated and tested and found to have no pullby damage.

The results of these comparisons are contained in Table 1 of the position paper regarding pullbys and are summarized below:

- The number of conduits which met the screening criteria at BLN and SQN are comparable as a percentage of the safety-related conduit populations.

- The number of conduits which met the screening criteria at BLN is smaller than the number for BFN as a percentage of the total population reviewed.

- The median conduit length at BLN is roughly the same as the median conduit length for BFN and SQN.

- The most common conduit size at BLN is the same as the most common conduit size at BFN and SQN.

- The average number of cables per conduit at BLN is less than the average number at BFN and SQN.

- The average number of pullbys per conduit at BLN is equal to the average number at BFN and slightly less than the average number at SQN.

Based on the results of these comparisons, TVA concludes that the BLN conduits are part of a larger set of conduit installations comprised of the BLN, BFN and SQN populations. Accordingly, TVA concludes that the test results from BFN and SQN are applicable to the BLN conduits. Based on the above comparisons, the test results, and additional factors delineated in the position paper, TVA concludes there is reasonable assurance that pullby damage has not occurred at BLN.

4. <u>Reference 19</u>

Reference 19 is a United Engineers and Constructors (UE&C) letter to MPR Associates (R. Bryans to H. Estrada) dated April 25, 1991; "Bellefonte Nuclear Plant Cables in Conduit - Percentage Fill (PE129AE-07)." It forwards UE&C report PE129AE-07 which was generated to identify overfilled safety-related conduits at BLN. This effort was initiated because of concerns with large numbers of overfilled conduits at WBN. The report determined that, of the approximately 5600 safety related conduits examined, only 64 conduits are overfilled based on methodologies specified in the TVA electrical design standard. The worst case overfilled conduits were determined to have a calculated fill of 35.84%, which exceeds the allowable fill of 31% by 4.84 percentage points. TVA concludes, based on the small number of overfilled conduits and the small degree of overfill, that overfilled conduits are not a significant concern at BLN. (Note: Reference 19 is undergoing minor revision. Conclusions based upon it will not change.)

The UE&C report used as a data source the TVA Engineering and Construction Monitoring and Documentation (ECM&D) system database for BLN. Along with other construction information, ECM&D lists conduit, cable, and routing information. Special ECM&D reports were generated to obtain conduit fill data.

The ECM&D database was used as a construction status tool prior to construction deferral and, therefore, is believed to reflect accurately the current as-built cable and conduit status. To obtain additional confidence that the data utilized in Reference 19 reflected the as-built condition, several verification packages were prepared and included as attachments to Reference 19. Verification of the ECM&D reports utilized in Reference 19 was made through the statistical analysis of data collected during a walkdown of sample conduits.

During the generation of Reference 19, several construction and engineering anomalies were identified and documented. These anomalies are documented in Reference 19. None of these anomalies affect the data which were used to identify overfilled conduits, and they do not affect the conclusions which were drawn from that data. The anomalies will be addressed as part of the normal construction processes at BLN, when those processes resume.

The NRC questions address both the anomalies and the methods which will be used in the future to prevent cable damage due to overfilled conduits and pullbys. The particular questions and the detailed responses are provided below.

a) Question

Section 6.1 Conduits of trade size ."1" page 15 of 23

Which cables were found in the conduits that the drawing showed as removed?

Response

The conduit trade sizes identified in the overfill report mentioned above were verified in order to: 1) validate the accuracy of the data, 2) address unusual trade sizes and 3) re-assess conduit fills based on field verified trade sizes.

The only conduit trade size anomaly which was found was that 33 conduits were listed as having a size of .1 inch. Such a small conduit size does not exist and does not accurately represent the actual conduit. The conduits with this designation are shown removed from the conduit drawings, and have either been physically removed or action has been initiated to have them removed or reworked. The ."1" designation was apparently used in ECM&D to identify conduits which were undergoing change.

Open construction change documents exist for all the conduits in question. These were not completed at the time of construction deferral. When construction resumes, cable and conduit removal will be completed. In summary, plant records clarify this apparent anomaly.

b) Question

Section 8.0 Summary of Results

How will the anomalies be resolved?

Response

As discussed above, several anomalies were identified while the conduit overfill report (Reference 19) was being generated. These anomalies are documented in the report, and are the subject of the NRC question. The specific anomalies were:

- Conduit trade size ."1" in the ECM&D database

- Utilization of cable mark numbers not found in TVA design standards

- Field conduit trade sizes and [resulting calculated] fills in a few cases did not match the ECM&D database

- Conduit 1A3-1442B is missing (cables are exposed)

Each of these are addressed in turn below:

- <u>Conduit trade size ."1" in the ECM&D database</u>

  This is discussed in the answer to question 4.a above.

- <u>Utilization of cable mark numbers not found in TVA design standards</u>

  This anomaly refers to TVA Electrical Design Standard DS-E12.1.13, "Class 1E Cable OD's and Weights." This design standard lists cables used by TVA, with their corresponding weights and OD's. Each different type of cable is identified by a unique "mark number."

  The anomaly is that several cable mark numbers were found during the verification which were not listed in the design standard. This anomaly is believed to exist for the following reasons:

  a. The design standard was developed recently, and was based on cable mark numbers which were widely in use at the various TVA plants. Not all the BLN cables may have been entered into the design standard because of the curtailment of BLN construction activities at the time the design standard was under development.

  b. Certain specific cables which were supplied by equipment vendors do not appear in the TVA Corporate design standard. BLN design documentation will be revised to incorporate these BLN specific cables.

  Neither of these anomalies raises concerns about the quality of the cable which is installed or the conclusions drawn from the results reported in Reference 19. The concern instead is that all cables which are used are accurately listed in the database and that conduit fill is accurately calculated using the data. For the particular cable mark numbers identified in Reference 19, which are not listed in the design standard, conduit fill was recalculated. All conduits were filled to less than maximum allowable levels. Proper use of the cable data in the future will be addressed as part of the reactivation of the BLN project.

- <u>Field conduit trade sizes and fills in a few cases did not match the ECM&D database</u>

  This is not an anomaly. In all the cases which were identified, the actual installed conduit was larger than the specified conduit. TVA conduit installation design documents permit field installation of conduit larger than specified. It results in lower conduit fill, which is desirable.

- Conduit 1A3-1442B is missing (cables are exposed)

Attachment 3, Form 3, page 8 of 8 contained in Attachment 1 of Verification Package V-2, indicated that conduit 1A3-1442-B was shown on the conduit design drawing but not installed in the field. This should not have been reported as an anomaly. The conduit in question is in fact installed in the field.

The source of the confusion arose from the conduit configuration. Conduit IA3-1442B is a threaded conduit fitting which is connected to a conduit tee from which the cables drop approximately 2 feet to an adjacent tray. The conduit fitting is only approximately 1/2 inch Iong, but was given a conduit identification number for cable routing purposes. The conduit fitting is properly marked with the conduit identification number.

c) Question

Section 9.0 Conclusion

In the overfilled conduits, how does TVA plan to prevent any pullbys in the future?

Response

As is described above, a small number of BLN conduits are slightly overfilled. The question relates to how BLN will ensure that, when cable routing and installation resumes, no additional cable will be pulled into the conduits which are overfilled.

There are four questions which this issue raises, including the NRC question. They will be addressed as part of the reactivation of BLN. Each question is listed below, with the associated response:

- What will be done about the conduits which are already overfilled?

  All overfilled conduits which were identified in Reference 19 will be evaluated to ensure cable ampacity concerns are addressed. Corrective actions will be taken as necessary.

- Why are the conduits overfilled?

  The cable sizes and weights used in the previous cable routing were not verified. This resulted in some inaccuracies in calculated conduit fills.

- How will additional cable pulls into the overfilled conduits be prevented in the future?

  Current TVA practices regarding pullbys address conduit fill and prohibit the installation of additional cables in overfilled conduits where the potential for pullby damage may exist. This practice is consistent with current recommendations of the IEEE Insulated Conductors Committee. For future cable routing, cable sizes and weights will be verified before they are used. In addition, cable routing practices will be established so that routes which result in overfilled conduits are not selected.

  Since the cable sizes will be correct, the cable routing practices will identify the overfilled conduits as such, and will not route additional cables into them.

- How will it be assured that other conduits will not be overfilled?

  As described above, verified data and the restrictions of future cable routing practices will prevent pulls which result in overfilled conduit.

5. Verification Package V-2, Attachment 3, Form 3 - Page 8 of 8

Question

Where do the 8 cables go? How will the missing conduit or the drawing problem be solved?

Response

These cables are contained in conduit 1A3-1442B. As discussed in the response to question 4.b above these cables emerge from a conduit tee through a conduit fitting (UNID 1A3-1442B) to an adjacent tray. The conduit fitting is properly labeled and consistent with the design drawing for this installation.

6. Verification Package V-4

a) Question

Need discussion of the number of conduits, the cables which could not be verified, the conduit fills, the missing cables, and how the confidence level was determined.

Response

The number of cables in a conduit and the type of cables in a conduit are parameters affecting conduit fill. Accordingly, Verification Package V-4 (Attachment 7 to Reference 19) was prepared to confirm that the ECM&D Reports utilized in Reference 19 reflected the current as-built status for these parameters. The statistical analyses performed on the walkdown data collected for the verification indicated that there was a 95% confidence that the parameters in the ECM&D Reports which affect conduit fill had greater than 95% accuracy.

Verification Package V-4 did identify a few discrepancies between the ECM&D Reports and the current as-built status. These discrepancies will be resolved as part of the BLN reactivation effort.

b) Question

Example to discuss (note in attachment 9, Form 7 - Page 2 of 2)

Is there any investigation/verification of what happened to the third cable?

The two largest cables in the conduit were utilized for calculations - what is meant by largest?

Response

During the walkdown conducted to verify the number of cables per conduit listed on the ECM&D reports (utilized in Reference 19) a discrepancy was identified for conduit 1K3-0233B. The ECM&D reports indicated that this conduit contained 3 cables. The field verification walkdown identified only 2 cables in this conduit. The cable identification numbers and the cable mark numbers could not be identified from points accessible to the walkdown team. As a result, the percentage fill for this conduit was calculated assuming the two of the three cables listed in the

ECM&D report with the largest cross sectional area were installed in the conduit (the conservative assumption). The result of that calculation indicated this conduit is overfilled by a few percentage points. The discrepancies between the ECM&D report and the field will be resolved during reactivation of BLN.

7. <u>Reference 22</u> (in the conclusion Page 11 of 12)

Reference 22 is the report of the independent assessment of the cable raceway installation at BLN ("Qualitative Assessment of the Cable Raceway Installation at Bellefonte Nuclear Plant," April 1991).

To provide an independent assessment of the design and installation of the conduit and cable at BLN, a four man team was assembled to perform conduit walkdowns at BLN and make a qualitative assessment of the cable tray and conduit installations. The team consisted of non-TVA personnel each possessing over 20 years experience related to the design and installation of cable and raceway systems.

a) <u>Question</u>

Why doesn't G-38 require that all pull points be utilized? Why didn't the team comment on pullbys?

<u>Response</u>

Revision 10 of TVA General Engineering Specifications G-38 dated November 30, 1990, addresses the use of pull points. Specifically, Section 3.2.1.1, paragraph B states "Pull points (i.e., condulets, other than "C" condulets used to inject lubricant, [and] manholes [and other pull points such as pull boxes]) shall not be bypassed when pulling cables unless authorized by engineering."

In the qualitative assessment report (Reference 22), the team addressed pullbys as follows:

> "The team observed numerous instances of conduit with cables and a pull rope installed. This would indicate that future pullbys were planned. In some of these instances the conduit was obviously under-filled and, as previously noted, there was ample use of conduit bodies/pull boxes and appropriate installation of bends and flex conduit. The general opinion of the team was that the pullbys in these conduits could be made and, if proper pulling techniques are used, there will be no damage to the cables."
>
> "However, the team recommends avoiding pullbys as much as reasonably possible. When pullbys are called for, the requirements of [G-38] must be adhered to."

b) <u>Question</u>

Attachment B, Page numbers 5 of 30, 13 of 30, and 26 of 30

(1) How many cables in the run?

(2) Any inspection of the cables for damage at pull points?

Response

Attachment B of Reference 22, which is the subject of this NRC question, consists of a copy of the data sheets for specific conduit installations which were included in the walkdown. A total of 31 conduits were reviewed by the team during the walkdown. The three specific conduits referenced in the question above are:

Conduit UNID	Size (in)	Number of Cables
1R1-324B	2	15
0C4-596B	4	4
1R4-2075B	3	5

The team inspected and evaluated the following attributes during the walkdowns:

- quality of the conduit design and installation,
- accessibility of the conduits for cable installation activities
- types, numbers and locations of pull points
- types of bends, including offsets and the total degrees of bends between pull points

It was the unanimous agreement of the walkdown team that "the BLN raceway systems are designed and installed such as to facilitate ease of cable pulling and would minimize the potential for cable damage during installation."

As indicated in the answer to question A.1.b above, additional walkdowns and inspections will be performed at BLN on a sample of cables and conduits which were involved in pullbys, to further confirm that pullby damage has not occurred. During these walkdowns, inspections of installed cables will be made at accessible points (e.g., conduit ends, intermediate pull boxes and condulets). In response to this NRC question, this sample will include the three conduits noted above.

c) Question

Any pullbys documentation for installations in 1977, 1980 and 1981? Were they done under strict supervision and how?

Response

Installation of cable at BLN began in late 1977. The first cables installed were those needed to support construction. In response to the NRC question, the dates of the installation of cables in the 135 conduits with some credible chance of experiencing damage from pullbys have been reviewed. The earliest installation date of any of these safety related cables is in 1979. Nevertheless, procedures controlling the installation of the cables and monitoring the installation process were in effect starting in 1977. For example, beginning with its earliest revision in 1977, SOP-229, BLN Standard Operating Procedure "Cable Installation Inspection," required the inspector to monitor the cable pulling process to assure the cable was not damaged. Site Quality Control Procedures also documented the training requirements for personnel who installed and inspected cables at BLN.

These training procedures, which were issued prior to the start of large scale cable installation, specified the training requirements for construction engineers, electrical craft supervisors and foremen responsible for installing cables and for quality control inspectors responsible for verifying that safety related cables were installed in accordance with site procedures. As discussed in the position paper, checks of construction records in 1991 confirmed the implementation of these training requirements.

Documentation of each cable pull, including the installation date, is contained on a pull card. Each pull card has been signed by the inspector who monitored the installation of the cable. This QA record documents the proper installation of the cable in accordance with the design and the governing installation procedures.

8. Reference 27

Reference 27 documents the results of the 1991 evaluation of the records of the rework of conduits completed prior to construction deferral (Gilbert/Commonwealth letter to MPR Associates [R. A McNabb to R. M Carritte], dated April 23, 1991; "Bellefonte Nuclear Plant, OS Conduit Evaluation"). This evaluation identified 32 conduits which contained cable which were involved in pullbys and which were subsequently pulled back and inspected prior to construction deferral in 1988. The pullback was required to accomplish rework of these conduits. Reviews in 1991 of the BLN construction records for the pullback and inspection of the cables within these 32 conduits identified no pullby damage.

A separate unrelated effort in 1991 reviewed the BLN conduit fill (Reference 19). This effort identified 64 safety-related conduits which are slightly overfilled, as discussed in the position paper.

a) Question

Are the 32 conduits in Reference 27 a subset of the 64 overfilled conduits?

Response

A comparison between the list of 64 overfilled conduits and the list of 32 reworked conduits shows that none of the overfilled conduits are among 32 reworked conduits.

b) Question

Need to discuss the overfill, any inspection for damaged cables. Especially the tbree conduits with two pullbys and the conduit with seven pullbys.

Response

For the overfilled conduits identified in Reference 19, Reference 21 of the position paper determined the number of pullbys which were performed in each conduit. (Reference 21 is a letter from UE&C to MPR [R. Bryans to H. Estrada] dated April 24, 1991; "Summary Report - Cable Pullbys in Overfilled Conduit.")

Reference 21 identifies three conduits in which two pullbys were performed:

1A3-6070A
1K3-233B
2A3-851B

Reference 21 also identifies one conduit with seven pullbys:

1A3-5931B

The initial evaluation of overfilled conduits did not include an inspection of the cables within these conduits. However, in response to the NRC question, above, the conduits will be inspected at accessible points for the presence of cable damage which might be attributed to pullbys.

B. SIDEWALL BEARING PRESSURE AND JAMMING

1. **Reference 19**

Reference 19 reports the results of the evaluation of conduits with critical jamming ratio (Gilbert/Commonwealth letter to MPR Associates [B. S. Kohout to R. M. Carritte]; "Bellefonte Nuclear Plant -- Evaluation of Conduits with Critical Jamming Ratio"; dated May 10, 1991). A total of 90 conduits were identified with cable/conduit configuration which falls within the critical jam ratio. As part of this evaluation, certain of these conduits were inspected at accessible locations and no damage was found. The NRC questions relate to the extent of the inspection.

a) Question

Ninety conduits are identified as having critical jam ratio. Please reconcile the following numbers. There is a statement that 57 conduits were inspected. Fourteeu were excluded from the inspection, and only 43 were inspected at accessible points.

Response

Fifty-seven (57) of the 90 BLN conduits identified as having critical jam ratios were included in the initial walkdown, which was documented in Reference 19. This walkdown determined conduit length, size, and total degrees of bends. Fourteen (14) of the 57 were found to be 30 feet long or shorter, or to contain 180 degrees or less in bends. No cable inspections were initially made for these 14 conduits because the conduit lengths and degrees of bends between pull points were judged to be sufficiently small as to minimize the possibility of jamming. The remaining 43 conduits were inspected at accessible points (conduit ends, intermediate pull boxes, and intermediate condulets) during the initial walkdown. No cable damage was found. Since Reference 19 was issued, an additional inspection has been completed for the 14 conduits which had been initially omitted from the inspection effort. The results of these inspections identified no cable damage due to jamming.

b) Question

What is the basis for not inspecting the remaining 33 conduits?

Response

The initial walkdowns documented in Reference 19 addressed 57 of the 90 conduits falling within the critical jam ratio. In response to NRC questions raised during the May 22-23, 1991 meetings at BLN, TVA conducted additional walkdowns which included the 33 remaining conduits not included in the original walkdown. The collective walkdowns have included an inspection for cable damage at accessible points for all 90 BLN conduits identified as having critical jam ratios. The results of the inspection efforts have identified no cable damage due to jamming. Reference 19 is currently undergoing a revision to include the results of these additional walkdowns.

2. Sectiou 5.0 Conclusion

The following NRC questions relate to the embedded conduits addressed in the critical jamming ratio evaluation.

a) Question

Identify the next worst condition, perform an inspection at conduit entry and exit, junction and pull boxes, condulets, and report the results.

Response

As indicated in the response to the preceding question, all conduits with critical jam ratios have now been inspected at accessible locations. No cable damage due to jamming was found.

b) Question

Explain and justify why the cable in conduit 1A4-3820B was found undamaged and justify your conclusiou.

Response

During the walkdowns of conduits with critical jamming rations, this conduit was inspected at accessible points. No cable damage was identified. The bases for the conclusion that "...the worse case conduit contains cables free from any jamming related damage." are as stated in the Reference 19 document. TVA believes that the stated assumptions are reasonable and provide rational support for this conclusion. Additionally, it should be noted that TVA's position, as stated in the position paper, is not based solely on this conclusion from Reference 19. Many other factors, enumerated in the position paper, provide additional support for the overall TVA position that the potential for cable damage due to jamming at BLN is extremely low and that there is reasonable assurance that the cable installation is adequate.

Reference 2 identified this conduit as exceeding the 360 degree bend criterion and committed to an evaluation of the SWBP for the cable. Preliminary calculations of the expected pull tension and SWBP for this cable indicate a possible violation of pull force in one direction. Since plant records do not indicate in which direction the cable was pulled, Consolidated Maintenance Request CMR 2703 was issued on July 1, 1991 to replace the cable.

C. CABLE BEND RADIUS

1. **Reference: TVA letter of June 15, 1990**

Question

Compare Table 1 and Table 2 of BLN position paper to Table I of WBN in TVA letter of June 15, 1990. WBN cables are retrained to ICEA. Why uot at BLN?

Response

The differences between the WBN and BLN criteria are primarily the result of the additional evaluations performed by TVA following the definition of the WBN criteria. These differences are discussed below.

Table 1 of the BLN position paper specifies criteria for temporary bend radius. The BLN criteria for training radius are summarized in Tables 2 and 3 of the BLN position paper. In order to eliminate any ambiguity, the reference to Table 1 previously included in Table 2 has been eliminated. The revised Table 2 is attached.

BLN Table 2 addresses training radius for single-conductor cables including individual conductors of multi-conductor cables when the outer jacket and shield have been removed. The criteria of Table 2 are generally consistent with those included in Table I of WBN CAP for single-conductor power cables. Both tables require that medium voltage power cables be trained to 8 x OD. They specify a minimum limit of 4 x OD for most low voltage power cables located in worst-case accident areas.

A difference exists, however, between the requirements of Table 2 of the BLN position paper and those of Table I of WBN CAP with regard to large low voltage single-conductor power cables since the ICEA standards referred to in Table I establish a minimum radius of 5 x OD for cables with a diameter larger than 1.00 in. TVA will adopt a minimum limit of 5 x OD for low voltage single-conductor power cables which are located in worst-case accident areas and have a nominal diameter greater than 1.00 in. The attached Table 2 has been revised accordingly. (TVA notes that the largest low voltage single-conductor cables used at BLN are 400 MCM and 500 MCM cables with a nominal diameter of 1.015 in. and 1.094 in. respectively and a nominal insulation thickness of 0.065 in. Based on its evaluations of damage mechanisms described in the position paper, TVA considers that a minimum limit of 4 x OD would be acceptable for these cables.)

A difference exists also between BLN Table 2 and WBN Table I in the case of single conductors of low voltage control and signal cables since Table 2 does not require that these conductors be trained to the ICEA limit even in worst-case accident areas. As explained in the position paper, this exception to the ICEA standards is justified by the absence of any significant thermal aging of the insulation of control and signal cables over the life of the plant.

There is also a difference between BLN Table 3 and WBN Table I with regard to multi-conductor cables located in worst-case accident areas. Table I requires that these cables be trained to 4 x OD of the cable (ICEA limit) whereas the limits of Table 3 are based on the OD of the individual conductors. As explained in the position paper, the limits of Table 3 are based on the recommendations of Rockbestos Technical Bulletin No. 28. These limits are consistent with the ICEA limits for the individual conductors and take also into account the number of conductors in the cables.

2. **Reference 6**

Question

Discuss Table 1 Electrical Design Standard DS-E12.1.5, page A-14. This Table 1 is using Training Radius and Pulling Radius based on the OD of the cables. Tables 1 and 2 of the position paper are based on medium voltage and low voltage. Will the Design Standard be revised?

Response

Table 1 of the BLN position paper specifies criteria for temporary bend radius. The BLN criteria for training radius are summarized in Tables 2 and 3. In order to eliminate any ambiguity, the reference to Table 1 previously included in Table 2 has been eliminated. The revised Table 2 is attached.

The distinction between cable diameters included in Table 1 of DS-E12.1.5 has no practical effect at BLN since virtually all BLN low voltage cables have an OD of 1 in. or less. Nevertheless, as explained in the response to Question 1, TVA has revised Table 2 of the BLN position paper to include a specific requirement for cables larger than 1.00 in. Furthermore, the categorizations of Table 1 of DS-E12.1.15 and Table 2 of the position paper are essentially equivalent, since most low voltage cables are treated as unshielded (see response to Question 3) and medium voltage cables are treated as shielded. The main differences between the requirements of DS-E12.1.5 and those of Tables 2 and 3 of the position paper are:

- the training radius limit for shielded cables is 8 x OD in BLN Table 2 instead of 12 x OD in DS-E12.1.5;

- the training radius limits of BLN Table 3 for low voltage multiconductor cables are based on the OD of the individual conductors rather than on the overall OD of the cables as is the case in DS-E12.1.5.

The bases for the limits of BLN Tables 2 and 3 are explained in the position paper. The somewhat different presentation of these limits, when compared to that of Table 1 of DS-E12.1.5, is the result of the differences described above and of the special consideration given to environmental conditions and to low voltage control and signal cables. There is presently no plan to revise DS-E12.1.5. Such a revision may, however, be considered in the future.

3. **Reference 12**

Question

Table 3 of BLN is based ou Rockbestos recommended.

a) Are multiconductors at BLN non-metallic sheath cable - no shields?

b) During installation, what pulling tension is used/or will be used for this type of cable?

Response

The shield used for safety-related BLN multi-conductor cables consists of an aluminum-backed mylar or aluminum foil tape. Only coaxial cables use wire shields. As indicated in the note on page 1 of Rockbestos Technical Bulletin No. 28, foil shields are not considered metallic shields for the purpose of establishing bend radius limits. The limit for coaxial cables is provided in Note 3 of BLN Table 2. The limits for pulling tension are specified in Sections 3.2.1.5 and 3.2.1.6 of TVA General Engineering Specification G-38 - Installation, Modification and Maintenance of Insulated Cables Rated up to 15,000 Volts. These limits are established based on the allowable values for conductor pull tension and sidewall bearing pressure.

TABLE 2

MINIMUM ALLOWABLE TRAINING RADIUS FOR SINGLE-CONDUCTOR CABLES AND INDIVIDUAL CONDUCTORS OF MULTI-CONDUCTOR CABLES[1]

CABLE TYPE	ENVIRONMENT	
	WORST-CASE ACCIDENT[2]	OTHER
Medium Voltage	A	A
Low Voltage Power[4]	B	C
Low Voltage Control and Signal[3,4]	C	C

A: Training radius not less than 8 x OD

B: Training radius not less than: 4 x OD if nominal OD is 1.00 or less
5 x OD if nominal OD is greater than 1.00 in.

C: Training radius not less than: 2 x OD for sizes 8 AWG and larger
1 x OD for sizes 10 AWG and smaller

NOTES:

1. Radius based on conductor OD over insulation (or jacket, if any). The radius specified refers to the inner surface of the conductor and not to its axis.

2. Accident environment with ambient temperature higher than 200°F and/or radiation dose higher than 5.0×10^6 rads.

3. Training radius for coaxial and triaxial cables not less than 8 x OD (Ref. 12).

4. Cable installations located in mild environments will not be inspected for compliance with these limits for the reasons explained in section 5.0 of the text.

ENCLOSURE 2

ANSWERS TO FURTHER NRC QUESTIONS CONCERNING CABLES IN CONDUIT AT BELLEFONTE NUCLEAR PLANT (BLN)

1. Question:

In conjnnction with conduit rework, 32 conduits whicb were involved in pullbys bad their cables pulled back and inspected prior to constructiou deferral. What is the percentage fill of the longer conduits in this gronp? How does this compare witb the fill of the 64 BLN conduits which have been determined to be overfilled?

Response:

Conduit reinspections were initiated prior to BLN construction deferral for reasons other than cable damage. The cables in a number of the conduits had to be pulled back to permit conduit rework. Thirty-two (32) of these conduits contained cables which were involved in pullbys.

The first part of the NRC question deals with the percentage fill of the longer conduits in this group of 32. In response to this question, BLN identified the four longest conduits in the group. These conduits are longer than 35 feet and are substantially longer than the others in the group. The cables in these conduits, because of their length, are more likely to have experienced significant pull forces. The conduits are listed below, along with their percentage fill, size, length, number of cables, and number of pullbys.

Conduit No.	Conduit Size	Conduit Length	No. of Cables	No. of Pullbys	%Fill
0A2-0425A	3.0 in.	95 ft.	8	3	17 %
0A2-0531A	1.5 in.	71 ft.	2	1	9 %
1A3-6360A	1.5 in.	120 ft.	2	1	14 %
2A3-3692A	2.0 in.	105 ft.	3	2	8 %

The second part of the NRC question deals with a comparison of the conduit fills listed above with the fills of the 64 BLN safety-related conduits which have been identified as exceeding TVA maximum allowable fill limits.

The 64 BLN overfilled conduits have percentage fills which range from a low of 36% to a high of 44%. Allowable conduit fills range from 31% to 40% depending upon the conduit and the cable configuration. The worst-case overfilled conduit exceeds the allowable fill limit by only 5 percentage points. The four conduits listed above are lightly filled, and are less filled than the 64 overfilled conduits.

Additional Information

In response to the NRC questions, TVA has done two additional things. First, the records for those cables which have some credible chance of having sustained pullby damage were examined to determine if any of the cables have been inspected in detail.

Second, the effect of conduit fill on the potential for pullby damage at BLN has been examined. The results are described below.

Inspection of Pullby Cables

In 1991 TVA identified the 135 BLN conduits which are considered to have some credible chance of having sustained pullby damage. The selection criterion was similar to that used at BFN, which selects long conduits with significant numbers of cables. Longer conduits result in greater pull tensions and sidewall bearing forces. A larger number of cables increases the potential that multiple pullbys occurred.

TVA has identified additional information concerning the condition of the cables in some of these 135 conduits. In particular, TVA has determined that cables in four of the conduits have been pulled back and inspected as part of the rework of 32 conduits before construction deferral. These conduits are listed below.

Conduit No.	Conduit Size	Conduit Length	No. of Cables	No. of Pullbys	%Fill
0A2-0425A	3.0 in.	95 ft.	8	3	17 %
1A2-7111A	4.0 in.	25 ft.	11	4	11 %
1A3-1225B	5.0 in.	35 ft.	10	6	5 %
1A4-6012A	5.0 in.	20 ft.	4	2	19 %

Construction records for the cables in these conduits show no indication of pullby damage. TVA considers that this provides additional objective evidence that cable damage due to pullbys has not occurred at BLN.

Effect of Conduit Fill

TVA and the industry recognizes that the potential for incurring pullby damage increases with increasing fill. Where a clear path is not obtained, the risk also increases with the number of pullbys performed. TVA concludes that the risk of pullby damage at BLN as a result of these factors is negligible for the following reasons:

- As noted above, the highest-fill conduit at BLN is filled to only 44%

- Only one of the 64 overfilled conduits is contained in the group of 135 BLN conduits which were identified by the pullby selection criterion

- Most of the conduits at BLN which have the highest percentage fill did not have cable pullbys. Of the 64 overfilled conduits, only 12 had pullbys. Their fills ranged from 36% to 44%.

2. Question:

Specification G-38 now requires that additional cable testing be performed after pullbys which use pull tensions greater than 300 lbf. When was this requirement initiated? How was cable pull tension limited before then?

Response:

After a pullby is performed, G-38 currently requires the new cables to be megger tested to determine if they have been damaged. Above 300 lbf pull tension, G-38 also requires megger testing of the existing cables. The upper limit which G-38 imposes for pull tension for pullbys is 400 lbf. These requirements were imposed starting with Revision 9 of G-38, dated February 23, 1990.

The 400 lbf is an upper limit for pullbys only. This limit is consistent with the current guidance provided by the IEEE/ICC Working Group on Station Cable Installation. G-38 contains additional detailed requirements for limiting pull tension, regardless of whether pullbys are involved. The pull tension limits are based on conductor strength, number of cables involved in the pullby, and sidewall bearing pressure limits of the cables being pulled.

As described in the pullby position paper, pull tension has always been controlled at BLN. Applicable procedures required the control of pull tension (e.g. via use of dynamometers or pull ropes with a known breaking strength) for all mechanically assisted pulls throughout the period of cable installation at BLN. Use of dynamometers by installation personnel during the period of cable installation activities was confirmed by a review of construction records. Conversations with personnel involved with the cable pulling activities at BLN indicated that break ropes were also used for manual pulls throughout the period of cable installation, and this was reflected in procedures starting in 1984.

This supports the TVA conclusion that cable pulling practices, including control of pull tension, were adequate to substantially eliminate the potential for pullby damage at BLN. Megger testing of pullby cables and the 400 lbf limit for pullby tension which are in the current revision of G-38 provide additional assurance for limiting the potential for pullby damage for future pullbys; they are not necessary to ensure the acceptability of past pullbys.

ENCLOSURE 3

COMMITMENTS

1. TVA will perform additional walkdowns and inspections at accessible points of a sample of cables and conduits which were involved in pullbys, to further confirm that pullby damage has not occurred. The sample will consist of conduits drawn from the 135 conduits which BLN has identified as having some credible chance to have sustained pullby damage. This sample will include cables pulled both before and after 1980. The sample will also include conduits 1R1-324B, 0C4-596B, and 1R4-2075B.

2. All overfilled conduits which were identified in Reference 19 of the pullby position paper will be evaluated to ensure cable ampacity concerns are addressed. Corrective actions will be taken as necessary.

3. Verification Package V-4 (Attachment 7 to Reference 19) did identify a few discrepancies between the ECM&D Reports and the current as-built status. These discrepancies will be resolved as part of the BLN reactivation effort.