4.5.1.2 Site Specific - WBN (continued)

V1, V2, and V3 level trays had no spacing requirements between cables other than a maximum cable tray loading of 60 percent of the cross sectional area of the tray. V4 level trays also had no specific spacing requirement except for a maximum cable tray loading of 30 percent of the tray cross sectional area. However, V5 level trays did have specific spacing requirements. They consisted of grouping cables larger than 2/0 AWG into three phase circuits separated from other groups a distance which depended on the radius of the largest cable in the adjacent circuit. Those cables smaller than 2/0 AWG could be grouped randomly, but they could not touch three phase circuits. The investigator reviewed General Construction Specification G-38 and found the same information. Site procedure WBN-QCP-3.05 provided the same information as G-38.

Design Information Request E-55 (WBN 810427 101) was transmitted to DNE asking for approval to bunch V1, V2, and V3 level cables together to aid in the application of the Vimasco coating. This request was approved by DNE (SWP 810527 069). Another request, E-56 (WBN 810729 162), was sent ensuring that the V4 and V5 level cables were not to be bunched. The DNE memorandum (SWP 810902 028) confirmed this.

Walkdowns were conducted at various areas in the plant. The investigator concluded that cables in safety-related trays were arranged neater than in nonsafety-related trays and that V5 level trays (observed in the unit 1 6900 V Shutdown Board Room) did have the three phase grouping as required.

Interviews were conducted with DNC personnel to determine the process used to prepare the cables for coating. It was discovered that in 1981 (when the cable coating process began) V4 level cables were bunched together and coated. Corrective action was initiated to remove the Vimasco and redistribute the cables. From then on V4 and V5 level cables were not disturbed before applying Vimasco.

4.5.1.2 Site Specific - WBN (continued)

Interviews were conducted with knowledgeable DNE personnel and revealed no problems due to disorderly arrangement of V1-V4 trays. The DNE personnel also stated that since V1 and V2 level trays carry only low energy cables it was not reasonable to expect overheating problems due to cable arrangement. The DNE personnel also mentioned informal studies had been conducted in relation to V3 level cables. The studies indicated that it was not likely that an overheating problem existed due to intermittent loading of the circuits, expected cable tray fill, and conservatism in cable sizing.

Since the cable coating was not a part of the original design concept, the effects of Vimasco on cable sizing were not considered. Therefore, Vimasco contracted Factory Mutual Research to conduct a test on the effect of Vimasco on ampacities in cable trays. This test was conducted December, 1980. The results indicated a two to four percent ampacity derating factor with a coating of 1/8 inch. DNE personnel believed that the coating would not cause any overheating problems.

The site procedure to apply Vimasco was WBN-QCP-3.7. The procedure stated that the thickness of the coating was to be monitored between 3/16 inch $\pm$ 1/16 inch. Inspection records were reviewed and were between 2/16 inch and 4/16 inch. There was a DNE file note (B43 850906 921) which documented an inspection of cable covered with Vimasco with no discrepancies noted.

A review by Black and Veatch on the Auxiliary Feedwater System raised the concern that the spacing between medium voltage cables was compromised by Vimasco. An evaluation conducted by DNE concluded that even if the cables were touching adequate ampacity margins would exist.

4.5.1.2 Site Specific - WBN (continued)

A WBN unit 2 pre-INPO finding concluded that the effect of Vimasco on cables had not been documented to correlate these test results specifically to all cable applications at WBN. A review of the Factory Mutual Research report confirmed this.

The report concluded that the concern that cables were bunched together was valid for cables in V1, V2, and V3 level trays but concluded that this bunching was based on approval by DNE. The heat buildup problem was not verified because (1) V4 and V5 level cables had not been bunched, (2) V1, V2, and V3 level cables were sized based on a random arrangement of cables, and (3) DNE evaluation. However, the report concluded that the effects of Vimasco coating on cables with respect to ampacity had not been specifically documented for all WBN applications.

A memorandum from J. S. Wigington to the Electrical Engineering Files dated January 22, 1986 (B43 860121 947) was the DNE response to this report. It referenced Factory Mutual Research Report No. J.I. OFOQ5.AF as the required verification of the effects of Vimasco on the ampacity of V3 and V4 level cables. An ampacity analysis of V5 level cables prepared February 2, 1984 (EEB 840203 901) was referenced as verification that Class 1E V5 level cables had an adequate ampacity margin to ensure they did not exceed their rated maximum continuous copper temperature. V1 and V2 cables were considered low energy cables creating insignificant heat buildup. The DNE conclusion was that the derating effect of Vimasco coating was insignificant. Further justification of TVA's ampacity tables for V3 level trays was provided in a DNE calculation (B43 860307 902).

New ampacity tables were generated in DS-E12.6.3 which included the derating effects of cable coatings. This design standard was based upon a DNE calculation entitled,"Methodology Used as Basis for Cable Ampacities Shown in TVA Electrical Design

4.5.1.2 Site Specific - WBN (continued)

Standard DS-E12.6.3 "(B43 860902 901). As a result of the changes made in the ampacity tables, the adequacy of installed cables became questionable. WBEP-SEP-86-05 had been written to provide a sampling procedure for verifying the adequacy of ampacity of V3, V4, and V5 level cables installed prior to the issuance of DS-E12.6.3, Revision 0. The sampling program had not yet begun.

The NSRS report later recommended that there be testing of WBN cables with conditions typical for installed cables. There had been no DNE response to this recommendation.

IN-86-268-002 dealt with removing Vimasco with sharp objects. These instruments could potentially damage the cables. In relation to this concern, a letter from the Nuclear Regulatory Commission to TVA dated October 15, 1984 (A02 841018 009) was reviewed. This letter was a summary of inspection activities conducted on August 27 through 30, 1984 and September 11 through 14, 1984 at WBN. The letter referenced NCR 5612 which had been written because cables had been damaged due to the removal of Vimasco. Questions were raised which included:

(1) What type tools were used to remove Vimasco?

(2) What type provisions in procedures existed to verify no cable damage had occurred due to Vimasco removal?

(3) Have there been other instances where Vimasco was removed and what steps were taken to determine if there was any cable damage?

Unresolved item 390/84-66-02 was used to track the problem. This item was closed on June 7, 1985 when DNC committed to the following items:

4.5.1.2 Site Specific - WBN (continued)

(1) Restricting the use of sharp tools by using other tools such as wooden wedges and hammers to remove Vimasco.

(2) WBN-QCP-1.55, "Seals, Fire Stops, and Cable Coatings," was revised to include a requirement to visually inspect cable for damage after Vimasco was removed but before the coating was reapplied.

In further review of NCRs on the subject, NCR 5094 also reported cable jacket damage caused by the removal of Vimasco. This was the only other incident which was uncovered in a review of the NCR log.

A review of the ONP procedure for application of Vimasco (MAI-14," Installation and Inspection of Electrical Penetration Pressure Seals, Fire-Stop Barriers, and Flame-Retardant Cable Coating") did not reveal any provisions for ensuring that sharp instruments were not used to remove Vimasco. This was confirmed in a conversation with a knowledgeable Mechanical Maintenance engineer who also stated that there was no other ONP procedure where this would appear (such as a Special Maintenance Instruction).

OW-85-007-005 stated that Vimasco was applied to cables over dirt and trash such as pieces of sandwich and that the work was performed by non-electricians. The former CQC supervisor was interviewed for information on requirements to clean cables prior to application of Vimasco. The application process was described as follows:

(1) Electricians would cut the tie wraps on the cables, shake the cables clean, and bunch them together.

(2) Insulators would apply the coating.

4.5.1.2 Site Specific - WBN (continued)

The supervisor said that WBN-QCP-3.7 required the cables to be inspected for cleanliness and signed off by a QC inspector before Vimasco was applied. WBN-QCP-3.7, Revision 4 confirmed this statement. He said that he had talked to the Vimasco representatives when they were here for the start of the coating program and asked them how clean the cables had to be, particularly referring to dust. The representatives stated that dust would not pose a problem because the coating would still stick to the cable.

The supervisor was confident that there were no large pieces of trash left with the cables when they were coated. He recalled that some Vimasco had been removed when it was applied prior to the cleanliness inspection. No NCRs on this particular subject were ever discovered.

XX-85-094-005 dealt with the removal of foam from penetrations with a fish hook tool. Two knowledgeable CQC inspectors and the former CQC supervisor were interviewed about the use of this fish hook tool. They had no knowledge of any tool of this type being used. However, broom handles and fiberglass rods were used and were acceptable. An NSRS report (I-85-702-WBN) addressed breaching fire barriers with fish tape in relation to concern IN-85-207-002. It was conceivable that the concerned individual had meant fish tape - not fish hook. If this was assumed, the NSRS report was applicable to XX-85-094-005. This was coordinated with the ECTG Operations Subcategory 30402 (which was responsible for IN-85-207-002). As a part of this report, there was no evidence that any cables had been damaged as a result of this practice. The corrective action in the report required procedural changes to MAI-14 to prohibit the use of fish tape to breach fire barriers and training for Maintenance personnel not to use fish tape to breach fire barriers. These changes and training had been completed.

4.5.1.2 Site Specific - WBN (continued)

IN-85-018-004 dealt with supervision not following cable pulling procedures. NSRS report I-85-699-WBN was reviewed with respect to this concern. Information supplied from QTC indicated that the problem was with breaching permits for fire barriers. The evaluator determined that the ERT report on IN-85-130-002 completely addressed the subject and that no further evaluation was necessary for this report. IN-85-130-002 was evaluated in Operations Subcategory 30601.

In the investigation for IN-85-130-002, the evaluator discovered that before October 17, 1984, construction was performing breaching operations using a work release which was found in WBN-QCI-1.07 "Work Control". They were not using PHYSI-2 "Fire Protection Plan" Attachment D "Penetration Fire Barrier/ABSCE Boundary Door Breaching Permit" because this was an ONP procedure. On October 17, 1984, a memorandum to the DNC project manager from E. R. Ennis requested that DNC breach fire barriers using PHYSI-2 to prevent unknown degradation of fire boundaries.

The WBN QA group performed a surveillance of fire barrier penetrations and breaching requirements. As a result of this surveillance, WB-CAR-85-24 was generated. Deficiencies included:

- Penetrations were breached without an Attachment D posted.
- Attachment Ds were not being initiated as required by PHYSI-2.
- Breached penetrations were not adequately tracked.

The ERT review of PHYSI-2, Revision 21 noted:

- PHYSI-2 did not require that an Attachment D be posted at the breach.
- There was no maximum time limit for a breaching permit.

4.5.1.2 Site Specific - WBN (continued)

- There was no evidence that a fire watch was notified or established at the breach.
- There was no one designated to post permits, retrieve them, or transport them to the Shift Engineer's office upon completion.
- The criteria for use of Attachment D were vague.
- A punchlist section stated that PHYSI-2 was to be implemented gradually until licensing when it was to be fully implemented. This contradicted the E. R. Ennis memorandum dated October 17, 1984 mentioned previously.

The evaluator discovered that DNC was gradually changing over to the Maintenance Request program. Interviews with WBN QA and Industrial Safety personnel revealed that most of the ERT items were already known and were being addressed in PHYSI-2, Revision 22 which had not been issued at that time.

ERT performed walkdowns which uncovered that:

- Three of the 24 penetrations observed had outdated permits.
- All work on these three penetrations was complete, but the permit had not been removed.
- The Shift Engineer's log had permits six months old with no action taken.

The evaluator reviewed an advance copy of PHYSI-2, Revision 22 and was not satisfied. Questions raised included:

- Was the permit to be posted on both sides of the breach?
- Who was responsible for removing the permit and transporting it to the Shift Engineer's office?

4.5.1.2 Site Specific - WBN (continued)

- Who was responsible for assuring the seven day maximum time limit had not been exceeded on active permits?

WB-CAR-85-24 was closed on May 17, 1985. At that time previous deficient assemblies had been reinspected, and DNC had begun using PHYSI-2. A second walkdown was conducted after the CAR was closed and deficiencies were noted. It was suggested that ONP and DNC should review the controls established for breaching fire barriers and to improve them.

The TVA response consisted of detailing how fire barriers were to be breached by ONP and DNC. At that time, breaching permits were requested by DNC using SOP-42 "Breaching and Sealing Behind Unit One Security." The Nuclear Services Branch would have Mechanical Maintenance breach the fire barriers through the use of a Maintenance Request. All ONP breaches were to be performed by the Mechanical Maintenance Section. ONP was to review requirements to determine if the total number of breaches allowed at once should be restricted. This action was to be completed by August 15, 1985. The response was accepted by the NSRS on July 26, 1985.

ERT reviewed the response and disagreed that it was acceptable. Several questions which had been posed previously had not been answered. They included:

- Since uncontrolled breaching had been identified, who was to perform an additional walkdown to identify and correct open breaches?

- Was the permit to be posted on both sides of the breach?

- Who was responsible for assuring the seven day maximum time limit was not exceeded on active permits?

Further information was given by DNC to answer the ERT comments. They included:

4.5.1.2 Site Specific - WBN (continued)

- A review was conducted by ONP and DNC of the Shift Engineer's Log, and all completed breaching activities were closed out of the log.
- All breaches with expired completion dates were resealed.
- All open breaching permits were reviewed for completeness and corrected as needed. In the future, this was to be performed by the Shift Engineer and the initiator.
- All breaches without a permit posted were resealed.
- ONP had scheduled SI walkdowns to detect and reseal nonconforming breaches.

In addition, questions posed by ERT were answered as follows:

- The breaching permit was posted on only one side of the breach.
- The craft supervisor or designee was responsible for taking the completed breaching permit to the Shift Engineer's office for closure.
- The permit was to be removed as soon as the resealed breach was documented.
- The seven day time limit on breaching duration was not applicable per PHYSI-2, Revision 24.
- QC was not required to sign the permit because Attachment D was for administrative control. The acceptance criteria were found on the restoration documents.
- The Shift Engineer was to transmit the Attachment Ds to Document Control.

4.5.1.2 Site Specific - WBN (continued)

For this evaluation, no evidence of a 100-percent walkdown of all fire barriers was discovered. Consequently, the Mechanical Maintenance engineer responsible for maintaining the fire barriers was interviewed to verify the walkdowns were complete. They had been conducted in November through December 1985 and all identified problems were repaired at that time. These walkdowns were now under the Surveillance Instruction program and were to be conducted every 18 months by the Mechanical Maintenance Section. He also stated that PHYSI-2 had been revised to limit the number of breaches to 25 in order to provide better control of breaching.

A memorandum from E. R. Ennis to G. Wadewitz dated June 21, 1985 (T10 850618 908) emphasized how the breaching procedure was to be handled. Any penetration associated with unit 1 operation was to be breached using a maintenance request and PHYSI-2, Attachment D. All penetrations not required for unit 1 operation were to become part of this program upon the architectural transfer of the area in which the penetrations were located.

PHYSI-2, Revision 26 and SOP-42, Revision 2 were reviewed to determine how the breaching program had evolved since 1985. The maximum number of breaches allowed remained at 25. A difference in who was to breach fire barriers was discovered. The Mechanical Maintenance Section was still responsible for breaching penetrations for ONP. However, the Modifications Section was responsible for breaching penetrations for DNC. Both groups were to use PHYSI-2, Attachment D to breach. SOP-42 was an administrative procedure which outlined how DNC was to request ONP to breach unit 1 fire barriers. This procedure was found to be out-of-date in that it referenced the Nuclear Services Branch which had been merged with Modifications.

4.5.1.2 Site Specific - WBN (continued)

All breaching on penetrations not required for unit 1 operation but which had been documented used WBN-QCI-1.60, "Work Control." At transfer of the penetration, the procedure used became PHYSI-2, Attachment D and the penetration became a part of the Surveillance Instruction program.

4.5.1.3 Site Specific - SQN

The fireproofing issue was covered under cable coating and fire barriers. In relation to cable coating problems, M&AI-13, Revision 6, "Electrical Pressure Seal, Firestop Barrier, and Flame Retardant Cable Coating" and SQN Inspection Instruction A4, Revision 1 and Revision 6, "Inspection of Electrical Penetration Seals and Firestop Barriers" were reviewed for any precautions against the use of sharp instruments to remove Flamemastic (the cable coating used at SQN and BFN) and for the acceptance criteria for the application depth of the coating.

The application depth was the same value (3/16 inch $\pm$ 1/16 inch) as at WBN. There was no warning against the use of sharp tools to remove the coating. Therefore, one Modifications and three Electrical Maintenance personnel were interviewed to determine if there were any other procedures which might have a precaution against the use of sharp tools to remove Flamemastic. There was no other procedure. However, in the discussion with a knowledgeable general foreman, it was determined that it was not approved practice to use sharp instruments to remove the coating. He also stated that they had not removed Flamemastic except at penetrations where the cables were terminated. Here the procedure was to flex the cable until the coating cracked and then peel it off.

The SQN Generic Concerns Task Force report on OW-85-007-004 and IN-86-262-002 was reviewed for adequacy of findings and conclusions. The Joslyn Research Center report on the effect of Flamemastic on cable ampacities was reviewed along with the task force report. The task force report leaned heavily

4.5.1.3 Site Specific - SQN (continued)

on the Joslyn report in not verifying the concerns. On further study, the Joslyn report was practically identical to the Factory Mutual report written on the effects of Vimasco. The Vimasco report had been questioned by the NSRS and the same finding was reached on the Joslyn report. This conclusion was that the effect of Flamemastic on cables had not been documented to correlate the test results specifically to all cable applications at SQN.

As stated in section 4.5.1.2, new ampacity tables were generated in DS-E12.6.3 which included the derating effects of cable coatings. As a result of the changes in the tables, the adequacy of installed cables became questionable. An interview with the responsible DNE onsite engineer stated that a sampling program for ampacity would be conducted at SQN similar to the program at WBN. However, presently there was no procedure drafted for sampling. Problems regarding cable coating derating were evaluated in Engineering SQN element report 240.0 (B) and were to be covered in subcategory 24000.

There was some question that the Flamemastic coating had exceeded the limits set by DNE for depth of coating. A walkdown of the Cable Spread Room resulted in trays (VCA, VCB, and WB) which appeared to have excessive coating. It was noted that these trays were non-QA trays and that safety-related trays were much neater.

Surveillance Instruction, SI-233.1, "Visual Inspection of Penetration Fire Barriers-Mechanical", SI-233.2, "Visual Inspection of Penetration Fire Barriers-Electrical", and Physical Security Instruction, PHYSI-13, "Fire", were reviewed for the controls used to breach fire barriers. An interview was also conducted with the Safety Section Supervisor on the same subject. From this review it was determined that SQN had only one procedure for control of breaching fire barriers (PHYSI-13). There was no problem with attempted control through multiple organizations as at WBN. It was also verified that there was a surveillance program in place to ensure the integrity of the penetration fire barriers was maintained.

4.5.1.3 Site Specific - SQN (continued)

With regard to a concern on the use of a fish hook tool to breach penetrations, Modifications and Additions Instruction M&AI-13, "Electrical Pressure Seal, Firestop Barrier, and Flame Retardant Cable Coating", was reviewed to determine if a hook tool was acceptable as a method of breaching fire barriers. No evidence of this instrument was found. However, the procedure allowed the use of a metallic breaching tool. The foreman was required to note and sign the data sheet that the tool was free of burrs and sharp edges before use.

Interviews were conducted with a knowledgeable Modifications supervisor and general foreman to determine if a fish hook tool was used to breach penetrations. They stated that a fish hook tool was not used to breach fire barriers. Therefore, as at WBN, it was assumed that the concerned individual had meant to use the term fish tape.

Fish tape was an acceptable method to breach fire barriers as defined in M&AI-13. No problems had been identified due to the use of fish tape.

4.5.1.4 Site Specific - BFN

Concern number OW-85-007-004 described a condition involving excessive cable coatings so thick that heat could not dissipate. Concern number IN-86-259-005 dealt with cables bunched together in cable trays to make it easier to cover them also resulting in heat buildup. Discussions with three DNE engineers revealed that TVA committed to the coating of exposed surfaces of electrical cables (whether divisional or not) throughout the secondary containment area of the Reactor Building, Diesel Generator Buildings, Intake Pumping Station (IPS), IPS cable tunnel, and cable spreading rooms as part of the Fire Recovery Program, following the March 22, 1975 fire. After application of the Flamemastic fire retardant coating, it was discovered that TVA had applied the coating thicker than recommended by the manufacturer.

4.5.1.4 Site Specific - BFN (continued)

Review of corrective action report number BF-CAR-86-0078 revealed the following description of the problem:

> "The Flamemastic coating on electrical cables has been applied in excess of 1/4 inch maximum thickness recommended by the vendor. The coating in some cases may be 1/2 inch or thicker. There is no ampacity derating data available for coatings in excess of 1/4 inch."

The apparent cause was stated as follows:

> "Inadequate administrative control over the application was the major cause of the excessive coatings."

Corrective action was described as follows:

> "Determine the ampacity derating required for cables due to the overfill of cable trays and the excessive application of the Flamemastic coating. Evaluate the capacity of the affected cables and resolve any deficiencies. Any new cables installed shall have a flame retardant jacket (IEEE 383) and the use of Flamemastic is no longer required."

In response to BF-CAR-86-0078, DNE developed an action plan to determine the derating effect of Flamemastic and to evaluate the effect on installation. As a result, Joslyn Research Center test number 85-033, was conducted to determine the effects on cable ampacity for various thicknesses of Flamemastic (from 1/4 inch to 2 inches dry). Joslyn Research Center test report titled "Test Report of Effect of Flamemastic 71A and Flamemastic 77 Fire

4.5.1.4 Site Specific - BFN (continued)

Protective Coatings on the Ampacity of A Grouped Power and Control Cable Assembly Tested for The Tennessee Valley Authority," was written to present the test results. Also, United Engineering was contracted by TVA to walkdown and analyze the adequacy of installed cable. The initial results were favorable. However, BF-CAR-86-0165 was later written against the calculation and walkdown procedure which questioned the results.

Review of BF-CAR-86-0165 revealed the following adverse condition:

> "Contrary to the requirements of ANSI-N18.7, ANSI-N45.2.11, ANSI-N45.2.8, 10 CFR 50, Appendix B and (Office of Engineering Procedures) OEP-7, the Flamemastic/Ampacity walkdown and the walkdown instruction (BFN-PP-03) do not meet the requirements for the performance of equipment inspection and verification walkdowns."

Also, the derating calculations provided by Joslyn Research Center test number 85-033 assumed that the only variable affecting the test results was the thickness of coating, and no attempt was made to standardize the test results to account for the differences between the test conditions and the BFN design installation conditions.

As a result of the above mentioned problems identified in BF-CAR-86-0165, W.S. Raughley issued a memorandum on September 8, 1986, titled "Corrective Action and Sampling Program For Electrical Cable Ampacity" which provided direction for each project to proceed in establishing a new sampling procedure to determine the adequacy of electrical cables with respect to their ampacity rating. At the writing of this report, each project was in the process of writing a walkdown procedure which was not available for review.

4.5.1.4 Site Specific - BFN (continued)

Generic concern number IN-86-268-002 dealt with removing cable coatings with sharp objects. An interview with a DNE engineer revealed BFN would route a new cable rather than remove cable coatings. However this did not cover work performed on a damaged or spliced cable. The concern was not factual at BFN. However, there was no precaution in site procedures to prevent sharp objects from being used.

Concern number IN-85-018-004 involved breaching a fire barrier to pull cable without the proper form. Discussions conducted with two knowledgeable Modifications engineers revealed the following concerning the use of improper breaching found at BFN: Standard Practice BF14.15 and form BF-32 were deleted and incorporated into FPP-01 without notifying Electrical Modifications. As a result, MMI-75 was instructing site personnel to use the wrong form for breaching fire barriers. For this reason, all breaching of cable fire barriers were stopped at BFN until new instructions could be written and approved in a new site procedure (which was being drafted).

Review of Discrepancy Report number BF-DR-0397 dated August 11, 1986, revealed the following statement concerning the use of improper forms to breach fire barriers:

> "Standard Practice BF14.15 and Form BF-32 were deleted and incorporated in FPP-001 without coordinating the change with all affected sections. Modifications has the responsibility for MMI-75, but was not informed of the change. This resulted in a Plant Operation Review Committee approved procedure referring to a procedure which has been deleted."

4.5.1.4 Site Specific - BFN (continued)

Review of Mechanical Maintenance Instruction MMI-75, Revision 1, revealed the following statement concerning the use of fire barrier breaching permits:

> "6.5.1.1 BF32 will be filled out by the craft foreman or cognizant engineer. A copy of BF32 shall be submitted to the QA supervisor by the craft foreman. The original form will be placed at the location of the breaching and will remain there until the fire stop has been restored. If the fire stop breach is not initiated within eight hours after the BF-32 is issued, that BF-32 shall be voided and the shift engineer so notified. Another form BF-32 must be issued prior to beginning the breach."

From this statement, it was apparent that the wrong form was being used to breach fire barriers.

Concern number XX-85-094-005 dealt with improper fire barrier breaching tools such as an "illegal" fish hook type tool. No evidence of the use of a fish hook tool was discovered. During the Fire Recovery Program, Modifications was instructed to use a metallic split conduit tool with a plastic head to push through Room Temperature Vulcanizing (RTV) foam to make an opening for pulling new cable. Due to a problem with the plastic head slipping off and sometimes being caught in the foam, this device was discontinued. Later, non-metallics, such as a sharpened wooden broom stick handle, were used. Modifications now used a fiberglass wand.

4.5.1.5 Site Specific - BLN

Generic concern number OW-85-007-004 described a condition involving excessive cable coatings. Generic concern number IN-86-259-005 dealt with cables bunched together in cable trays to make it easier to cover them. Concern IN-86-268-002 dealt with cable coatings removed with sharp instruments. Discussion with a knowledgeable Quality Assurance Manager revealed that no fire retardant cable coatings had been used at BLN. Also, there was no procedure at BLN to apply cable coatings in the future because cables at BLN were to be qualified in accordance with the Institute of Electrical and Electronics Engineers (IEEE) Standard 383-1974 which did not require cable coatings. |R3 |

Review of L.S. Cox's memorandum to J.P. Darling dated March 24, 1986 (C20 860325 683) revealed that fire retardants were not to be used on cables at BLN.

BLN specific concern number XX-85-094-005 dealt with an "illegal" fish hook type tool which was used to remove the foam on penetrations so more cable could be pulled. NCR 4222 was reviewed and the apparent cause of damage to cable identified therein occurred due to a "hook type" digging tool commonly used for removing fireseals. The cable identified in the NCR was reworked and the NCR was closed out. The NCR was determined by DNC to be insignificant.

Concern number IN-85-018-004 involved breaching a fire barrier without the proper form. Review of Quality Control Procedures BNP-QCP-5.18, Revision 11, and BNP-QCP-10.6, Revision 18, revealed a work release form was required before breaching a cable tray fire stop. The form, obtained from Attachment A of BNP-QCP-10.6, required applicable drawing identification, location, component UNID, special instructions, procedures, precautions, and engineering approval.

4.5.1.5 Site Specific - BLN (continued)

The evaluator witnessed a breach of a cable tray fire barrier to observe the type of tool which was currently being used to breach fire barriers. During the breach, the Quality Control Inspector provided work release form 56023, and the form was completed with proper signatures as required. The breaching tool was made from a metal split conduit with a wooden head locked down with a cable tiewrap to a metal pipe. This was determined to be the same tool which had been used at SQN and WBN but had been discontinued at both sites due to the size of the tool and the limited amount of space available at penetrations for new cables. Discussion with the QC inspector revealed that BLN did not currently have a problem due to the amount of space available at the cable tray penetrations.

4.5.2 Findings/Conclusions

4.5.2.1 Generic

The findings were handled on a site specific basis for this issue.

4.5.2.2 Site Specific - WBN

Concern IN-85-186-002 dealt with incorrect fire wrap. This concern was not verified as factual after destructive examination of two installations in the area in question revealed no problems.

Concern IN-85-733-002 reported that insulators were inserting cables in penetrations. The concern was not verified as factual in the PMO report written for the concern. The evaluation agreed with the report. The international agreement between the electrician's union and the insulator's union specified the tasks to be performed by each union in breaching and pulling cables through penetrations. In this division of duties, electricians were to install cables. Interviews with an electrical job steward, an electrical superintendent, and a general foreman did not reveal any discrepancies.

4.5.2.2 Site Specific - WBN (continued)

IN-86-028-003, IN-86-259-005, and OW-85-007-004 dealt with bunching cables and coating them with Vimasco so thickly that heat was not allowed to dissipate. NSRS report I-85-569-WBN was reviewed in relation to these concerns. The report validated that cables were bunched together in V1, V2, and V3 (low, medium, and control) level trays but not in V4 (480V) or V5 (6900V) level trays. However, the V1, V2, and V3 level cables were bunched based on approval by DNE. The concern with heat buildups was not validated because (1) cables in V4 and V5 level trays were not bunched, (2) cables in V1, V2, and V3 level trays were based on a random arrangement, and (3) evaluations conducted by DNE. However, the report concluded that though evidence appeared to support that overheating of cables due to the Vimasco coating was not a problem, the effects of Vimasco with respect to ampacity had not been specifically documented for all WBN applications. The report asked that documentation be provided to show the ampacity effect of the Vimasco coating on cables. It also asked that WBN applications be reviewed to determine that no problems existed with present cable sizes. The NSRS later recommended that there be testing of WBN cables with conditions typical for installed cables. As a result, the ampacity tables were updated to incorporate the effect of Vimasco and placed in DS-E12.6.3. A sampling procedure had been drafted at WBN to ensure the adequacy of installed cable size in relation to ampacity considerations. However, no satisfactory response to the recommendation on testing cables for typical conditions in the plant had been received. IN-86-028-003, IN-86-259-005, and OW-85-007-004 were factual and identified a problem, but corrective action for the problem was initiated before the employee concerns evaluation of the issue was undertaken.

4.5.2.2 Site Specific - WBN (continued)

IN-86-268-002 dealt with the removal of Vimasco with sharp instruments. The concern was found factual due to NCRs 5094 and 5612. The response to these NCRs was to prohibit the use of sharp tools to remove Vimasco and to provide a requirement to visually inspect cable before Vimasco was reapplied. This was added to DNC instructions but had not been included in ONP procedures. The concern presented a problem for which corrective action had been, or was being, taken as a result of an employee concerns evaluation.

OW-85-007-005 was not verified as factual in an interview with the former section supervisor of the group which inspected the coating application. The concern reported that the coating was applied over dirt and large pieces of trash. The cleanliness of the cable was a QC hold point which had to be signed off prior to the application of the coating.

XX-85-094-005 dealt with the use of a fish hook tool to breach fire barriers. The use of this type tool was not verified as being factual in conversations with two CQC inspectors and the former CQC supervisor. WBN was using fiberglass rods or wooden broom handles to breach fire barriers. NSRS report I-85-702-WBN was discovered which dealt with the use of fish tape to breach penetrations. It was assumed that the concerned individual had meant fish tape. The use of fish tape to breach penetrations was factual. The corrective action had been completed. It consisted of revising MAI-14 to prohibit the use of fish tape and training maintenance personnel not to use fish tape to breach fire barriers.

IN-85-018-004 was found factual in NSRS report I-85-699-WBN and the ERT report on IN-85-130-002. This concern dealt with the inadequate control of breaching permits. The investigation discovered that ONP and DNC were using two different procedures to administratively control the breaching process.

4.5.2.2 Site Specific - WBN (continued)

DNC and ONP now use PHYSI-2, Attachment D to breach fire barriers. Mechanical Maintenance breached for ONP and Modifications breached for DNC. The fire barriers were under the SI program and were walked down every 18 months. The only discrepancy noted was that SOP-42 (the DNC procedure which outlined how DNC was to request a breach behind the security barrier) referenced the Nuclear Services Branch group which no longer existed. The concern was factual and presented a problem for which corrective action had been, or was being, taken as the result of an employee concerns evaluation.

4.5.2.3 Site Specific - SQN

The portion of the investigation conducted at SQN which dealt with removal of cable coating with sharp instruments was not verified in conversations with Modifications and Electrical Maintenance personnel. The only example of the removal of Flamemastic was at penetrations where the cables were terminated. The procedure here was to flex the cable until the coating cracked and then to peel it off. However, there was nothing in site procedures which prevented their use or any provisions for inspecting the cable for damage after the coating was removed. Therefore, the issue was factual and presented a problem for which corrective action had been, or was being, taken as a result of an employee concerns evaluation.

The portion of the SQN investigation which dealt with the use of cable coatings and their effects on cable ampacity was factual. New ampacity tables, which were used to size cable, were developed to incorporate the effects of Flamemastic. This meant that all cables pulled and coated prior to the issuance of this table were in question. An evaluation of as-installed cables was scheduled. However, no work had been completed at the time this report was written. Therefore, the concern presented a problem for which corrective action had been, or was being, taken as a result of an employee concerns evaluation.

4.5.2.3 Site Specific - SQN (continued)

The site procedural control concern (IN-85-018-004) was not verified factual at SQN. The problem at WBN had resulted from the fact that multiple organizations were breaching fire barriers. This was not the case at SQN. They had only one procedure for breaching fire barriers. They also had a surveillance program in place to verify the integrity of the penetration fire barriers.

The use of a fish hook instrument to breach fire barriers was not verified factual in interviews with a cognizant Modifications supervisor and general foreman. However, fish tape was allowed in M&AI-13. This was assumed to be the problem material. Fish tape had been deleted from MAI-14 at WBN and this should be evaluated at SQN.

4.5.2.4 Site Specific - BFN

Generic concern numbers OW-85-007-004 and IN-86-259-005 described a condition involving bunched cables and excessive cable coatings. Based on discussions with three cognizant DNE engineers and review of Corrective Action Report number BF-CAR-86-0078, the concern was found factual. Cable coatings could be found thicker than 1/4-inch throughout the plant which was in excess of the manufacturer's recommendation. At the writing of this report, BFN was in the process of writing a walkdown procedure. The concerns were factual and identified a problem, but corrective action for the problem was initiated before the employee concerns evaluation of the issue was undertaken.

Generic concern number IN-85-018-004 involved breaching a fire barrier to pull cable without the proper form. Based on discussions with two cognizant Modifications engineers and review of Discrepancy Report number BF-DR-0397, BFN had been using improper forms to breach fire barriers. Therefore the concern was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the issue was undertaken. All breaching of electrical fire barriers was suspended until breaching procedures were correct.

4.5.2.4 Site Specific - BFN (continued)

Generic concern number XX-85-094-005 dealt with improper breaching of fire barriers with an "illegal" fish hook type tool. However, the concern was not a problem at BFN because they used a fiberglass wand to breach fire barriers. Therefore, the concern could not be verified as factual.

4.5.2.5 Site Specific - BLN

Generic concern number IN-86-268-002 dealt with removing cable coatings with sharp objects. This particular concern was not verified as factual because cable coatings were not used at BLN. |R3

Generic concern number OW-85-007-004 involved excessive cable coatings and generic concern number IN-86-259-005 dealt with cable which was bunched before Vimasco was applied. This was not a problem at BLN because cable coatings were not used, therefore, the concern was not verified factual.

BLN specific concern number XX-85-094-005 described an "illegal" fish hook type tool used to remove RTV at cable tray penetrations. Use of this type device was described in NCR 4222. The identified cable was reworked. Therefore, the concern was factual and identified a problem, but corrective action for the problem was inititated before the evaluation of the issue was undertaken. BLN was observed in the field to currently be using a metal split conduit type tool with a wooden head to breach fire barriers.

Generic concern number IN-85-018-004 involved breaching fire barriers without the proper form. The proper form was found in Attachment A of BNP-QCP-10.6 which required applicable drawing identification, location, component unique identification, special instructions, procedures, precautions, and engineering approval. A field evaluation of a breach revealed no problems. Therefore, the concern was not verified as factual.

4.6 Maintaining Cables

Based on the findings of this element the issue raised by the subject employee concerns was factual.

4.6.1 Discussion

4.6.1.1 Generic

The findings were handled on a site specific basis for this issue.

4.6.1.2 Site Specific - WBN

Concern EX-85-092-003 dealt with steel filings found in conduit which could cause damage to cables. WBN-QCP-3.05, Revision 25, "Installation, Inspection, and Testing of Insulated Control, Signal, and Power Cables," and WBN-QCP-3.03, Revision 19 (draft), "Inspection of Electrical Conduit and Junction Boxes," were reviewed to determine if there were any site requirements to ensure the condulet covers were installed after (1) the conduit was installed or (2) cables were pulled in the conduit. It was assumed the problem was encountered with respect to uncovered condulets since provision was made for sealing conduit ends.

Interviews with a former responsible EQC inspector and EQC supervisor revealed that no efforts were made to install condulet covers until just prior to the conduit transfers (which were among the last transfers made). Examples of conduit which were found to be dirty due to the fact that condulet covers had not been installed were discovered in the unit 2 Boron Injection Tank Room on elevation 713. One of the examples was full of metal filings, dust, and rocks while the other one had been used as an ashtray. A review of MAI-3 and MAI-13 (the ONP procedures for installing cables and conduit) revealed that ONP did not have provisions for installing condulet covers in their procedures. This issue was also evaluated in Construction Subcategory 19200. This issue was evaluated by the 19200 subcategory at all plant sites.

4.6.1.2 Site Specific - WBN (continued)

Concern numbers IN-85-346-001 and IN-85-374-001 reported cable which was left unprotected on the floor after they were pulled through conduit. WBN-QCI-3.05, "Cable Installation," WBN-QCP-3.05, "Installation, Inspection, and Testing of Insulated Control, Signal, and Power Cables," and WBN-QCI-1.36, "Storage and Housekeeping," were reviewed for requirements of cable protection after it was pulled and prior to termination. From this review, it was determined that cables are allowed to be coiled up and unterminated if the equipment was not ready for termination. The only precautions stated were to have the cables out of walkways and not to have them kinked or bent over sharp edges (steps 6.4.6.5.8 and 6.4.6.8 of WBN-QCI-1.36). A walkdown was conducted on elevations 772, 737, and 713. Two examples were located where cables were on the floor. One of the examples was 2-3V-81-9246A and 2-3A-81-5665 located under the unit 2 Boron Injection Tank (the example given in concern IN-85-346-001). An interview was conducted with the DNC system 81 engineer about these cables. He stated that they had just been working on the cables to prepare them for termination when a hold was placed on terminations involving Raychem products. He was to have the cables recoiled. The other example was found on the motor driven Auxiliary Feedwater level control valves platform on elevation 737. In both cases it should be emphasized that the cables were in out of the way areas. Since the procedures did have provisions for protecting cable, the Assistant Construction Superintendents who performed the housekeeping walkdowns should be instructed to pay more attention to this area.

IN-85-373-001 reported damaged cables in the unit 2 Reactor Building Rod Drive Control Cabinet. NSRS report I-85-123-WBN was reviewed with respect to this concern. The report stated that the cables in question were damaged and that the MBR of the conductors had been violated. In response, DNC EQC inspectors were sent to the area. They examined the cable and determined that there was no violation of MBR and that the damage consisted of a nick in the insulation which did not require repair.

4.6.1.3 Site Specific - SQN

There was no evaluation of this issue at SQN.

4.6.1.4 Site Specific - BFN

There was no evaluation of this issue at BFN.

4.6.1.5 Site Specific - BLN

There was no evaluation of this issue at BLN.

4.6.2 Findings/Conclusions

4.6.2.1 Generic

There were no generic findings for this issue.

4.6.2.2 Site Specific - WBN

EX-85-092-003 reported steel filings in conduit which could damage cable. The concern was found factual in an examination of conduit in the unit 2 Boron Injection Tank Room. This could be attributed to the fact that there were no provisions for installing condulet covers until just prior to the conduit transfers and after all cables were pulled. This was true for ONP and DNC. Concern number EX-85-092-003 presented a problem for which corrective action had been, or was being, taken as a result of an employee concerns evaluation.

IN-85-346-001 and IN-85-374-001 were found factual in a walkdown of various plant areas. These concerns reported cable which was left unprotected on the floor after it was pulled but before termination. Only two examples of improperly maintained cables were discovered. The problem was not widespread. A review of WBN-QCI-1.36 revealed in step 6.6.3 on page 16 of 17 that Assistant Construction Superintendents were responsible for monthly inspections of their areas of responsibilities. More emphasis was needed concerning observation of cable maintenance after pulling. The concerns presented a problem for which corrective action had been, or was being, taken as a result of the employee concerns evaluation.

4.6.2.2 Site Specific - WBN (continued)

IN-85-373-001 was found factual in NSRS report I-85-123-WBN. The report stated that cables in the unit 2 RB Rod Drive Control Cabinet were damaged and had been bent beyond the MBR values. However, no problems were discovered during inspection by DNC EQC personnel. The evaluation agreed with the response to the report. The concern was factually accurate, but what it described was not a problem (i.e., not a condition requiring corrective action by ONP).

4.6.2.3 Site Specific - SQN

There was no evaluation at SQN.

4.6.2.4 Site Specific - BFN

There was no evaluation at BFN.

4.6.2.5 Site Specific - BLN

There was no evaluation at BLN.

4.7 Insulation Damage

Based on the findings of this element, the issue raised was factual.

4.7.1 Discussion

4.7.1.1 Generic

The findings were handled on a site specific basis for this issue.

4.7.1.2 Site Specific - WBN

This issue was not evaluated at WBN.

4.7.1.3 Site Specific - SQN

OO-85-005-014 dealt with insulation which was cut off of a cable routed to the Condenser Circulating Water gate hoist motors. Interviews were conducted with two Electrical Maintenance engineers and one Operations Section individual to determine the location and function of these motors. The conversations revealed that these motors were used to control the gates which prevented the backflow of

4.7.1.3 Site Specific - SQN (continued)

hot Condenser Circulating Water to the intake when the Essential Raw Cooling Water pumps were located at the initial intake pumping station. This was a necessary precaution needed to maintain the Essential Raw Cooling Water supply temperature requirements. However, the Essential Raw Cooling Water pumps had been moved to another intake structure and the need for the backflow gates no longer existed. Currently, these gates had been blocked in the open position and the subject cables had been de-energized.

A field evaluation of these motors verified that they were numbered as the concerned individual stated, and they had been taken out of service as described above. The field evaluation did reveal a disconnected cable inside a control panel with a tag referencing workplan 11043. A review of this workplan revealed that work was done to remove several instruments from service. This was required according to Engineering Change Notice L5720. A review of this notice revealed that it gave the same information concerning these gates as stated above.

The SQN system 27 Systems engineer was interviewed on the specifics of how the gate hoist motors had been removed from service. The engineer discovered that the breakers were open with a Caution Order attached. Based on the fact that the subject cables were not energized, were no longer needed, and had been taken out of service, the need for further evaluation concerning this item was not required.

A similar concern (00-85-005-003) was evaluated in QA/QC SQN element report 80203.

4.7.1.4 Site Specific - BFN

This issue was not evaluated at BFN.

4.7.1.5 Site Specific - BLN

BNP QCP-10.35-7 dealt with thermocouple insulation damage for Makeup and Decay Heat Pumps which when repaired might not have been inspected. A review of NCRs 1101 and 1087 revealed the wires for the thermocouples for these pumps had been overheated to the point that the insulation had partially melted and that the wires were bent at a sharp angle and were exposed through the insulation. The observation was made that since the damaged wiring was embedded in the motor windings, the damage to the wiring might indicate damage to the motor itself. For this reason, both NCRs were determined to be significant as defined by 10 CFR 50.55(e). A memorandum from R. M. Hodges to W. R. Dahnke dated November 13, 1979 (NEB 791113 121) acknowledged NCR 1087 had been upgraded to significant with the requirement that the motors be restored to their warrantied conditions by Babcock and Wilcox.

The first interim report to the Nuclear Regulatory Commission dated December 21, 1979, on NCRs 1087 and 1101 (A27 791221 005) essentially restated the problem with the wiring and indicated that the damage occurred prior to receipt at the site. It indicated that Babcock and Wilcox had been directed to repair the damage. The fourth interim report to the Nuclear Regulatory Commission dated October 7, 1980, on NCRs 1087 and 1101 (A27 801008 004) contained notification that TVA had received the Westinghouse procedure for testing the motors. The fifth interim report reviewed was contained in a memorandum from J. A. Raulston to L. M. Mills dated February 21, 1981 (NEB 810224 275). It stated that TVA was waiting on Westinghouse site representation before running the test mentioned in the fourth interim report.

The work of repairing the leads was performed under Babcock and Wilcox field change number FC-110. The inspection and test records were reviewed. There were provisions for inspecting the work while it was being performed. There was also a sign off for satisfactory thermocouple repair. Westinghouse

4.7.1.5 Site Specific - BLN (continued)

certified the thermocouples to have the same reliability as if repairs had not been required in a letter to TVA (NEB 811027 605).

A memorandum from R. R. Hoesly to L. S. Cox dated February 18, 1986 (B45 860218 251), was generated in response to concern BNP QCP-10.35-7. The cause of the damage was given. It was stated that all the thermocouples were terminated in a central box. This box was removed to drill holes in it for conduit installation. In the process, the insulation for the thermocouples began to crack. Since the portion of the leads inside the motor housing were not subjected to the same abusive handling as the portion in the junction box, there was no reason to assume that the thermocouple insulation inside the motor housing was damaged. The function of the thermocouples was given as a means to provide temperature measurements from the motor stator/bearings to detect problems with overheating. It was stated that if the thermocouples did become junctioned at some point other than the intended, as mentioned in the concern, the thermocouples would still detect changes in motor operating temperatures. The memorandum cited the repair, and the fact that the thermocouples were recertified by Westinghouse as actions which lended a high level of credibility to the adequacy of the repairs.

BNP QCP-10.35-8-5 mentioned cables which were repaired with tape in the Turbine Building. The investigation conducted at BLN did not find factual the concern in observations made of the location given in the concern. In addition, SRN-G-38-8 contained the provision in step 3.4.1.1 that equipment in mild environments (the Turbine Building was a mild environment) may use tape on splices.

4.7.2 Findings/Conclusions

4.7.2.1 Generic

There were no generic findings for this issue.

4.7.2.2 Site Specific - WBN

There was no evaluation at WBN.

4.7.2.3 Site Specific - SQN

OO-85-005-014 was not verified factual. The concern dealt with cables whose insulation had been taped back on the cable. The equipment in question was no longer in service so the need to evaluate further was no longer necessary.

4.7.2.4 Site Specific - BFN

There was no evaluation at BFN.

4.7.2.5 Site Specific - BLN

BNP QCP-10.35-7 was factual and identified a problem, but corrective action for the problem was initiated before the employee concerns evaluation of the issue was undertaken. This concern dealt with a lack of inspection for damaged thermocouple leads and referenced NCR 1087 and IIO1. The damaged thermocouple wires were repaired and reinspected, and the thermocouples were recertified.

BNP QCP-10.35-8-5 was not verified factual in a walkdown of the area conducted in relation to this concern. The concern reported cable damage in the Turbine Building which was taped. In addition, a review of an addendum to G-38 (SRN-G-38-8) revealed that tape could be used to repair cables in mild environments (such as the Turbine Building).

5.0 COLLECTIVE SIGNIFICANCE

5.1 Collective Significance of Each Issue

5.1.1 Cable Pulling

A pattern appeared concerning inadequate cable pulling design criteria which was attributed to insufficient past emphasis on SWP, MPT, and MBR guidelines to accomplish the cable pull activities. For instance, DNE did not previously include SWP calculations nor define the method for calculating MPT for multi-cable pulls in General Construction Specification G-38. They also allowed Construction to bend cables to radii less than the MBR of various cable manufacturer's values. This brought up the question of the adequacy of the cable pull to be successfully completed without insulation degradation, potential cable elongation, and damage to the qualified life of safety-related cable required for safe shutdown of a plant in the event of a postulated design base accident. The potential for a condition adverse to quality existed due to the above, but the evaluation disposition of CATD 10900-NPS-01 was to provide resolution. Another pattern was developing which defined the practice of ignoring the procedural requirements in both safety and non-safety electrical installations. This appeared to be prevelent throughout the installation work phase.

Poor quality installation was apparent for non-QA cable pulls based upon the craft's conception that management's emphasis was on quantity rather than quality. This was also apparent based upon the craft's misconception that site procedures were not important unless enforced by a QC inspector. To this end, poor quality work resulted in costly rework.

5.1.2 Splicing

A pattern appeared concerning inconsistent and unclear design criteria used for installing cable splices resulting in installations with improper hardware. For instance, General Construction Specification G-38 was not clear on what Thomas and Betts connectors were to be used on voltages greater than 600 volts and for the installation of Raychem splices.

Cable splice installations using improper hardware could result in cable failure and costly rework.

A pattern also appeared concerning a lack of emphasis on the requirements for maintaining equipment qualification. For instance, Raychem HVS high voltage splice kits (which were not qualified for harsh environments) were installed on

5.1.2 Splicing (continued)

Class 1E circuits in harsh environments. Also, Standard Drawings referenced harsh environments when the Environmental Data Drawings were not issued until August 26, 1983.

Cable splices and terminations using Raychem heat shrinkable breakouts, end caps, and sleeving completed before December 2, 1985, did not meet current requirements as listed in TVA standard drawings, General Construction Specification G-38, and the manufacturer's application guide for Class 1E cable terminations and splices in harsh environment areas.

Failure to comply with equipment qualification requirements could result in a reduction in the qualified life of the splice and failure of safety-related systems required for safe shutdown of a plant in the event of a design base accident.

5.1.3 Cable Terminations

Although there was a procedure for installing and testing non-QA cables, employees were not aware that the procedure existed. This was the result of a lack of management emphasis on the procedure. The lack of testing could result in defective nonsafety-related circuits. This in turn could cause costly rework with relation to repairing and retesting the equipment.

In spite of the fact that there were specific Labor Agreements which spelled out the duties of the various crafts, non Electricians were used to perform electrician's tasks. Management violated these agreements in order to increase work output to meet deadlines. There was a potential quality impact when unskilled personnel were requested to perform skilled tasks. It then became the sole responsibility of the QC inspector to verify the work was performed correctly.

The use of AMP PIDG lugs on solid conductor leads had the potential to impact plant safety. The failure of a lead in a solenoid surge suppression network could decrease the life of the valve actuating contact and increase voltage spikes into the DC system. A failure at a status monitor relay could cause a control power failure input to the Bypass Inoperable Status Indication (BISI) system. A failure in the Foxboro control racks could prevent a safety circuit from operating. A

5.1.3 Cable Terminations (continued)

failure to a nonsafety-related electro-thermal link of a fire damper could prevent it from operating. A failure of diesel generator alarm circuits could cause loss of alarm function. A failure of a strip chart recorder selector switch could cause loss of recorded data. Finally, a failure in a relay or local panel could prevent a safety circuit from operating. In summary, there was a potential for safety-related equipment required for safe shutdown of the plant in the event of a design base accident to be inoperable.

5.1.4 Inspection of Cable

In order to meet cable pulling deadlines, management allowed engineers to be used to inspect more than one cable pull at one time. This was the result of management emphasis of quantity over quality. Since engineers were observing more than one cable pull, the potential for cable damage existed because they could not be present at all phases of the pull.

5.1.5 Fireproofing Cables

Evaluation of the fireproofing issue revealed a complex matter dealing with such topics as removal of RTV foam, discrepancies in breaching procedures, and removal of coatings with sharp instruments. The major finding revealed that TVA did not take into account ampacity losses due to the application of fire retardant cable coatings at SQN, WBN, and BFN. The adequacy of installed coated cables was questionable. This increased the potential for safety-related equipment required for safe shutdown of the plant in the event of a design base accident to be inoperable.

5.1.6 Maintaining Cables

Even though procedures were adequate and requirements were in place to protect cables from being damaged after they were pulled but prior to termination, some cables were found lying unprotected. This was the result of a lack of implementation of the site procedures on housekeeping in the area of maintaining cable.

5.1.6 Maintaining Cables (continued)

Finding unprotected cables on the floor was an indication of a perception by employees that management did not enforce the housekeeping procedure. Allowing cables to lie unprotected in walkways increased the potential of cable damage due to abrasive treatment such as walking on the cables.

No provisions were found in site procedures to ensure condulet covers were installed to protect cable from dirt, rocks, steel filings, etc. This could result in insulation damage to the cables and ultimately cable failure.

5.1.7 Insulation Damage

No collective significance was assigned. The damaged thermocouple leads for the Makeup and Decay Heat Pumps were damaged in an isolated instance of poor construction practices.

5.2 Collective Significance of the Subcategory

5.2.1 Generic

The major findings revealed a general lack of management control over the issuance of adequate design output criteria and compliance with installation requirements. Problems with cable pulling criteria were identified by NSRS Report No. I-85-06-WBN issued July 8, 1985, which were found unresolved during this evaluation. Inadequate criteria was found in both the cable pulling and splicing issues. Poor cable pulling practices were utilized in several instances even when adequate procedures existed. Also, the employees' general perception indicated that management emphasized meeting schedule over quality. Lack of work control in these areas could result in cable failure, a reduction in the qualified life of the cable, and failure of safety-related systems required for safe shutdown of a plant in the event of an accident (design base event). However, these problems were being addressed by TVA.
Collectively, there were two significant findings. First, more emphasis was needed in regards to work control and following procedures. Second, more emphasis was needed in regards to technical training for engineers with attention given to design criteria.

5.2.2 Site Specific - WBN

The major issues at WBN were covered in section 5.2.1.

5.2.3 Site Specific - SQN

The issues at SQN were generic and were covered in section 5.2.1.

5.2.4 Site Specific - BFN

The issues at BFN were generic and were covered in section 5.2.1.

5.2.5 Site Specific - BLN

The issues at BLN were generic and were covered in section 5.2.1.

6.0 CAUSES

6.1 Cable Pulling

Two problem areas were apparent in the cable pulling subsection: (1) the fact that DNE did not recognize a need to calculate SWP and establish MBR values which were fully supported by manufacturer's test data, and (2) management emphasized quantity over quality in order to meet the schedule rather than enforce site procedures.

Design criteria was inadequate, inconsistent, and in some cases nonexistent in regards to sidewall pressure calculations, maximum cable pull tension calculations, and minimum bend radius values. NSRS investigation report I-85-06-WBN found that DNE and DNC's established and documented program was inadequate to accomplish cable pulling activities. The report identified three problem areas with the cable pulling program:

- DNE previously did not include sidewall pressure calculations in the cable pull specification. SWP calculations were not incorporated into General Construction Specification G-38 until January 15, 1986. Before this date, there was not sufficient information to ensure that SWP had not been exceeded. This lack of adequate criteria increased the potential for insulation degradation of cables which might not necessarily be detected visibly or through testing.

6.1 Cable Pulling (continued)

- DNE did not previously define the method for calculating MPT. MPT for multi-cable pulls was not defined until September 15, 1985, and most cable pulls (those not mechanically assisted or what were considered "tough pulls") did not have their pull tension monitored until October 18, 1983. This brought up the question of the adequacy of the cable pull to be successfully completed without insulation degradation.

- DNE's handling of the question concerning exceeding MBR was inconsistent. They allowed bending radii less than the MBR of various cable manufacturer's values. Bending cables to values less than industry standard values potentially damaged cable shields and insulation resulting in a potential reduction of the qualified life of the cable.

Bad cable pulling practices were utilized in several instances even when adequate site procedures existed. In one instance an EEU engineer was asked by his supervisor to ignore a problem with oversized wire to 480 volt receptacles because the schedule had to be met. Six other concerns reported that the emphasis on pulling was quantity over quality. In all interviews with craft, it was noted that no effort had been made to explain the reasoning behind procedural changes. Craft personnel saw no need for these new procedures and did not use them unless forced to by a QC inspector.

DNE also did not recognize a need to establish Quality Assurance records on the total cross sectional area of fill of cables in conduits or to retain auditable cable outside diameters used in the cable fill program. A DNE evaluation was initiated based on a WBN NCR. In the disposition, DNE discovered the cable outside diameters used by the projects in their fill programs were not required to be as-built cable dimensions resulting in a potential for conduit overfill and excessive SWP values. As a result, new cable outside diameters were issued to be used to calculate conduit and cable tray fill for past and present installations.

6.2 Splicing

Splicing problems were the result of inconsistent and unclear design criteria.

Design criteria was inconsistent and unclear in regards to the installation of Raychem splices and for hardware requirements of 6.9KV splices.

6.2 Splicing (continued)

General Construction Specification G-38 was not clear on what Thomas and Betts connectors were to be used on voltages greater than 600-volts.

Cable splices and terminations using Raychem heat shrinkable breakouts, end caps, and sleeving completed before December 2, 1985, did not meet current requirements as listed in TVA standard drawings, General Construction Specification G-38, and the manufacturer's application guide for Class 1E cable terminations and splices in harsh environment areas.

Cables were spliced before December 2, 1985, using WCSF-N tubing with different application ranges.

Raychem HVS high-voltage splice kits (which were not qualified for harsh environments) were installed on Class 1E circuits.

Standard drawings referenced harsh environments. However, the Environmental Data Drawings, which defined harsh environmental areas, were not issued until August 26, 1983.

6.3 Cable Terminations

Termination problems were caused by failure of TVA and Foxboro to follow vendor recommendations in the application of terminal lugs and failure by TVA to follow General Construction Specification G-38.

6.4 Inspection of Cable

Inspection problems were a result of management emphasis of quantity over quality.

6.5 Fireproofing Cables

Excessive cable coating was a result of not following site procedures. Also, DNE did not recognize a need to take into account ampacity losses because of the application of cable coatings.

6.6 Maintaining Cables

Problems with maintaining cables in conduits resulted because management did not recognize a need to protect installed cable when condulet covers were removed or when terminations were not completed.

6.7 Insulation Damage

No cause was determined for this issue.

7.0 CORRECTIVE ACTION

7.1 Corrective Action Already Taken

7.1.1 Cable Pulling

7.1.1.1 Generic

DNE had revised Construction Specification G-38 and G-40 to incorporate resolutions to the identified problems discussed in this report concerning SWP, MPT, and MBR issues.

TVA had recently implemented an extensive trend analysis program to track, consolidate, and categorize identified conditions adverse to quality. This trend analysis program was to readily identify trends associated with cable at TVA nuclear plants.

7.1.1.2 Site Specific - WBN

Watts Bar field inspection obtained a sample size of 81 worst-case conduits for detailed SWP calculations. The worst-case conduits were selected by visual inspection of 778 conduits using the criteria of multiple bends (greater than 360°), long lengths, elevation changes, and conduit fill (greater than 30 percent) using EEB walkdown Engineering Procedure 22.29.

Concern number IN-85-527-001 stated that cables had been pulled without break ropes. NCR 6001 was written, the cables involved were scrapped, and new cables were pulled.

Several concerns dealt with a specific incident where a QC inspector was locked out of a room while electricians pulled cable inside. The incident was reported and the foreman and general foreman involved were given two weeks off without pay. The cable was scrapped, and a new cable was pulled.

The use of Yellow 77 cable lubricant was verified and the cables involved were repulled using proper lubricants.

7.1.1.3 Site Specific - SQN

Corrective actions taken for SWP, MPT, and MBR were generic and were as given in section 7.1.1.1.

Excessive MBR values for Conax connectors were reported in SQN-CAR-86-02-005. SMIs 1-363-1 and 2-363-1 were written to provide a walkdown procedure for reinspection of the connectors. SMIs 1-363-2 and 2-363-2 had been written to provide procedures for rework of unacceptable connectors. The walkdowns and rework were completed. The data packages were awaiting QA approval.

SCR SQNEEB8529 was generated to document conduit overfill of 55 conduits. The SCR was dispositioned use-as-is because exceeding conduit fill did not constitute a failure. Tests and inspections were performed on the cables in question and no damage was revealed. The SCR was closed out on January 28, 1986.

7.1.1.4 Site Specific - BFN

Corrective action for SWP, MPT, and MBR issues was generic and was as given in section 7.1.1.1.

7.1.1.5 Site Specific - BLN

Corrective action for SWP, MPT, and MBR issues were generic and were as given in section 7.1.1.1.

Stop Work Action Report number SW12 was issued on July 7, 1985, because Construction Specification G-38 did not contain provisions for SWP calculations. G-38 was revised and the stop work action report was released on January 7, 1986.

NCR 2987, Revision 0, was issued because cables were installed between October 14, 1983 to March 1, 1984 without using break rope requirements specified in Construction Specification G-38 (SRN-G-38-2). Cables pulled during that period were sampled per the instructions given in R. M. Hodges' memorandum to L. S. Cox, dated July 12, 1984 (EEB 840717 902). No further problem was identified and the NCR was closed out on February 20, 1986.

7.1.2 Splicing

7.1.2.1 Generic

The corrective actions for this issue were handled on a site specific basis.

7.1.2.2 Site Specific - WBN

NCRs 6623 and 6774 were written because splices using Raychem products before December 2, 1985 did not meet current standards. DNE dispositioned these NCRs use-as-is.

7.1.2.3 Site Specific - SQN

Site specific concern MAS-85-003 dealt with a splice which had been taped over instead of using Raychem products. The suspect cables were examined. One of these cables was repaired with Raychem products. The other was not damaged.

WBN generic NCRs 6208/6224 were tied to the resolution of splicing problems at SQN. These NCRs dealt with splices made with Raychem products in harsh environments which were not made in accordance with SD-E12.5.7-1. All splices at SQN questioned by these NCRs were inspected and corrections had been made as necessary. The documentation for the rework had been sent to the EQP to become a part of the EQ binder. The NCRs were closed on the SQN site. WBN generic NCRs 6623 and 6774 were written because splices using Raychem products before December 2, 1985 did not meet present standards. DNE dispositioned these NCRs use-as-is.

7.1.2.4 Site Specific - BFN

The corrective actions were not complete at BFN. The proposed corrective actions were described in section 7.2.2.4.

7.1.2.5 Site Specific - BLN

A review of NCR 2494, Revision 1, revealed that site personnel were omitting the shim in Raychem type NPKV-2-14 splice kits when the Raychem sleeve was being used as the lug and bolt cover sleeve. All Class 1E applications in harsh environments were reworked to the proper configuration. Mild environment splices were dispositioned use-as-is.

7.1.3 Cable Terminations

7.1.3.1 Generic

The corrective actions for this issue were handled on a site specific basis.

7.1.3.2 Site Specific - WBN

There was evidence to suggest that subjourneymen were terminating cables which was a job for which they had not been trained. There was a reported instance of a subjourneyman performing cable terminations. The practice was stopped immediately and all work performed by the subjourneyman was inspected. At the time of the DNC response to the concern, there were no subjourneymen in DNC. Provision was made that employment of subjourneymen would be preceded by instructions from the project manager to all involved supervisors of subjourneyman job responsibilities. Also, there was to be a form for the subjourneymen to sign when hiring in which stated they had been instructed on job requirements, safety, and QA responsibilities.

7.1.3.3 Site Specific - SQN

The corrective actions were not complete at SQN. The proposed corrective actions were described in section 7.2.3.3.

7.1.3.4 Site Specific - BFN

The corrective actions were not complete at BFN. The proposed corrective actions were described in section 7.2.3.4.

7.1.3.5 Site Specific - BLN

There was no corrective action for this issue at BLN.

7.1.4 Inspection of Cable

7.1.4.1 Generic

There was no generic corrective action for this issue.

7.1.4.2 Site Specific - WBN

There was a particular incident in which a QC inspector was locked out of a room while electricians were pulling a cable. The incident was reported, the cable was scrapped, and the foreman and general foreman were given two weeks off without pay. A new cable was pulled.

There were cases in which a single inspector was asked to watch more than one pull. This was no longer the case because there were better controls in place. Examples included the fact that the inspector may not view more than one pull at a time, and they must be present at all times the cable was pulled.

7.1.4.3 Site Specific - SQN

There was no corrective action for this issue at SQN.

7.1.4.4 Site Specific - BFN

There was no corrective action for this issue at BFN.

7.1.4.5 Site Specific - BLN

There was no corrective action for this issue at BLN.

7.1.5 Fireproofing Cables

7.1.5.1 Generic

The generic corrective actions were not complete. The proposed corrective actions were described in section 7.2.5.1.

7.1.5.2 Site Specific - WBN

One of the fireproofing concerns dealt with the use of a fish hook tool to remove foam from penetrations. At the time the WBN evaluation was conducted, no evidence of a fish hook tool was noted. There was a NSRS report (I-85-702-WBN) which described the use of fish tape to breach fire barriers. It was assumed that this was the instrument in question. The corrective action in the report consisted of revising MAI-14 to prohibit the use of fish tape to breach fire barriers. This procedure had been revised. Maintenance personnel were also trained not to use fish tape to breach.

7.1.5.3 Site Specific - SQN

No corrective actions were complete at SQN. The proposed corrective actions were described in section 7.2.5.3.

7.1.5.4 Site Specific - BFN

No corrective actions were complete at BFN. The proposed corrective actions were described in section 7.2.5.4.

7.1.5.5 Site Specific - BLN

The use of a fish hook tool was verified at BLN due to NCR 4222. The cable was reworked, and the NCR was closed.

7.1.6 Maintaining Cables

7.1.6.1 Generic

There were no generic corrective actions for this issue.

7.1.6.2 Site Specific - WBN

No corrective actions were complete for this issue at WBN. The proposed corrective actions were described in section 7.2.6.2.

7.1.6.3 Site Specific - SQN

There was no corrective action for this issue at SQN.

7.1.6.4 Site Specific - BFN

There was no corrective action for this issue at BFN.

7.1.6.5 Site Specific - BLN

There was no corrective action for this issue at BLN.

7.1.7 Insulation Damage

7.1.7.1 Generic

There was no generic corrective action for this issue.

7.1.7.2 Site Specific - WBN

There was no corrective action for this issue at WBN.

7.1.7.3 Site Specific - SQN

There was no corrective action for this issue at SQN.

7.1.7.4 Site Specific - BFN

There was no corrective action for this issue at BFN.

7.1.7.5 Site Specific - BLN

There was a BLN site specific concern which dealt with thermocouple insulation damage for the Makeup and Decay Heat Pumps. NCRs 1101 and 1087 were written to record the problem. The work of repairing the leads was performed under Babcock and Wilcox field change number FC-110 and was inspected by a Westinghouse inspector. The thermocouples were recertified to have the same reliability as if repairs had not been required.

7.2 Corrective Action Required

7.2.1 Cable Pulling

7.2.1.1 Generic

DNE initiated an extensive testing program to determine the adequacy of Class 1E cable installations at each of TVA's nuclear plants. A test was conducted at TVA's Central Labs to determine the maximum possible sidewall bearing pressure (SWBP) on cable pulls without cable degradation. Each plant's engineering project was instructed to begin a screening program to determine the worst-case conduits to apply this information to the SWBP test results. At the writing of this report, DNE was involved in contract negotiations with a third party engineering company to evaluate the adequacy of how worst-case conduits were selected at WBN for the Sidewall Bearing Pressure Test. This evaluation and DNE's final response was to be required to determine the adequacy of cable for all TVA nuclear plants as it related to SWP.

DNE was evaluating SWP in regards to past cable pulling requirements. Since violations of cable pulling procedures had been verified in this evaluation, DNE must evaluate cable in regards to exceeding MPT, SWP, and MBR requirements (CATD 10900-NPS-01) (QR).

The line management response on a corporate level was:

1. SIDEWALL PRESSURE

TVA's central laboratory test results on cable sidewall bearing pressure concluded that allowable pressures were four (4) to five (5) times higher than previous manufacturer's limits. Initial calculations for WBN have been performed and are under review. Final calculations for SQN have been completed and test results concluded that cable pulling practices in the worst case cable conduit configurations for SQN would not result in sidewall pressures that cause damage to the cable insulation. These test results were consistent with the EPRI Report No. EL-3333. An independent third party, David A. Silvers & Associates, Inc., has concluded that the TVA testing is a reasonable

7.2.1.1 Generic (continued)

basis for increased sidewall pressure values.

The testing and analysis results have been submitted to the NRC. TVA is continuing resolution with the NRC on this issue. If any additional corrective action, either short-term or long-term, is required as a result, then the CAP will be revised accordingly.

In addition General Construction Specifications G-38 and G-40 have also been revised to limit the total sum of all bends in a conduit run to 360° between pull points.

NOTE: Calculations for BLN and BFN will be completed prior to restart for BFN and prior to fuel load for BLN.

2. DISTRIBUTION OF CABLE PULLING FORCES

TVA practice of monitoring total tension rather than individual tension, does assure individual conductor strength limits are not exceeded, and is consistent with IEEE 690-1984, "Standard for the Design and Installation of Cable Systems for Class 1E Circuits in Nuclear Power Generating Stations." In fact, TVA practice is more conservative. Since August of 1978 we take 80% rather than 100% of individual conductor strength on multi-cable pulls. Besides industry experience, acceptability of this practice was demonstrated in a recent cable pull in which the total pulling tension in a multi-cable pull was 3750 lbs. Several cables in the pull had a conductor strength limit of 65 lbs. If the tension had not been distributed proportionally, the smaller cables would have snapped. These cables did not break or elongate. The above demonstrates that TVA's practices with respect to the distribution of cable pulling forces had maintained the adequacy and integrity of Class 1E cable. Therefore, TVA considers this issue closed.

7.2.1.1 Generic (continued)

3. CABLE BENDING RADIUS

TVA's Electrical Engineering Branch (EEB) has used the NSRS report in addition to the manufacturer's requirements, to form the basis for its evaluation. Each of the areas of potential concern is being resolved into elements for further analysis. In each case the actual bend radius to which a cable has or could have been subjected is determined. This is accomplished for each Class 1E safety-related cable to which the concern applies. Subsequently, a determination is made of the effects, both short and long-term, on the integrity of the cable and its ability to perform its safety-related function as a result of being subjected to the reduced bend radius. This determination is based on consultations with and recommendations from the cable manufacturers, a review of the cable materials and constructions involved, the particular application of the cable at TVA, and a review of TVA and industry environmental qualification testing as it relates to cable bend radius. In particular, EEB has identified the elongation stress, to which a cable is subjected as the result of a bend, as the critical parameter in determining acceptability. The evaluation of the concerns indicates that the minimum bend radius to which cables could have been subjected is that of one times its overall diameter. The resulting elongation stress has been calculated and compared with the cable's corresponding capability following its postulated accident scenario. This information is compiled from the environmental qualification test reports. Preliminary conclusions of the study indicate that this worst case bend at SQN does not reduce the cable's available elongation properties below that required for it to perform its safety-related function.

7.2.1.1 Generic (continued)

A final report, including EEB's conprehensive detailed analysis of the concern, including evaluation results, conclusions, and recommendations will be provided.

The effects of a reduced bend on shielded medium voltage power cable and coaxial, triaxial and twinaxial cables will be evaluated separately. EEB has issued project specific actions for the evaluation of these cables. These actions will include field inspections for the existence of pull boxes or condulets of any type in which the cable is bent as well as individual inspections of a cable's bend radius. The actual bend radius will be determined and the resulting effects on the integrity of the cable will be established.

The testing and analysis results have been submitted to the NRC. TVA is continuing resolution with the NRC on this issue. If any additional corrective action, either short-term or long-term is required as a result,then the CAP will be revised accordingly.

CAQs written were WBN NCR 6270, WBN NCR 6347, SCR SQNEEB8703, SCR BLN4907, PIR GENEEB8605, and PIR WBNEEB86107.

7.2.1.2 Site Specific - WBN

- Cable outside diameters used by Watts Bar Engineering Project in their conduit fill program were not adequate. Two SCRs, WBNEEB8589 and 8590, were written. Samples of different types of cables were sent to TVA's Singleton Labs to determine actual average cable diameters. The new cable outside diameters were given to the Watts Bar Engineering Project computer programmers to place in the conduit fill program. The Watts Bar Project engineer was to evaluate the program for conduit overfill. If problems were discovered, NCRs were to be generated and corrective action taken as required (CATD 10900-NPS-05) (QR).

7.2.1.2 Site Specific - WBN (continued)

The line management response on a corporate level was:

> QA values for class 1E and NC cable weights and outside diameters which are used in Category I structures, have been established and documented. These values have been incorporated into Engineering Design Standards DS-E12.1.13 and DS-E12.1.14 for use in performing calculations for cable minimum bend and training radius, and sidewall pressure. In addition, these QA values will be used for the calculation of conduit and cable tray cross-sectional area fill and seismic loading. QA values for new cable mark numbers and/or outstanding cable mark numbers will be established and documented.
>
> As a result, evaluations will be performed on any existing overfilled condition to determine the impact on cable ampacity, cable sidewall bearing pressure as a result of cable pulling, and raceway structural support systems. Conditions that are determined to be technically acceptable will be documented and accepted for use as is, for conditions that are determined to be unacceptable corrective actions, which may include cable removal and rerouting, will be taken.

CAQs written were SCRWBNEEB8589, SCRSQNEEB8601, PIRBLNEEB8601, and SCRBFNEEB8602.

It should be noted that the term QA in the corrective action plan did not refer to the QA organization but to the term QA with respect to actual, auditable values.

- NCR 4194 was written in 1982 and addressed problems with MBR in cable trays. NCR 4933 was written in 1983 identifying MBR problems after a 100 percent walkdown of V5 (6900-volt) level cables. NCRs 4274 and 5062 were written to document problems with MBR in conduits . The disposition of these NCRs was in question due to the findings in NSRS report I-85-06-WBN and the adequacy of these dispositions will depend on DNE's final response to this report (CATD 10900-NPS-01). See section 7.2.1.1 for corrective action.

7.2.1.2 Site Specific - WBN (continued)

- DNE was actively involved in an evaluation to determine the adequacy of installed cable in regards to MBR. The determination was to be based on consultations with and recommendations from the cable manufacturers, a review of the cable materials and construction involved, the particular application of the cable at TVA, and a review of TVA and industry environmental qualification testing. Finally, recommendations were to be formulated which, if necessary, would include cable testing, surveillance inspections or rework, or replacement of the cable in question (CATD 10900-NPS-01). See section 7.2.1.1 for corrective action.

- NCRs W-290-P and 6295 had been generated on violations of MBR in the MCR and violations due to nonexistent acceptance criteria in MAI-4 and 5. These procedures had been revised to give MBR acceptance criteria. However, the NCRs were still open (CATD 10900-WBN-01) (QR).

The line management response was:

TVA at WBN has recognized that there is a possible problem with all cables concerning bend radius. This condition is documented with NCRs 6295 and W-290-P. These NCRs identified bend radius problems at specific points but DNE expanded them to include cable bend radius in all plant areas. DNE is currently working on the cable bending radius problems documented on NCRs 6295 and W-290-P. These NCRs are being tracked by respective TROI Numbers 6295 and W-290-P.

- Cable sidewall pressure calculations were not considered in the design process. The condition was identified in NSRS report I-85-06-WBN. Construction Specification G-38, Revision 5, did not address SWP. PIR WBNEEB8534 was written to identify the problem. NCR 6270 was issued for tracking purposes. NCR 6347 was issued because the conduits listed had more than 360° of accumulated bends between pull points in violation of Electrical Design Guide DG-E13.1.1 and the National Electric Code referenced by Construction Specification G-40. DNE's final response to I-85-06-WBN will be required to disposition the above mentioned NCRs (CATD

7.2.1.2 Site Specific - WBN (continued)

10900-NPS-01). See Section 7.2.1.1 for corrective action.

- It was determined that 480-volt receptacles in the fifth diesel area were sized for number 4 through number 8 AWG wires while DNE specified a number 2 AWG wire to the receptacles. Corrective action should be initiated (CATD 10900-WBN-02) (NQR).

The line management response was:

The 480 volt receptacles in the Additional Diesel Generator Building are being supplied by three single conductor size 2 cables, TVA mark #WDG-1, as specified by WBN cable status master report, and they are terminated as shown on dwg 45W1788-2 Rev 3. TVA conduit and grounding dwg 15W818-2 Rev 19 specifies a mark #SRA-3 which is a Crouse-Hinds cat. No. AEQ-1648-1-00000 plug, receptacle, 60 amp, 600V ac, 3W, 4P. A review of the Crouse-Hinds Electrical Construction Materials Cat. #4700 (1983), section iP-2 recommends a wire size of #6-#4 for a 60 amp rated receptacle with pressure connectors and then specifies, "Do not use wire size smaller than minimum size recommended." It further states that the ranges of wire sizes shown is intended only as a guide. The table did specify that the diameter of recess for the pressure connector is .312 of an inch so that a maximum size of bare conductor can be figured. The National Electrical Code 1987 edition, section 110-14, subsection (a), "Terminals," states that connection of conductors to the terminal parts shall ensure a thoroughly good connection without damaging the conductor and shall be made by means of pressure connectors, solder lugs, or spliced to flexible leads. The Standard Handbook for Electrical Engineers, by Fink and Beaty, eleventh edition, specifies in Table 4-15 and Table 19-5 that a 7 strand #2 conductor has an overall diameter of .292 of an inch. The receptacles in question more than adequately accept the #2 cable. A field check of the wire size was performed, and the design specified wire size is installed. The design dwgs for the Reactor Bldg 45W1766-8 Rev 11 specify the same

7.2.1.2 Site Specific - WBN (continued)

size of main feeder cable, however, the cable specified is a mark #WMT which is a 3 conductor #2 cable not 3 individual #2 wires as specified in the Additional Diesel Generator Bldg, and the ref dwg specifies reducing this main feeder cable by splicing a mark #WDF (single conductor #4 wire) to it. The receptacles in both buildings are the same type and size. MR-A-496500 field checked two receptacles in the Additional Diesel Generator Building for possible loose connections and binding cable. No loose terminations were found on the receptacles. The field cables were installed correctly with sufficient space in the junction boxes for the terminations. Since the manufacturer's recommendations did not place any restrictions on the use of larger wire, the installed cables meet all requirements of the National Electrical Code and are installed as defined on TVA dwgs, the cable size is smaller than the maximum .312 of an inch recess as defined by the vendor catalog and the Standard Handbook for Electrical Engineers, and the items in question are not related to a safety- related system, no further action is required.

- Evidence of steel choker use abuse was verified in the evaluation of IN-85-581-001. The true use of these chokers in cable pulling must be emphasized to QC inspectors such that choker use was limited to pulling in open areas. Also, the motor feeds to the unit-1 Reactor Coolant Pumps had been verified to have been pulled with excessive MPT (CATD 10900-WBN-03) (QR).

The line management response was:

Although steel choker abuse was verified, there is in force existing procedures to control pull tension on all cables pulled at WBNP. G-38 specifies the procedure for pull force monitoring, as does MAI-3 and QCI 3.05. All unit 1 systems at WBNP have undergone preop and functional testing. Additionally, all medium voltage cables are tested under the Plant's maintenance schedule. As referenced in IN-85-262-003, EQC personnel stated that a steel choker was often loosely placed over fuse links on large cable pulls to prevent a cable

7.2.1.2 Site Specific - WBN (continued)

from injuring a worker in case the fuse link suddenly breaks. The unit 1 reactor coolant pump motor cables were megger and DC High-Potential tested. These cables had a maximum allowable pull tension of 4000 pounds outboard and 6000 pounds inboard. As these cables are not class 1E cables, failure of these cables would be a rare random occurrence and will be remedied on an individual basis. The Watts Bar Construction Project and Modifications Branch will inform employees through the employee involvement and/or safety meetings of the use of steel chokers as an industrial safety precaution.

- NCR W-283-P was written to document unidentified cables throughout the plant. NSRS report I-85-362-WBN also identified this problem in the manholes. The corrective action consisted of accounting for all unidentified cables. WBN Modifications initiated workplans NW283P-1 and M5515-1. The work consisted of identifying all unidentified cables. All cables not in use were pulled out or spared when covered with Vimasco cable coating. Those still in use were to be marked with red and orange tape along their entire length and placed under the Temporary Alteration Control Program. WP M5515-1 also required MAI-3 and AI-2.15 (the ONP procedure for Temporary Alterations) be revised to add identification for temporary cables. All work on these workplans was complete except for the revision to AI-2.15 (CATD 10900-WBN-04) (NQR).

The line management response was:

NCR W-283-P is in final closure and workplan NW283P-1 is complete. Workplan M5515-1, which worked the items identified by Employee Concern I-85-362-WBN, is in final review with all items complete except that the Electrical Maintenance section has yet to revise AI-2.15. The revision to AI-2.15 is to include instructions identifying temporary cables installed in cable trays. At completion of the revision to AI-2.15, workplan M5515-1 will be closed and sent to the vault.

7.2.1.2 Site Specific - WBN (continued)

- It was verified in several interviews with electricians that training for craft management and electricians was needed to emphasize the reasoning behind the new cable pulling procedure (reason for SWP calculations, break ropes, etc.). The interviews indicated that the electricians saw no need for these new procedures and followed them only when forced to by a QC inspector (CATD 10900-WBN-05) (NQR).

The line management response was:

Additional training will be given to those electricians involved in cable pulling operations. The attached November 4, 1986 memorandum has been issued regarding in-process inspections, such as cable pulling operations. This has been previously discussed with the electrician superintendent. Training is expected to be complete by March 27, 1987.

- Although Yellow 77 has been banned from TVA nuclear plant sites, the computer program which lists all material in storage warehouses at all TVA plant sites (Materials Management System) indicated this material was at WBN, BFN, and BLN (CATD 10900-NPS-06) (QR).

The line management response on a corporate level was:

Use of Yellow 77 as an acceptable cable pulling lubricant was discontinued by Revision 3 of G-38 on September 27, 1982. DNE will issue a memorandum to all nuclear sites by June 1, 1987 to remove all unused portions of Yellow 77 from their respective sites.

7.2.1.3 Site Specific - SQN

- Corrective actions for SWP, MPT, and MBR issues were generic and were as given in section 7.2.1.1.

The line management response to CATD 10900-NPS-01 for SQN was:

To determine the magnitude of the SWP applied to SQN cables during installation, TVA reviewed all conduits containing safety-related cables against screening criteria. This was used to determine 16 of the worst conduit sections. The maximum SWP of cables within these conduits were determined. These values were compared to maximum SWP values determined from testing at TVA's Central Laboratories. The SQN values were less than those determined in testing. The overall conclusions of TVA's testing were confirmed by the report of a third party reviewer. TVA has, through the above testing and analysis, conclusively demonstrated that the practices employed during the installation of electrical cable at SQN maintained the adequacy and integrity of Class 1E cable with respect to SWP.

TVA practice of monitoring total tension rather than individual tension, does assure individual conductor strength limits are not exceeded, and is consistent with IEEE 690-1984. In fact, TVA practice is more conservative as since August of 1978 DNC takes 80 percent rather than 100 percent of individual conductor strength on multi-cable pulls.

TVA's EEB has used NSRS report I-85-06-WBN in addition to the manufacturer's requirements, to form the basis for its evaluation of MBR. Each of the areas of potential concern is being resolved into elements for further analysis. In each case the actual bend radius to which a cable has or could have been subjected is determined. In particular, EEB has identified

7.2.1.3 Site Specific - SQN (continued)

the elongation stress, to which a cable is subjected as the result of a bend, as the critical parameter in determining acceptability. Preliminary conclusions of the study indicate that this worst case bend at SQN does not reduce the cable's available elongation properties below that required for it to perform its safety-related function. The final report is expected to be issued in March 1987 for SQN.

The effects of a reduced bend on shielded medium voltage power cable and coaxial, triaxial and twinaxial cables will be evaluated separately. EEB has issued project specific actions for the evaluation of these cables. These actions will include field inspections for the existence of pull boxes or conduits of any type in which the cable is bent as well as individual inspections of a cable's bend radius. The actual bend radius will be determined and the resulting effects on the integrity of the cable will be established. The work is expected to be complete by March 1987. The work is being tracked by SCR SQNEEB8703.

SWP was a SQN restart item. MBR was not a SQN or BFN restart item as defined in Revision 3 of the corrective action plan.

- It was verified in interviews and in walkdowns that there were cables routed outside cable trays. The intent of G-38 concerning cable routing was not to allow cable to be routed outside of cable trays (CATD 10900-SQN-01) (QR).

The line management response to CATD 10900-SQN-01 was:

An evaluation will be performed on cables routed outside of trays to determine the potential areas of concern. In particular this evaluation will consider the potential impact on electrical separation, cable ampacity, physical support and protection of the cable, and adequacy of tray supports. A field inspection will then be performed to locate and determine the extent of cables routed outside of trays which are subject to the concerns evaluated above. This process

3.2.1.3 Site Specific - SQN (continued)

will continue until it is determined that all such cables with a potential concern are identified and the configuration justified or modified.

- Although M&AI-4 contained provisions to monitor pull tension for Class 1E cables, there was no requirement to monitor non-Class 1E cables. G-38 did not make this distinction (CATD 10900-SQN-03) (NQR).

The line management response to CATD 10900-SQN-03 was:

To prevent further recurrences the site procedure has been revised to comply with G-38 regarding cable pulling. M&AI-4 now requires monitoring and documenting the pulling forces used in the installation of non-Class 1E cables (with certain listed exceptions as contained in G-38).

The few associated cables (i.e., non-Class 1E cables routed in raceways designated for Class 1E circuits) that exist at SQN were pulled to the same requirements as Class 1E cables. All systems (including non-Class 1E cables) have undergone Pre-op or functional testing. Additionally, all medium-voltage cables (i.e., 480-volt equipment rated at more than 100 horsepower and 6900-volt equipment) are periodically tested under the plant's maintenance schedule (MI-10.20).

The inclusion of non-Class 1E cables in G-38's requirement for monitoring pull tension is an economic consideration only (to preclude damage and thus wasting material) and is not a safety-related concern. Failure of these cables would be a random occurrence and will be remedied on a case-by-case basis.